Functional and Conceptual Design
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Lecture No. 19
Product and Portfolio Architecture

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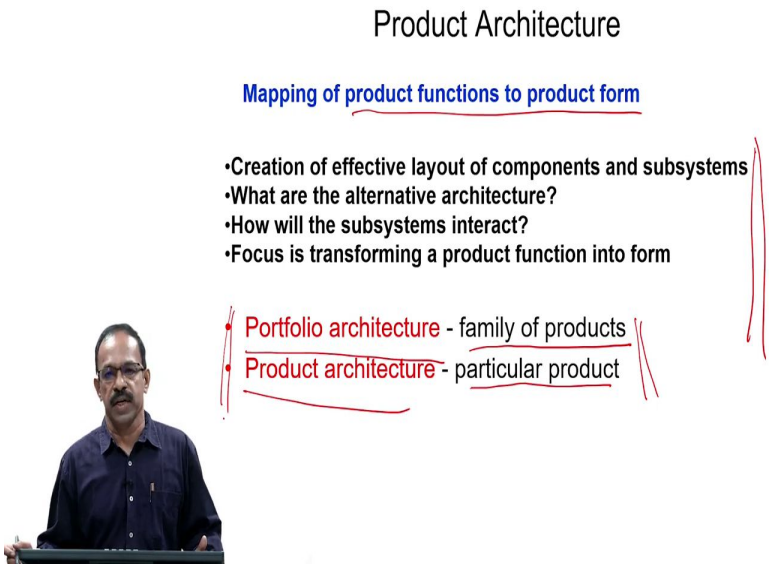

Good Morning, welcome back to the course on functional conceptual design. So, in the last class we briefly introduced Product Architecture. From the functional design we move to the design of the product in terms of its architecture, where we tried to map the product functions into product form. So that is what the architecture is.

And we found that the creation of architecture has a lot of influence in the design of the product. There are 2 types of architectures we normally encounter, the first one is known as the Portfolio Architecture and then the second one is the Product Architecture itself.

Portfolio Architecture talks about the family of products; how many products should be there in the product family and Product Architecture talks about how to architect an

individual product. So that actually depends on the number of products in the family so these two are interconnected.

You need to design the architecture of the product based around the number of products in the family and how do you want these products to share the components. So we look into these two aspects of product development which is Portfolio Architecture and Product Architecture.

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And yesterday I briefly showed these kinds of products where you can see each product is independent of the other one. There is nothing common to these products; the handle is different, the tool tip is different, and each one is an independent product. But in the case of this kind of product, you can see this is a toaster where you have a toaster with a 2 slice of 2 breads can be toasted or here we can have 4.

So they are two independent products so customers can decide to go for a 2 slice or a 4 slice toaster. However, when designing the product you need to see how best he can utilize the resources in order to get these products.

For example, if you have to make both the products completely different, then the cost of production, cost of design, cost of manufacturing everything will go up. But you can actually have many things common to both the products and therefore, by properly designing the architecture of these two products you will be able to make the products very cost effective and at the same time you can have you can have variety in the product availability also.

And here you can see the kind of film rolls where you can have the number of films available. Each roll can be different, and there can be many things common outer cover can be constant, the same center portion can be the same but still you can have a variety in the market. So, this is the way how any manufacturer will provide variety in the market. But how many products to be offered and how we decide the individual specification of each product or within the family matter a lot when it comes to the market and then satisfying the customer requirement.

That is why architecture becomes very important. So whether to have many products in the family or can have only just one product and then how these products need to be architecture matters a lot. That is why we have these two architectures, Portfolio Architecture and Product Architecture need to be understood.

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Portfolio means a set of different products that a company provides, and architecture is the layout of the components. So how you lay out the components within the product is basically the architecture and the set of different products that a company provides is the Portfolio. Now, what actually decides this Portfolio Architecture is the cost and revenue.

How much will be the revenue that you can generate, how much the product is, that actually decides how many products could be offered in the market. Because if the requirement is very small there is only a very small number of customers for a particular variety of product then there is no point in developing a product for the customer segment because the cost and revenue wont workout well.

This needs to be understood before we decide how many products to be there in the family. And the Product Portfolio Architecture is the system design strategy for laying out components and systems on multiple products to best satisfy current and future needs.

So, we have multiple products in the Portfolio Architecture so in this multiple products how best we can arrange the components keeping in mind the current requirements of the customer guess currently there will be some requirements for the customer but after 1 year customer requirement may change so we need to keep this also in mind when you do

for the portfolio architecture so that after 2 years you should will be able to easily modify the product to made the customer requirements.

So the current requirements as well as the future requirements need to be taken into account when we decide the number of products in the family and the architecture of the product. So, the design task here is to determine whether one might develop subsystems within the product that can be reused across different products.

The question is can we have some kind of subsystems in a product so that this subsystem can be used in a multiple product that you do not need to separately develop for each product within the family. So, we can have some kind of subsystem which or some subsystem can be made common to all those members in the family so that you can easily make the product and sell in the market.

Few things will change but many things can be the same for all the products and therefore you will be able to offer variety without much difficulty. So these are the things to be understood when we look for the Portfolio Architecture. First we will look at the type of architecture existing in the portfolio or what are the ways in which Portfolio Architecture is classified and how one can decide what kind of an architecture to be used for the Portfolio or the family of products that is what we are going to see.

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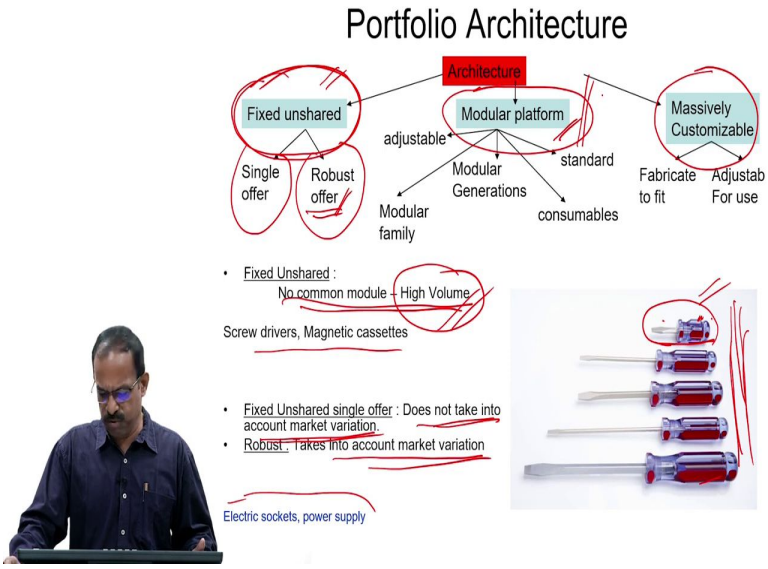

If you look at the portfolio Architecture as a whole, you can actually classify them into 3 major categories that is the first one is known as a Fixed Unshared Architecture the second one is Modular Platform and the third one is known as Massively Customizable. These are the 3 major categories of a Portfolio Architecture existing in the current market.

And many times this will be used but some of them will be preferred over the other considering the particular product and its specific characteristics, but most of them will be always following a particular architecture called Modular Platform.

But let us just look at the first category which is the Fixed Unshared Architecture. If a company decides to make 5 products to bring to the market and if they decide if they feel that I can be offered in the market and there is need not be anything sharing in these 5 products. And that kind of architecture is known as Fixed Unshared Architecture.

The family will be having many products but these products will not be having anything in common. Each one will be independent and it will be having its own components

which are not shared with any other products within the family. That kind of an architecture is known as Fixed Unshared Architecture.

Typical example is this screwdriver set. You can see these screwdriver has got its own handle and the tool tip also and here also it has got its own handle and which is different from this one and this tool also different similarly this is different from this, this one is different from this, this one is different this one so each one is completely independent that is nothing sharing between these products and that kind of an architecture is known as Fixed Unshared Architecture.

That means you have products in the family but the products do not share anything between themselves is known as the fixed unshared architecture. One of the typical examples is this one and like that you can see many products in the like hammer sets or spanner sets will be seen in the market so there will be many such products which actually go for Fixed Unshared Architecture.

A company can go for this kind of architecture only if there is a large demand for the product because if this product has to be made if they can make it in thousands they do not mind going for a design for this one special design for this and special design for this because the can make large numbers and cost of manufacture per unit will be less.

If there the requirement is only 10 or 15 or each one of these then making each one separate will be very costly that therefore, a Fixed Unshared architecture is opted only if there is a large demand for these products. So, that is the Fixed Unshared Architecture. So, whenever there is a large demand for this product will go for the Fixed Unshared Architecture.

In the Fixed Unshared unit itself you can actually have two categories known as Single Offer and Robust Offer. So, basically it says that in Fixed Unshared it is a Single offer; only one type of products in the market there is no variation to that all over the world it

will be the same so there is no variation in that but Robust offer still which is in a Fixed Unshared Architecture.

In the Robust Offer, it may provide you some kind of flexibility in the market to meet some specific requirements. For example, if you have a power supply unit where you want to connect to the wall socket you need to have some variations within the countries. So, if you use something in India you will be having these 3 pin configurations. But if you use it in some other countries it may be 2 pins or the pin will be different in other countries. Even if it is just 3 pins geometry will be different.

To that extent there will be variation and that kind of offers are known as Robust Offer. So, these are the two variations that can be there in the Fixed Unshared Architecture. So, there is no common module and its high volume for Fixed Unshared and the Screwdrivers, Magnetic cassettes are examples for this and the Fixed Unshared Single offer does not take into account market variation.

So, if it is a Single offer one, it would not really take care of the market variation and they assume that every market can actually take this and sell it. Sell it as a product. But the Robust Offer will take some examples that take into account some market variation specially the power sockets and other things in the electric sockets, power supply etc in the product that is the example for Robust offer.

So, this is not a very commonly used Architecture the Fixed Unshared is very rarely used specially when there is a High Volume requirement for a product, then the can go for a Fixed Unshared Architecture that is cost effective the cost and revenue matches in this case or you can still make good profit but when that is not when the volume is very small or not worth going for a Fixed Unshared Architecture, then we need to go for the Modular Architecture. So, that is the second Architecture which is the Modular Platform.

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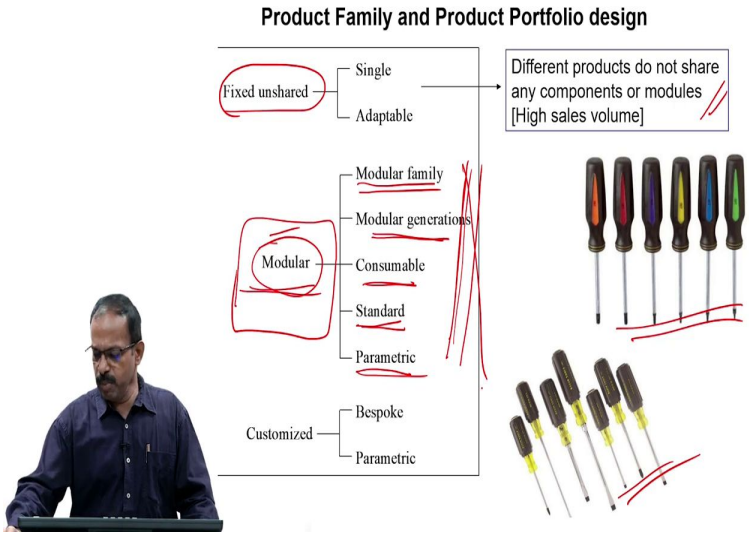

So, let us see this one, the different products do not share any components in the Fixed Unshared architecture and these are the examples for the Fixed Unshared Architecture. Screwdrivers and Spanner sets etc., you can see as an example for Fixed Unshared Architecture. Modular, the name itself says that it can be made of modules. So a product will have multiple modules and then these modules can be shared within the Family and that kind of an Architecture is known as Modular Architecture.

If there are 5 products in the family and the company decides to have 5 variants of a car in the market, for example, if Hyundai or Honda city wants to have 5 types of city models in the market. So, they cannot have each car as completely independent because that is not cost effective because each model is the number of units they can sell will be very limited.

So, what they do is they make the modules within each one will be having multiple modules, each product will be having multiple modules and many of these modules will be shared among the models. And only a few things will change in between the models.

Actually you can have different models in the market but there will be many common things in these products.

So, that kind of an Architecture is known as Modular Architecture. This is the most commonly used Architecture in Portfolio Development. It will check what modules can be developed separately and then can be shared among the family members. This has different variants too. As I mentioned the product should look at the current requirements of the customer.

Guess currently customers will be having some cost requirement, some performance requirement, some safety requirements etc., but after 2 years their preferences will change. Now after 2 years if they meet the customer requirement they cannot go again for designing a completely new product. So, they have to build up on the existing product and then make it suitable for the customer after 2 years. So they have keep that in mind what are the things going to change in the future so that also need to be taken into account when they design the module within the product so that is the another one requirement

Similarly, there will be a product which may require something which will be consumed very often so then you have to make that same model so that only can be changed or that consumable can actually be made different for different products so this way you will be getting different architecture for the product.

So, the Modular Architecture can be divided further into categories like a Modular Family, a Modular Generation, Modular Consumable, Modular Standard and Modular Parametric. So, these are the different categories within the Modular family that you can see. We will see each one what is the significance of each of these architectures.

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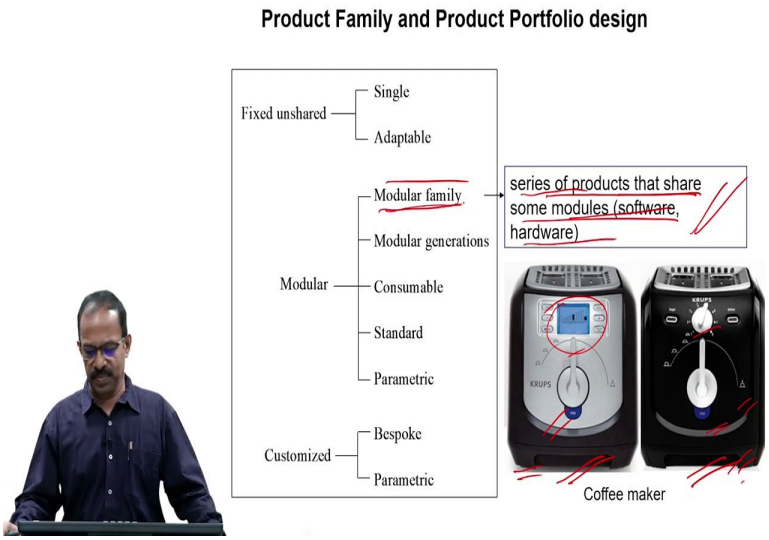

So, the Modular Family is a series of products that share some modules. That is the simple explanation for a Modular family. In most of these there will be a basic platform and on the basic platform we will add many modules; for example, the car will be having a chassis and you will be having modules for the transmission, a module for the engine, a module for the air conditioning and module for the steering system and a module for the dashboard and things like that.

So, each one can actually have a module. As such we will be having many modules in the product and this module will be shared amongst the models within the family. So, if you buy a Ciaz high end car or a low end car, there will be many things common in both these cars and very few things will be different.

This way if they can actually share the modules, software and hardware, then we called this as the Modular Family of products. This is known as the Modular Family where the modules are shared amongst the family members; that kind of an architecture is known as Modular Family.

For example, you take this Coffee Maker, so this Krups company is actually offering two products in the market. Somebody who is interested in going for a very high end and very nice product with lots of electronic controls and all, they actually opt for this one and somebody who is looking for a low end product they just want the function to be there coffee to be made they don't really care for the appearance and other things then there is a product for them.

So, this product can cost cheaper and this can be a costly one. Now, if the company has to offer these two products and if they make it completely independent, then there will be a lot of cost involved in the production. So they will make many things common, probably inside the heating element or the container and the way the containers are assembled.

Those things may be the same but the control and the display the control knobs display. These things can actually be made different so you will be getting a different product. So many things will be shared within the product, within these products but still the product will be different for the customer so that kind of an architecture is the Modular Family Architecture.

And you will see large number of products in the market is actually belong into this Modular Family where it is your Washing machine, Mobile phone, Television sets any product you take you will see that there are many product variants available in the market and most of these variants will be having many things common within the product architecture. So, that kind of an architecture is known as the Modular Family Architecture.

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Now, these are examples for the modular architectures as you can see all these products will have a lot of things shared amongst themselves. So, this toaster if you look at this toasting an element or the heating element will be common for this except that they are actually combined them and made it in separate one and the little bit of change in the control and other things will give you a different product with the 4 slice capacity and this will be a 2 slice capacity

So, a customer who is looking for a 2 slice he can actually buy low-cost and the somebody wants a 4 slice one they can actually get it by paying an extra some extra but the manufacturer need not make everything completely separate there will be sharing many of these things between these two products. That is the case with most of these products when your camera mobile phone iPad and printers so all those things will be able to see these kinds of sharing of modules. So, that is the modular family architecture. The set of products that are supported any one of the time by a platform. Always, all these products will be having a common platform supported by a common platform and they will add the modules. So, by changing some modules will get a new product but the basic platform will be almost the same.

That is how most of the company manufacturers are able to bring multiple products in the market because they have a common platform to which they will keep adding modules and some modules will be different compared to the other; so that you will get a variation in the product variety.

Here we can actually have different derivatives for the product by using a Modular Family Architecture you will be able to create the variance of the product you can actually have a cost variant that if you want to have a low cost and high cost product, so the low cost you can actually have some kind of some modules can actually be changed so that the cost will come down and if you are looking for high cost money you can actually change the module with the high cost element or high quality elements can be used to get a costly, costly products

This is possible because these are all modules can be changed by without changing the whole product; some critical modules can be changed to make it a better product and the cost variant and you can have product line extensions if you want to have like you know 2 slice, 4 slice or by bigger size. Like washing machines you can have different capacity washing machines. Many things can be common but only the motor and the drum size and things can be changed to get various capabilities or capacity. That is the product line extension.

It is basically to meet the customer needs because there will be customers who ask for various requirements and by providing this kind of variance you will be able to satisfy those customers. And additional features to address more difficult customers. Some customers may require very specific needs so we can actually add those needs or those modules into the product and then make it a much enhanced product or a high end product for the customers.

These are the ways in which actually you can provide multiple products in the market without changing the basic platform and without having it as a completely new product you can change the modules and then modify the product to get a different variant of this product and that is how the manufacturers are able to offer multiple products in the family. So, this is one of the most commonly used architecture modular families.

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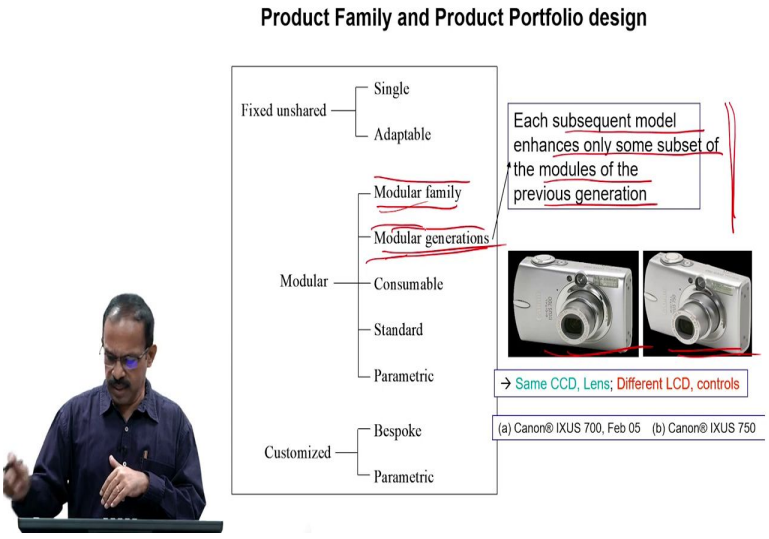

The next one is basically known as the Modular Generations. It is also a kind of modular product only so in this case you are not looking at the products currently to be offered in the market. The model family looks at how many products I need to offer currently in the market. So, if a company is trying to introduce a new washing machine to the market they need to see what kind of variants that we can offer in the market.

So, that a large customer segment will be happy in terms of cost in terms of capacities is in terms of water consumption or whatever it is. They can actually offer different variants of the product using the modular family. But the modular generation is looking at it in a different way, they are looking, now I can offer five products in the market but then after 2 years if I have to offer the product, can I offer the same product or you need to change

it completely? What will be the changes in the customer preferences over the period of maybe 2 years or 3 years depending on the product?

Now, if the company can offer a new product in the market to meet the customer requirement at that point of time after 2 years can we use the same platform and the same product change a module in order to meet the customer requirement? So, by looking at what is going to change in the future you make that as a module and then make sure that if you want to offer a new product in the market, you can actually change this module and insert a new module and then bring it as a product so that customers in will be happy at that point of time.

That is what actually happens in most of the electronic products. Guess if they offer a product today in the market after 1 year people will be looking for better features in the product. So, you can see each subsequent model and hence only some subset of the modules of the previous generation. So, some modules in the previous generation will be modified to meet the customer requirements of the current generation that is known as the Modular Generation Architecture.

So, typical examples are the cameras and other electronic products because today there will be LCD displays and after 2 years the display may be changed into something else and then people will be looking for that kind of a display in the product. So, the company cannot scrape the whole product and then make a new product, so they can actually have the only display module that can be changed to a new technology so that they will be able to offer something which actually meets the requirements of that generation.

That is the processor capacities, the RAM capacities etc., are actually added to the system so that, that system will meet the requirement of that particular generation this is known as the Modular Generation Architecture. So if there is going to be some change in the future then we need to think of a Modular Generation Architecture.

If there are not many changes expected, then we go for a Modular Family Architecture. So, this Module Family is normally employed in automobiles and products where actually the changes are not so drastic every year; there will not be too much of changes in the technology or the expectations of the customer.

They can actually go for Modular Family but in the case of electronic products most of the time they need to keep this in mind and then go for Modular Generation Architectures so that they can meet the expectations of the next generation or after 2 or 3 years. So, that is the Modular Generation Architecture.

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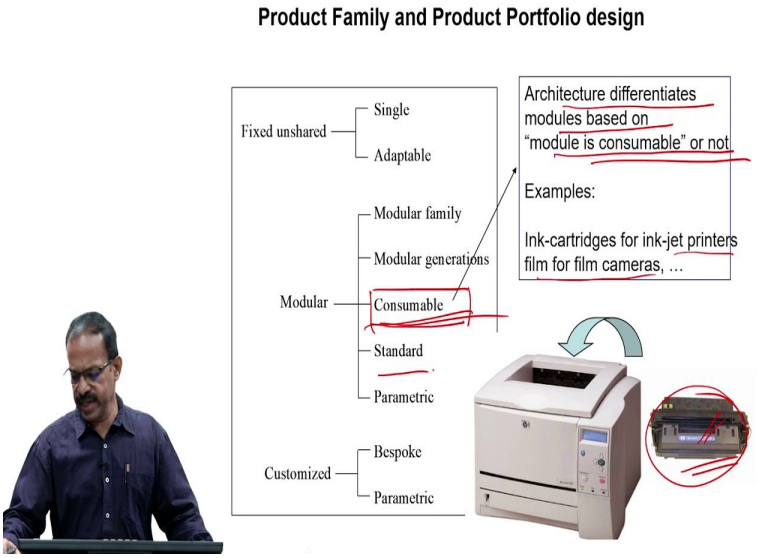

And the third one is known as the Modular Consumable Architecture Here, the architecture differentiates modules based on whether it is consumable or not. So, it is a very small number of products to actually fall into this category. Suppose there is a product and there are some consumables coming in the product and these consumables may change depending on the region or depending on the situation then we can actually make that as a module and then offer the product with this consumable as a separate module. This is known as Consumable Module.

For example, in the printer the toner is consumable; in this case they should make this as a module so that you can actually attach any kind of compatible consumables to this product and even if there is a change in the consumables use, you can still offer this product by changing the consumable and making sure that the consumable can actually go into the product. This is known as the Modular Consumable Architecture. This ink cartridges for Inkjet printers, Film for Film Cameras etc., are the Consumables Architectures. And the next one is Standard Architecture.

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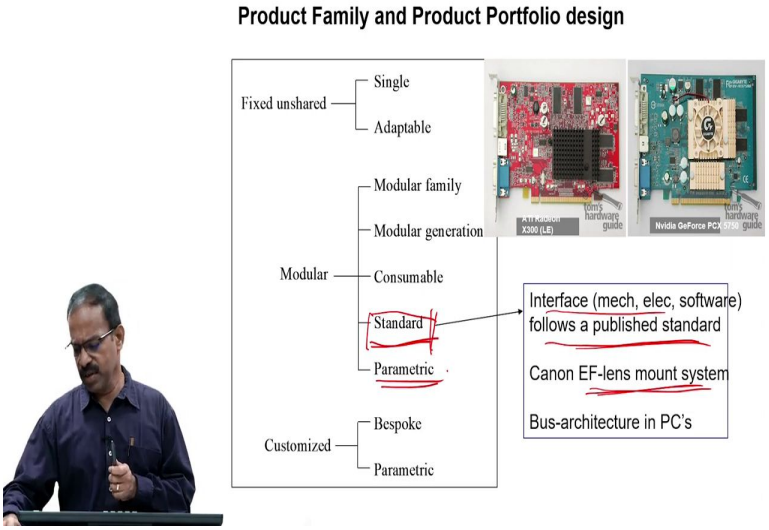

So, Standard Architecture is basically to look at the current standards of manufacturing and design so that there will be a lot of standards followed by industry in making products. That is a communication standard, interface standard and standards for connecting hardware to software and things like that, so we need to follow these architectures in the product.

Whenever there is a standard available for a particular product or a particular component we will try to ensure that this product meets that standard and then we will make part as a module so that whenever there is a change in standard or there is a need to change this

component with the different component which actually the same standard, we should be able to modify the product as per the requirement standard and that is known as the Modular Standard Architecture.

We follow the published standard in mechanical, electrical and software interfaces and then make sure that this product meets the industry standards; so that any product or any component which meets the standard can actually be interfaced. For example, the lens mount system in the cameras so you can actually see the camera structure will be there and you can actually mount the lenses so these are actually having a lot of standards in this design of such lengths and bounds.

Whenever there is a compatible stand compound which actually meets the same standard we can easily attach to this product and then can be used as a it… it can be used to meet the requirement of the customers so that is the Modular Standard Architecture. So, this is also not I mean that most of the companies need to follow this, but that will be coming from the existing standards so more than the customer's requirement this is coming from the industry standards. And the last one in this one is known as the Parametric, Modular Parametric.

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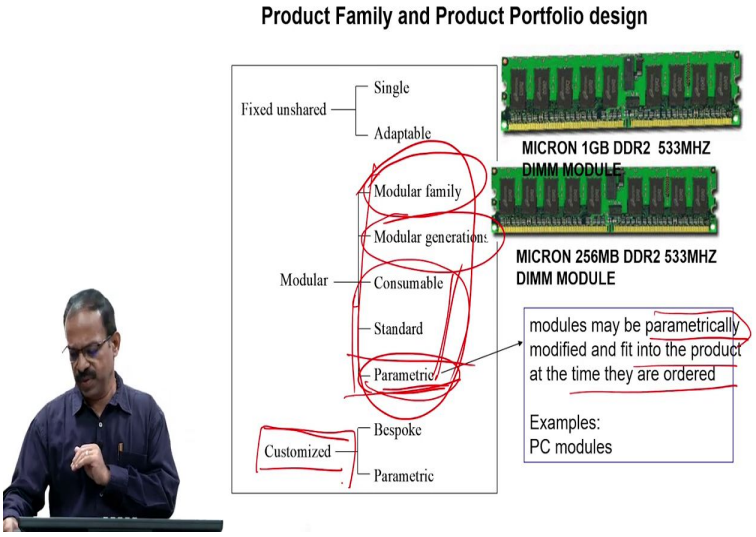

Modular Parametric is exhibited by changing the motives parametrically and fitting into the product at the time they are ordered. So, this is basically like if a customer requires a particular size or shape of a component or a product, you can modify the existing modules to meet that particular parametric limitations and then fit into the product that is known as the Modular Parametric.

In the case of a computer customer will say, I need to have a particular size of the product. Overall product I want this much only and I want to have a particular hard disk hard disk capacity, a particular RAM capacity etc. Depending on those parametric requirements you can actually fit those modules into the main platform and then generate the product that is the Modular Parametric Design

These are the 5 categories of modular family architecture which is basically used for the Portfolio Design and this you so this actually is Modular Family is the most commonly used one and modular generation is considered whenever there is an expected change in some of the requirements of the customer over a period of time.

Others are depending on the product's architecture rather than the customer's requirement. Of course customer requirements also play a role but it is more from the designers point of view to offer this kind of architecture. So, that is the Modular Architecture for Portfolio Design. I hope you are able to follow in case you have any questions please feel free to email me or ask me whenever we get an opportunity.

The last category is the customized one. So, customizing a product is actually modifying the product according to the requirement of a customer. That is basically the Customized Architecture. You are not going to offer too many products in the family as directly to the market; but look at the customer and if a customer is asking for a particular kind of architecture or particular product with some particular features, then you try to offer that as a product, one time offer of a product and that kind of architecture is known as Customized Architecture.

Only very few products offer this kind of architecture especially when there are very high end products like that you would not have a high end car and especially companies like BMW and all they offer customized cars. You can actually tell what you are expecting from your car; you can tell the color you can tell the engine capacity, the speed requirements etc.

And based on all these requirements they will actually create the product and give it to you. So, they will be having a basic platform and they will be having different modules to attach then depending on the customer's requirement they will add these modules to your products. So, that is basically a Customized Architecture.

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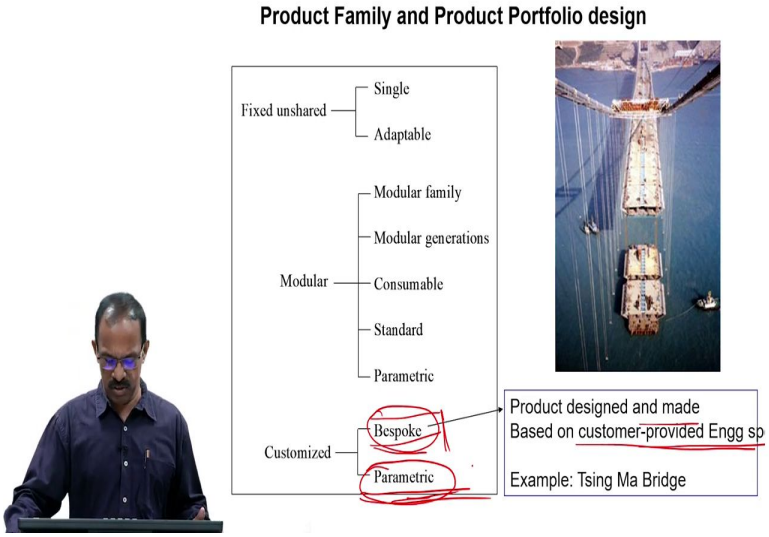

Here there are 2 types. One is known as the Bespoke and the other one is the Parametric. So, in Bespoke the product is designed and made based on the customers' engineering specification. So, the engineering specifications are given by the customer then you design the product accordingly and give. That is known as the Bespoke product.

This kind of thing normally happens in very high end products or something like fighter aircraft. If a country wants a fighter aircraft with specific requirements and they will give all those engineering specifications and then give this to the company and tell that now with these are the specifications we are looking for make one and give it to us. So, that is the customized design for the product and that is known as Bespoke Design.

The other one is Parametric; Parametric type is the one where the company has got many modules of various size, various dimensions, various capabilities of various parameters so the customer can say, my engine capacity should be this much and then they will say, my overall length and size should be this much, my seating capacity should be this way and my steering characteristics should be like this so I need a power steering or need a manual steering.

So, this way they can actually say okay these are the requirements and company has got this modules they have a power steering module they have manual module and they have an engine, various engine capacities available so based all these they used from the existing module they choose the module and assemble and give it that is known as the Parametric Design for the Customized Platform.

The first one is more on the there are no modules available with the manufacturer as per the requirement. The customer will give the engineering specification and the manufacturer to make accordingly and then give it that is the Customized Bespoke Architecture. But the Parametric customer will choose from the existing modules and then get the products. That is the Customized Parametric Design.

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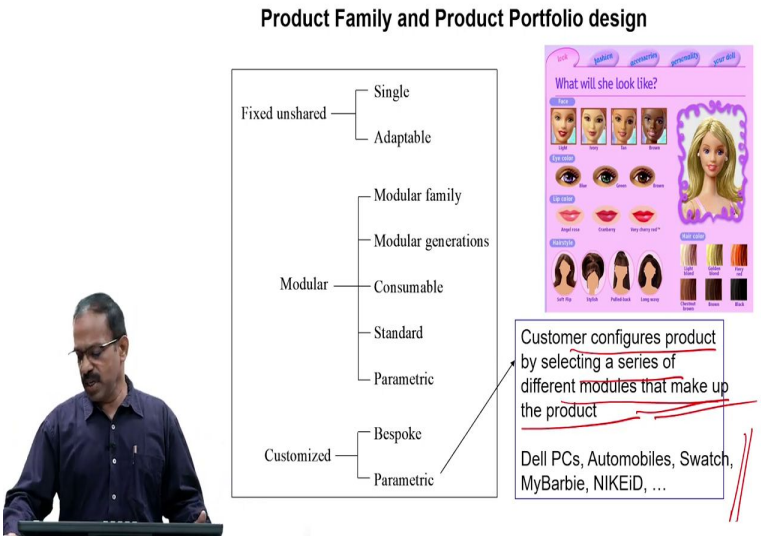

The customer configures the product by selecting a series of different modules that make up the product. For example, while buying a computer we tell the computer supplier or the manufacturer, these are my requirements and they will be giving different options for the computer and then you choose, this is my option then they will actually base on that

they will make the product and give it to you. So, that is the Parametric Architecture Customized Parametric Architecture for Portfolio.

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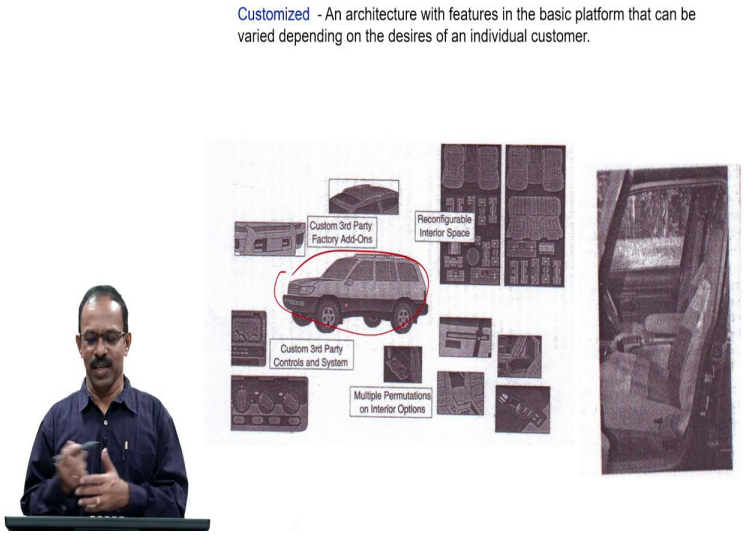

Alright so that is all the Portfolio Architectures so, Customized we already saw that the car can actually be designed based on the customer's choice of various modules and then they assemble it and give it to you. That is the customized one.

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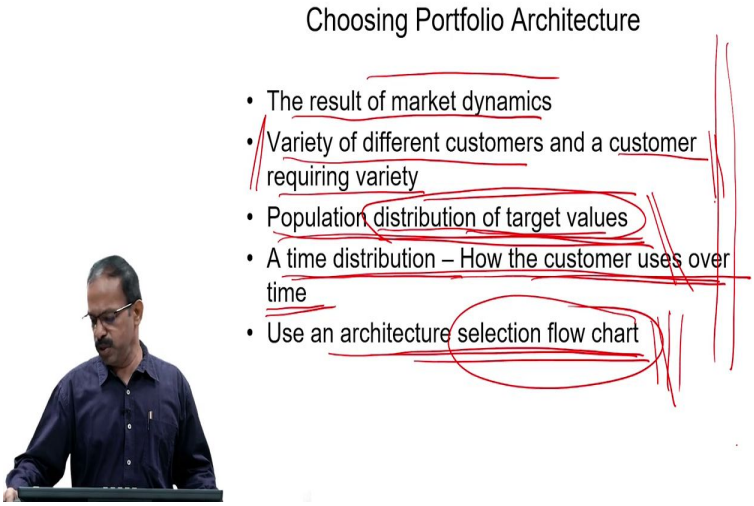

Now we saw that this main Architectures available can have a Unshared Architecture where there is no sharing of modules or components between the product, then you can have a Modular Architecture where there will be lot of sharing of Modules between the and within the products, this module can actually the Modular architecture. With the Modular Architecture you can have different ways of getting the modular architecture by Modular Family or Modular Generations or Modular Consumable like that.

Now, the big question is how can I choose the architecture? So, what are the criteria for choosing an architecture, on what basis a company can decide to go for a Modular Family or Modular Generation or a completely Unshared Architecture? This is the question for the designers.

The designer has to take this decision though the data comes from the customer and finally the designer is the one who actually decides how many products and be offered what would be the way this product should be architected at and that is what were the elements in the product can be arranged so that we can have that many products but it meets the customers' expectations.

So, as I told you it actually is the result of market dynamics. When I say market dynamics it actually involves the cost of the products, the number of units that can be sold and the changes in the market segments and how fast is market is growing or how fast growing market is changing with respect to time with respect to the design parameters or the customer requirements so, all those is actually affecting the choosing of Portfolio.

We know that there are a variety of different customers and a customer is asking for variety. So any product you take and you want this to be sold in the market, you will see that there are large variety of customers, customer will be having or customers can be segmented based on various criteria you can actually see that there are young customer is there are old customers or there are children who buy the product.

Or customers can be segment, housewives will be preferring something college going people will be preferring something adults would be adult male will would be preferring something. So, like that you can see there are a lot of customers in the market and each customer will be actually asking for the variety. So, today they will be asking for something and tomorrow they will be asking for something so there will be a lot of variation in their preferences also.

How do we actually meet these requirements? How do we actually address the requirements of varied customers and the customers asking for different varieties? So, one way to look at this is to see what is the distribution of the customer requirements across the population, that is, you have a large set of customer population say that for example you say that there are thousand people you can identify for a particular product.

Now, you have to find out what the target values is or how the target values are distributed within the population. Take a simple case of a mobile phone, you ask 1000 people what will be the approximate cost you are ready to pay for this product, that is one

target for the cost of the product. If you ask this population will actually see that there is a large variation, cannot be a single value. So, there be a large variation and then you need to see how this target values are distributed over a period of distributed within the population

So, that is one criteria that you can use and then you are to see a time distribution how the customer used over a period of time today there is some requirement and maybe after 6 months then their requirement will be changing. In what way the customer preferences are changing over a period of time and then using this information. You can use an architecture selection flowchart to select what kind of architecture to be used for this particular product.

That is the way designers can decide which architecture to be used and how many products to be offered in the market for that particular family. So this is the next step that we have to do first . We need to go for a population distribution of target values and then we have to look for a time distribution for a target value and then we use a selection flowchart to get architecture to be used.

We will see this in the next class. How do we actually use a selection flowchart to decide on the type of architecture to be used for the Portfolio we will discuss in the next class? Okay thank you very much I will meet you tomorrow.