Six Sigma
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Lecture - 59
Design for Six Sigma (DFSS): DMADV, DMADOV

Hello friends, I once again welcome you to our ongoing journey on Six Sigma and we have completed DMAIC; Define Measure Analyse Improve and Control phases of a typical six sigma cycle. We have seen in detail each and every phase and now finally, before we close this course on six sigma, I would like to discuss some of the six sigma implementation issues and challenges. So, let us have lecture 59 that is designed for six sigma DFSS DMADV and DMADOV, some other structure which are also very popular in conducting six sigma improvement projects.

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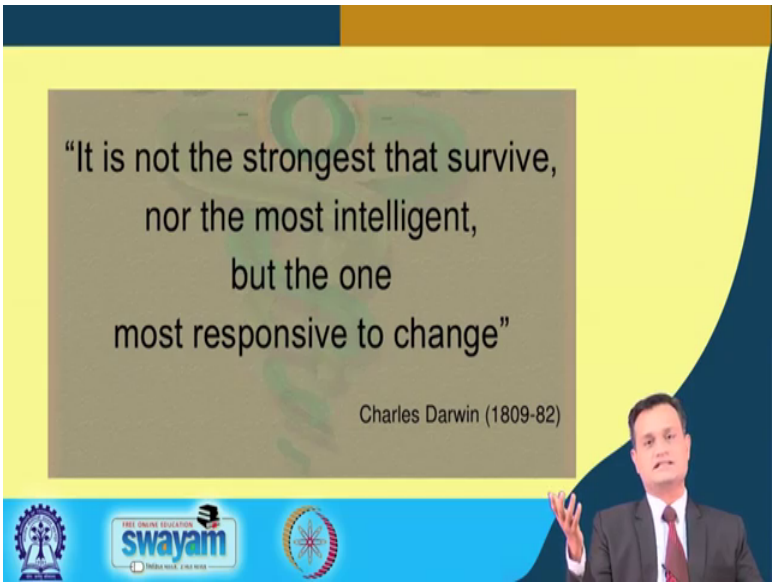

So, let us begin with a very good inspiration and Charles Darwin we all know, a great contributor in the history of mankind. He says that, "it is not the strongest that survive, nor the most intelligent, but the one most responsive to change". You, just see that how beautifully, maybe in the 1800 or 1882 when he was there, he gave such a great philosophy. So, it is not the strongest that survive, not the intelligent, but the one who is most responsive to change. So, you might be at two sigma level response to change, restructure the processes,

look at the benchmarks, strive for the best in class performance, jump to four sigma. Once again tighten your control, set the aspiration, move to five sigma, six sigma and this journey is never ending. So, your ability to respond to change basically decides your survival and this is where say Charles Darwin had given such an excellent inspiration.

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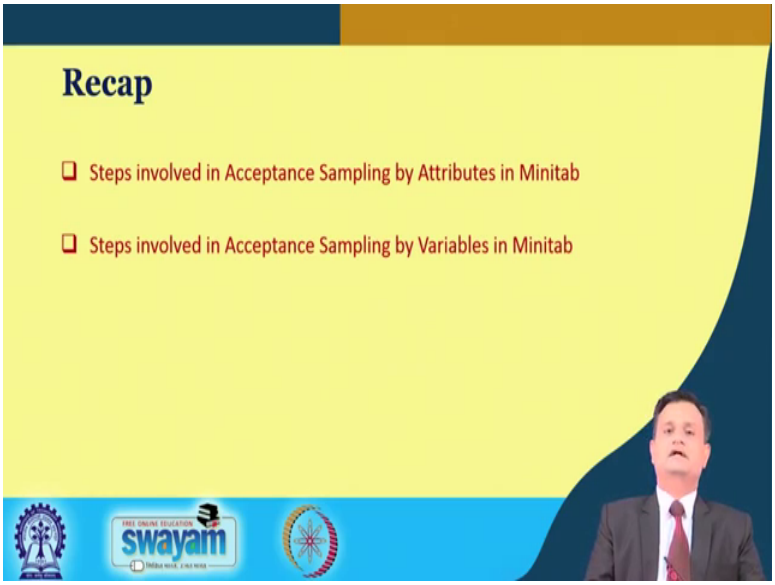

So, we had discussed the Minitab application for acceptance sampling plan, attributes as well as variables in the last lecture.

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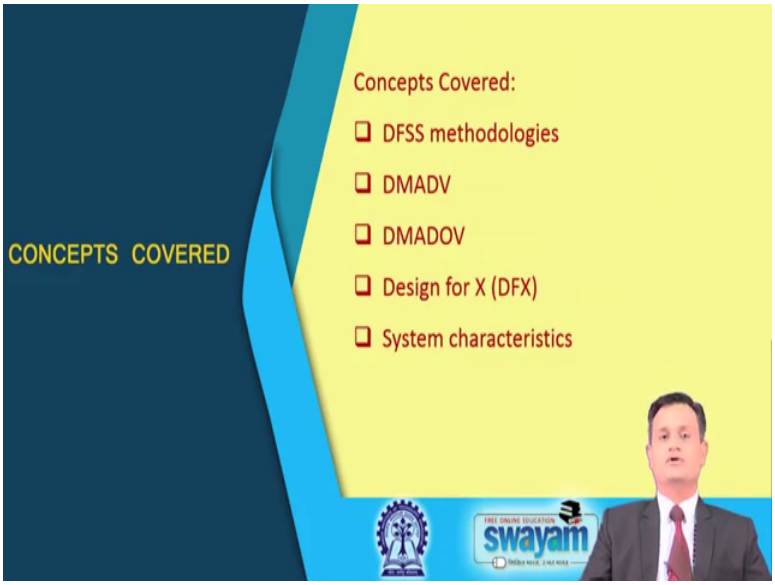

And now in this lecture I would just like to deliberate upon DFSS methodologies DMADV DMADOV, some idea on design for X and system characteristic. You cannot really improve the process unless you understand or you look at the entire system and understand the various components of the system. So, this knowledge is also extremely important and we would like to say, go little bit into the depth of this.

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So, DMAIC which we have covered in the say marathon journey of our six sigma and many lectures we have devoted on discussing the various phases of DMAIC. Typically this is more oriented towards the improvement of the existing processes and sometimes when you have to go little bit advance, then the other structure for implementing six sigma also exist, and two most popular structures are DMADV and DMADOV.

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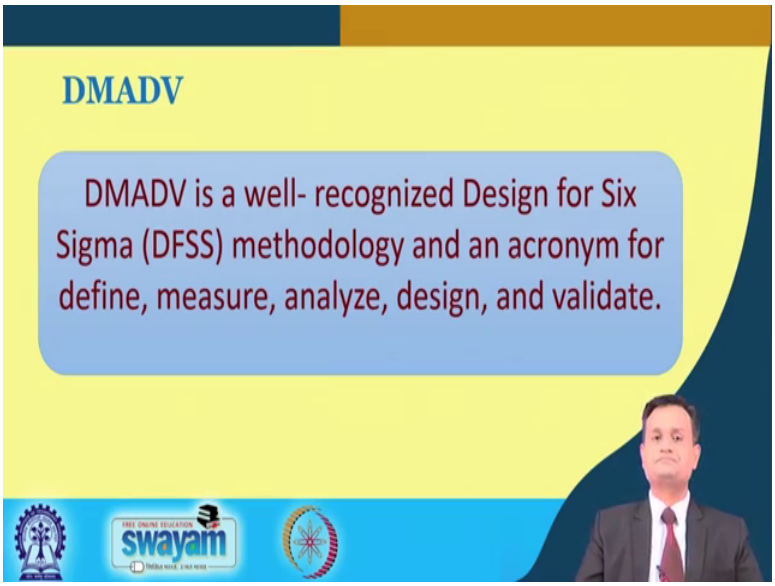

So, let us see DMADV is a well organized and recognized design for six sigma methodology and typically this acronym is for design for, DMADV is for define, measure, analyse, design and validate. So, you can see that define is as it is, measure is as it is, analyse is as it is. Now here you will find design and validate.

So, this is the concept DMADV it uses when you really have to go for the development of new product or processes and design specifically is given more emphasis. It is not that we have not touch this issue, we have very well covered this. I am just presenting the different variants so that you do not get confused, but we talked about say improve phase and typically in the improve phase we have discuss design of experiment that very well takes care of this design and validation requirement DMADOV this little bit go higher and here O stands for optimization.

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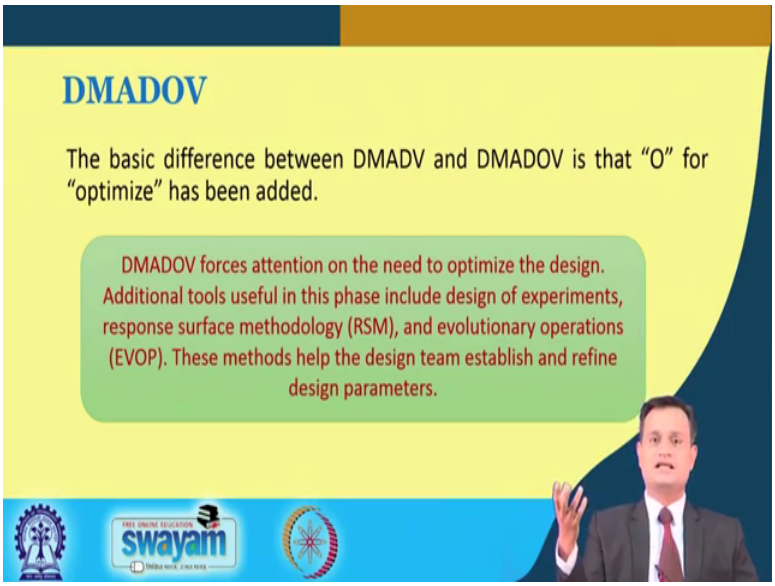

So, in this case, it is not only that conducting experimentation and finding what are the factors importance and not important, but we go one step ahead by applying the response surface methodology and we try to figure out that what is the optimal setting for a particular parameter and hence a process.

So, we just do not end up with what is significant and what is not, we also try to investigate through a well established methodology called response surface methodology and also evolutionary operations, that what is that optimal range of the parameter and if I operate it these then I can have the best utilization of resources or I can have the maximum output, maximum yield. So, this is something that we additionally try to cover and additionally try to address in case of the structure DMADOV.

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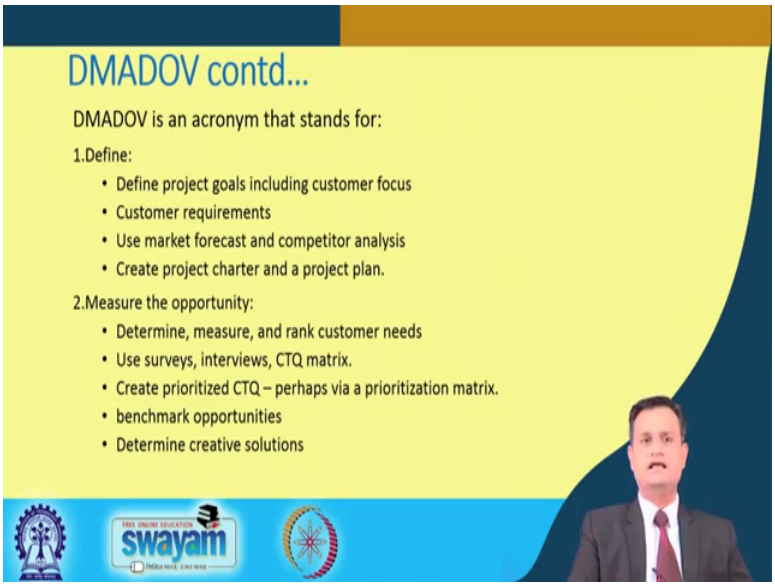

So, typically I will just give you the little brief of this. So, define it goes as usual, that define the project goals including customer focus, customer requirement, use market in competitor analysis and create project charter and project plan we have already covered. Measure the opportunities so, you have to figure out what is your say a determine measure and when the customer needs and use the surveys interviews CTQ matrix and try to identify what is your critical to quality requirement, because you cannot establish DMAIC for each and everything, you have to figure out what is your critical to quality and you look at the benchmark opportunities or data available and then you go for determining the creative solutions.

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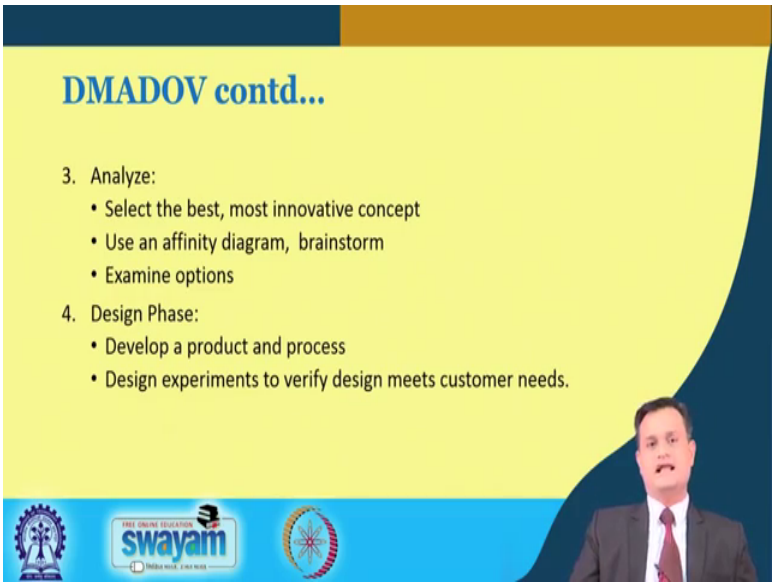

Then you have the analyse phase. So, in analyse phase once again you try to use either the descriptive or inferential statistics or some of the management and planning tools we have discussed to analyse the situation. Now in the design phase you basically conduct the experimentation, we have seen full factorial, fractional factorial and randomise block design, randomise complete block design and other say Taguchi method. So, you try to design the experiment so that you can really figure out that what are the factors that are really important and critical for your processes or product.

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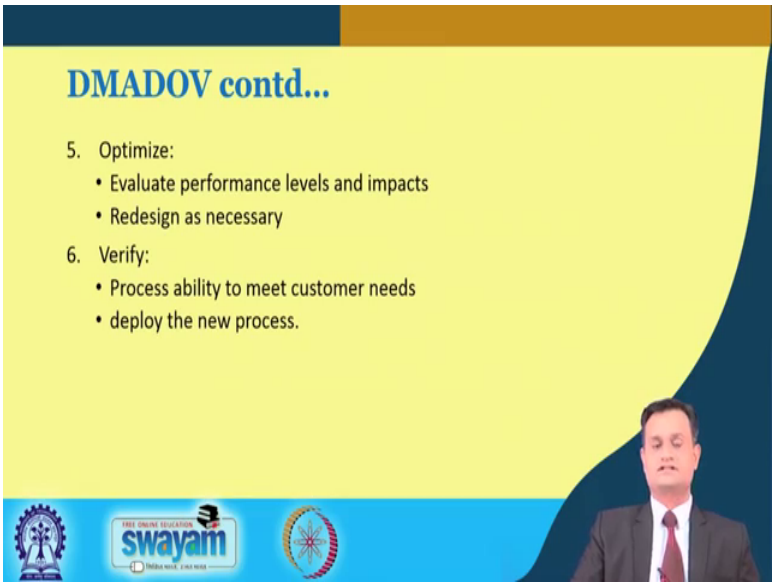

Then you have optimise phase. So, evaluate the performance level, make use of response surface methodology and try to see what is the optimal range in which you get the maximum yield or you are able to maximize or minimise your function. So, if you are dealing with a cost function you would like to minimise, if you are dealing with a yield or output function you would like to say maximize.

Finally, verify that process ability to meet customer needs and deploy the new process. So, here you also go for the validation, verification that whatever new process you have developed will it only give you the optimal or also simultaneously satisfy the customer needs and requirements. If it is done then you have better confidence in implementing your new process.

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So, design phase typically is very important and we make use of various kinds of tools and techniques we have seen; QFD matrixes helpful, FMEA is helpful, brainstorming, Taguchi robust design and typically DFX. So, is not only important that you only think about the parameters which are well defined for the process, you also go for analysis of some X factors. What is that additional you would like to have in your product or process, so that your design is not limited to setting the range of set of parameters, but it also includes some X factors: what are these X factors we will see in detail.

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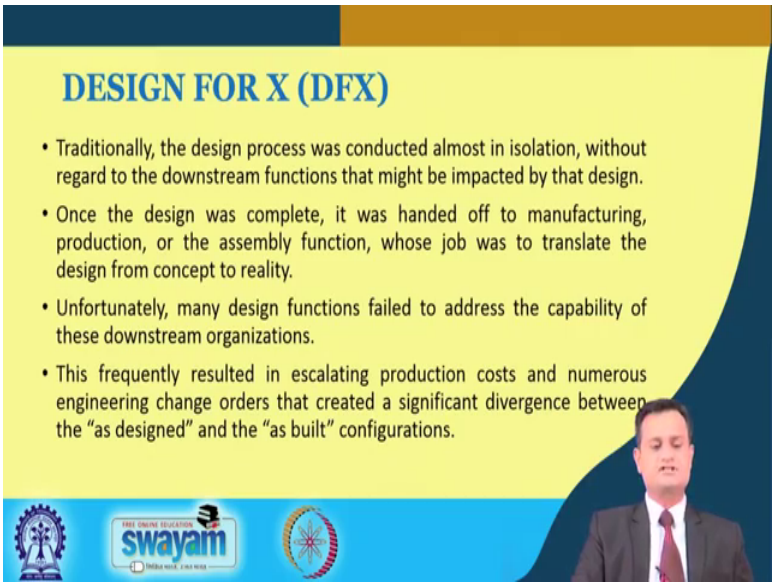

So, DFX typically, is the design process was conducted almost in isolation and many a times we do not take the cross functional input from the maintenance people or the customer or the packing department or the purchasing department or typically let us say are manufacturing department. And when you design the tolerances, when you design the features of the product in too much isolation, then you will encounter many issues and problems when actually product is put, either in manufacturing, the design is put in manufacturing or the product is delivered to the customer. So, maintenance, reliability. robustness, serviceability, testability, manufacturability there are various X needs to be address right at the design stage.

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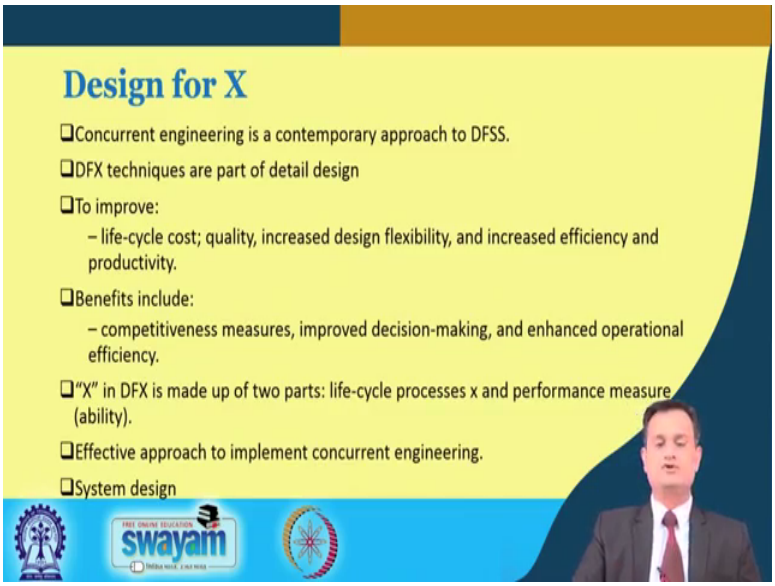

So, we have to look into this additional factor that is the X factor and we should see that how effectively we can have an approach for concurrent engineering. So, this is something which calls for the system design. You are not designing only a product or process, it is all about say designing a system and your system is not free from its environment boundaries and interfaces.

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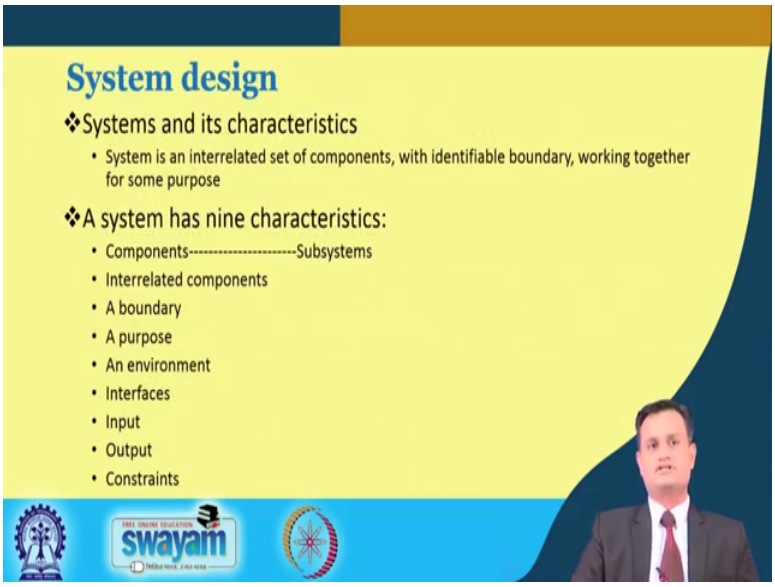

So, let us try to appreciate couple of things related to system, so that we can execute either DMAIC or DMADV or DMADOV any kind of structure in a more effective manner. So,

systems and its characteristic so, typically system is an interrelated set of components with identifiable boundary working together for some purpose. Just think about your body. So, your body has heart, kidney, lungs, many other organs, your eyes, hand, everything should be synchronised and must function in a synchronised manner; connected manner. If any of the organ or any of the part of your body is not functioning well then your overall functionality will get disturbed. So, it is all about a system.

Now this is not the only say conceptualization of the system, your body must have an immunity when it is interacting with the environment. So, your body has to operate in a particular environment. Suppose you are living in a dry area and if you come to humid area, your environment has change, your body may not act that effectively. Suppose you are living in India and you go to US or if a US guy would come to India then the system is placed in a different environment or all together I will say that it is a system which constitutes the components, boundaries, interfaces within a particular environment and it may not function well.

So, a system typically has nine characteristic starting from component to sub system, then interrelated components, a boundary, a purpose, environment, interface, input, output and constraints. So, this is fantastic and let us try to just immediately see the analogy in terms of the human body. So, you have the inter-related components as I said heart, lungs, kidneys and other organs and components, so they are interrelated components. You have a boundary, so because of this boundary the definition and the functioning of a particular component is well defined and they operate in a synchronised manner within a particular boundary, so that no overlap takes place. So, heart will do the function of heart and kidney will do the function of kidney and they are well separated by a boundary.

So, third is the purpose, so each particular say your organ has a purpose and so long it is functioning for the intended purpose your effectiveness is ensured. You have an environment to operate, so you may say cold environment, hot environment, stressful environment or may be sometimes you are living in a village or you are going to city then again your environment changes.

Then interfaces; so, various components of your system, they are well connected through an interface and you can very well understand that, suppose blood is not reaching to your heart.

If there is some problem in heart and blood is not properly pumped and if it is not reaching to different organs or if the backflow is not happening, then your organs will get damaged. So, there is an interface, through this the components are connected as well as they function. Then you have; obviously, input you take food, you take air, water just to ensure the appropriate functioning of your body and then you have the output in terms of the work, another functioning.

Constraints; yes, you cannot take the food of entire year in one day it is not possible, you cannot pass the urine. Let us say you will say that a for entire day I will pass the urine just in one go, not possible. Your body has to work under a particular constraint and this is where you have to satisfy the input output requirement. So, these are the nine functions which a system must obey and if it is then characteristics, then your system will really function effectively.

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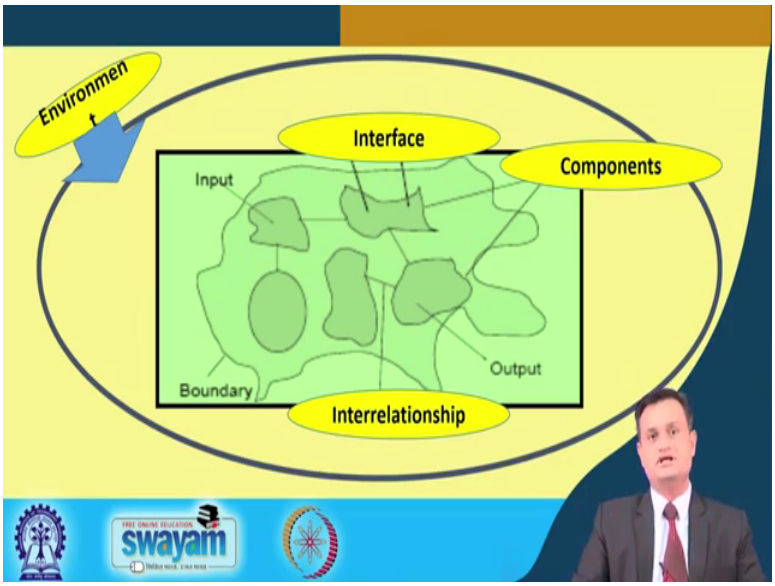

So, just see this to get an idea that you have the interface and this interface basically separates out the components from the boundary, your environment; you have a typical environment, you have the input, you have the components and you have the interrelationship. Among the various components and you can just visualise, I give you the better analogy of the body.

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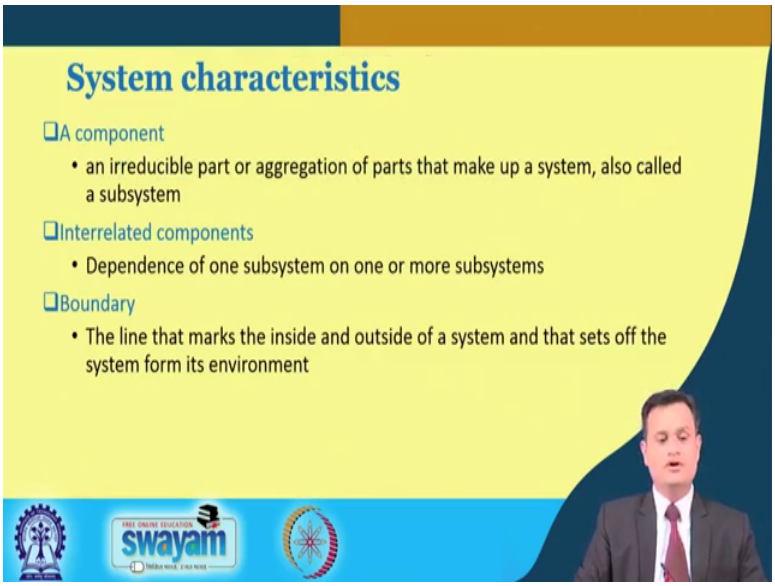

So, now a component I will just put the technical definition for what and irreducible part or aggregation of parts that make up system also called a subsystem. You have inter related component, so dependence of one subsystem on more sub system, kidney and heart they are not separate, they have some inter functional role to play. Boundary, the line that marks the inside and outside of a system that sets of the system from its environment. So, you can see very well here that you have a typical boundary that helps you to separate out your system from the environment.

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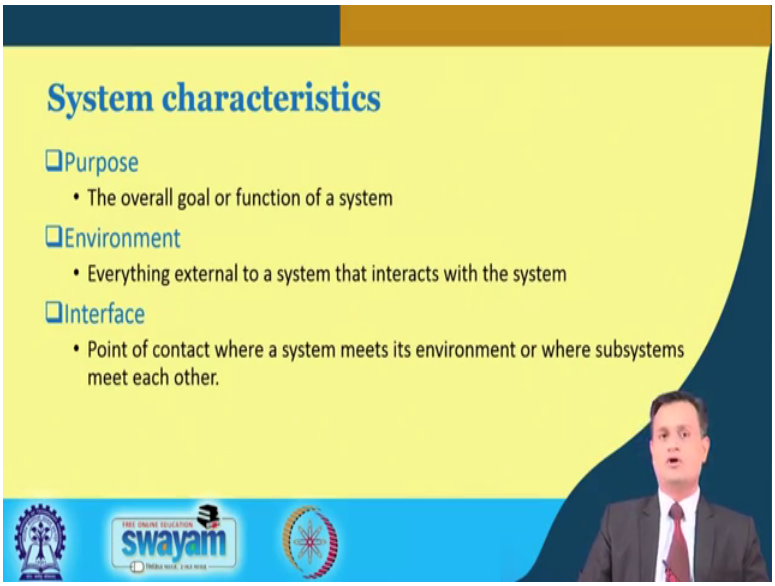

You have a purpose, so the overall goal or function of a system and that is the overall purpose for the system, your subsystem can have its own purpose for functioning. Environment, everything external to the system that interacts with the system, you can call it as the environment. An interface point of contact, where a system meets is environment as I said. So, this is something where your system meets its environment, this is what you call as the interface of the system.

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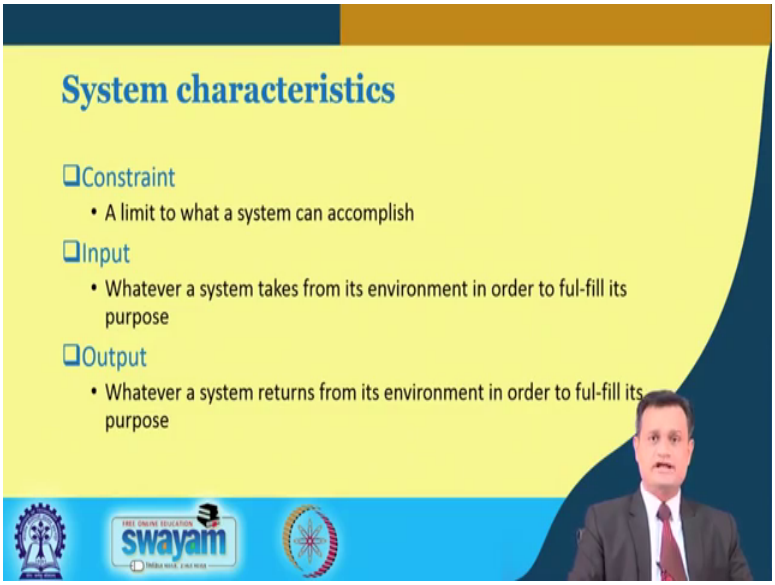

You have constrain, something which limits the functioning of the system or performance of the system and I have the constraint. Input, whatever system takes from the environment in order to fulfil its purpose and output, whatever a system returns from its environment in order to fulfil its purpose.

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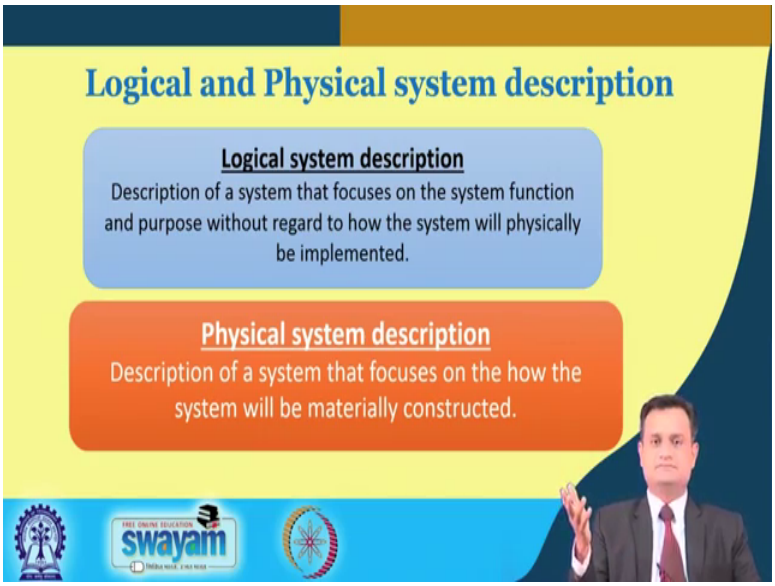

So, this is the technical way of defining the system and analogy can help you to better understand. Now as I mentioned that when you are trying to apply DMAIC, DMADV or DMADOV, you cannot just think about a subsystem or a very small component of the process, you need to have a systemic perspective, so that you can well appreciate the performance of the system well within the particular say environment.

So, just think about let us say an automobile four wheeler, suppose Maruti is producing a four wheeler and we all know that majority of the automobile company, they purchase the components or modules or kits from the different suppliers. Now you got a problem in your say car and now you will report it to Maruti, you will go to the service centre. Will Maruti service centre say that this component is supplied by vendor x, you go to vendor x and try to figure out, we cannot help you.

If that is the way then you would never like to purchase any such kind of product, whether it is vehicle or it is washing machine or anything. So, you need to have reliability of the subsystems. Now again say let us say you are one of the component of the vehicle which is well connected with the other component. So engine and maybe your rear front drive or maybe say axel and other components so, if they are not functioning well in a synchronised manner.

Again say, interface issue will come in picture and you need to say address this right at the design stage. Suppose you are using a car in hilly area or you are using a car in a heavily say, a metropolitan city where the heavy traffic prevails or a village. Now if you find a deteriorated performance of your vehicle as the condition or environment changes then also you would not be happy. So, your system must exhibit some robustness with respect to environment and this is also we are trying to address as a part of DMADV or DMADOV or you may say D M A I C.

So, you have logical and physical system description. Logical system description is a description of a system that focuses on the system function and purpose without regard to how the system will physically be implemented. So, we are not bothered when we talk about the logical system description, we only say that how will it function, but how will it be implemented that we are not thinking, we are not bothering about the implementation issue. You will say I have designed the engine and this particular engine will give this much of mileage.

Fine, logically you have done all the calculations and how the system will perform, that you are trying to bother, but when you really say fit the engine and what will happen at the phase of assembly, then this implementation issues you might be not thinking. When you talk about the physical system description, then this focuses on how the system will be materially constructed, how the entire components sub-assemblies will be assembled and what would be the physical performance of the system. So, physical system description is the another way, you are trying to think about the system either logical or physical.

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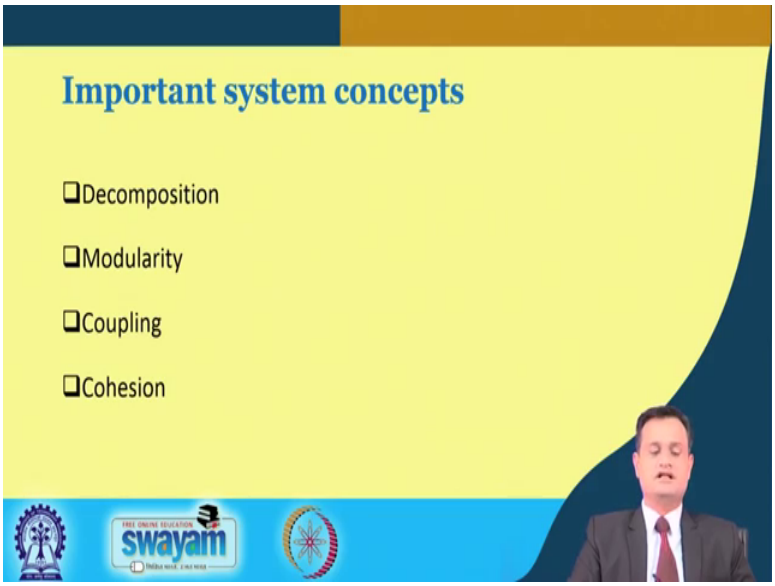

Now, there are some important system concepts; like decomposition, modularity, coupling and cohesion.

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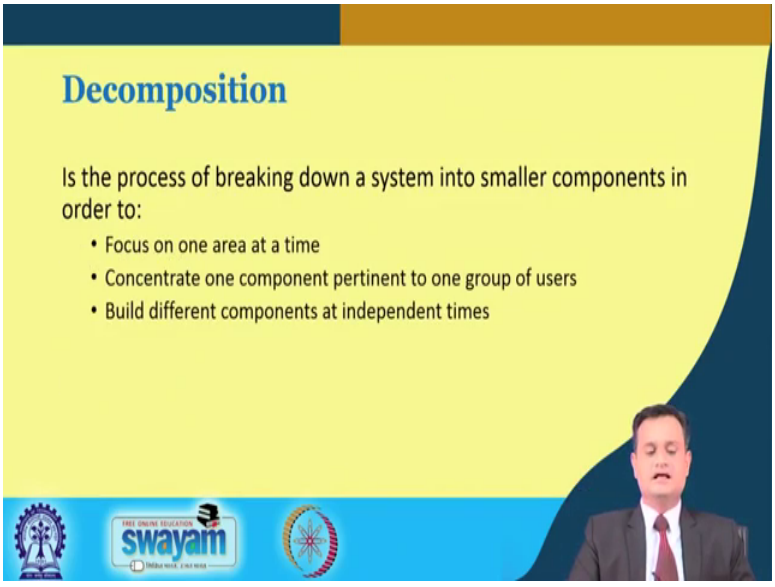

Let us try to appreciate them decomposition, process of breaking down a system in to smaller components in order to focus on one area at a time and concentrate one component pertinent to one group of user, build different components at different independent time. So now here I am trying to dismantle in a way decompose the system and let us say I have the gear mechanism, I have the axel system, braking system, steering system engine. And then I will

just try to say focus on a particular area at a time and see that how this different components of the system can be built in an independent manner. So, this is first the decomposition.

So, in medical line also you get MBBS degree where you are exposed to all the issues and then you try to go into detail, maybe of surgery or maybe you are becoming the kidney specialist or heart specialist and so on. So, decomposition does not mean we are losing the perspective of the system, but any system must be decomposed in order to appreciate the function of a particular component, subsystem and then manufacture this particular component, produce it independently.

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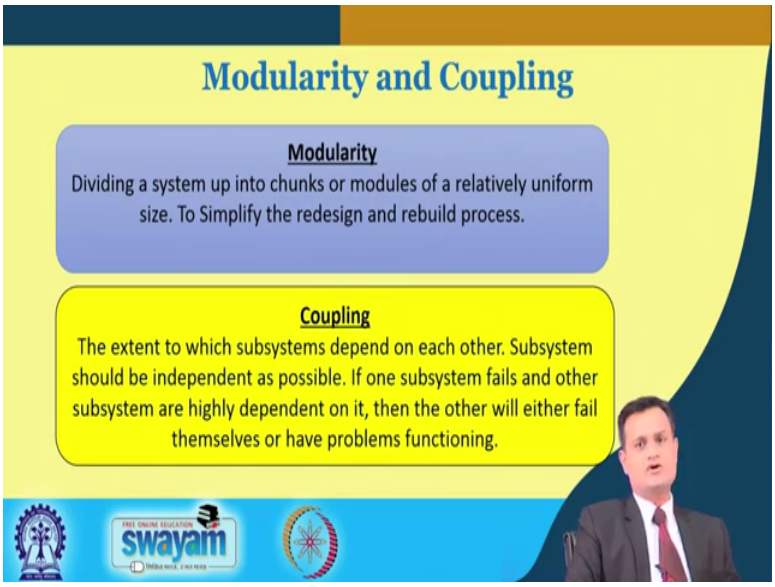

The second concept is modularity which is well popular in all the automobile industry as well as your electronic industry. There you go by the concept of modular mobiles, phones and your TV, projectors and similar way automobile industry. So, dividing a system into some chunks or modulus of a relatively uniform size to simplify the redesign and rebuild process. So, many a times you just open your say LCD projector or maybe the TV and you will find there are many many small components. And unless you try to apply the concept of modularity it is really very difficult to deal when you go for the re-rebuild or re-design of the system or process.

Coupling is the third concept in system, it says the extent to which sub systems depend on each other; there is a coupling. And subsystem should be independent as possible if one

system fails and other systems are highly dependent on it, then the other will either fail themselves or have problem functioning.

So, when you think about a system, when we want that system should work in a synchronised; subsystem should work in a synchronised manner, but simultaneously you must understand that coupling is necessary; decoupling and coupling is necessary, otherwise the failure of one component will have significant impact on the other component. And this you can understand very well in your body, where majority of the organ they work in a synchronised manner and if there is a huge dependency, let us say then something will go wrong with one then this will create a cascading effect on the other organs. So, this is a something about coupling.

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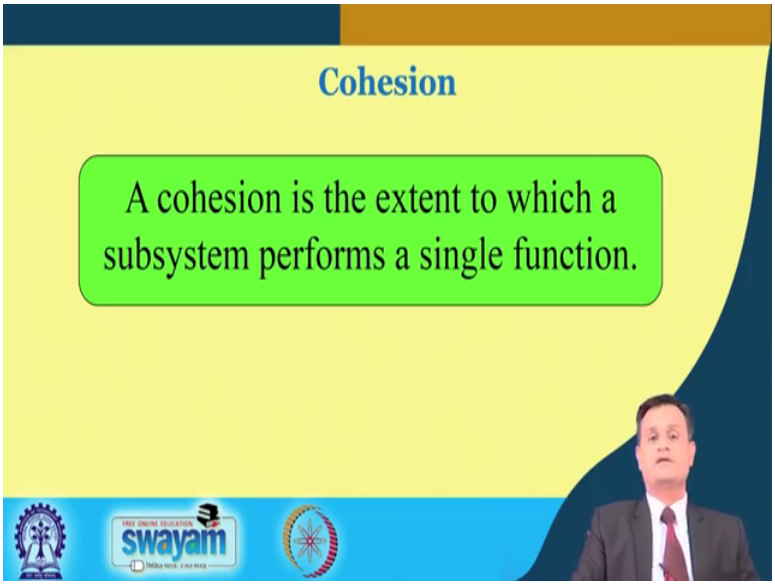

The fourth one is cohesion. So, cohesion is the extent to which a subsystem performs a single function. So now, you have a subsystem and to what extent your subsystem kidney, heart, lungs, they will perform their function; single function, satisfactory manner this is typically called as cohesion. So, we have four components; that is the concepts one is decomposition, modularity, coupling and cohesion. So, when you think about a system for improvement you cannot just think in isolation you have to address this issues in order to make your final product, process, more customer centric and effective in terms of the delivery of the performance.

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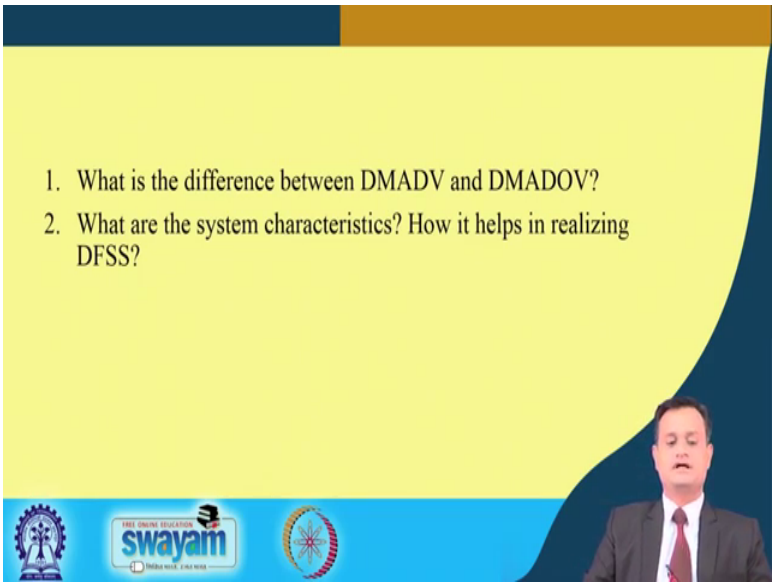

So, you think it what is the difference between DMADV and DMADOV, some simple question for your introspection what are the system characteristic, how it helps in realising DFSS and just try to think about couple of examples, so that you can draw the analogy and appreciate the concepts in a greater detail.

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So, thank you very much for your interest in learning the concept of system DFSS, DMADV, DMADOV and we can say that it is important to recognise the importance of the system and consider critically, say we can address the various requirements for the product or process right at the design stage.

So, thank you very much and we are just trying to cover couple of issues in the say six sigma implementation challenges and issues as a final part of our course and you will have couple of more lectures to appreciate. Please be with me, enjoy.