Manufacturing System Technology - II
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Lecture – 07

Hello and welcome to this Manufacturing Systems Technology part two - module 7. In the last module we had talked in major way about quality loss and how that could be used to take important management decision with two different case studies; where in one case study we try to select between two products based on the ultimate shear strength of bolt which would otherwise support rotor system. The other case was related to the shifting of the point of gear changing in an automatic transmission, where the comfort zone of the operator the truck driver was taken in to account for designing the factory tolerance. So, both of them were illustrations where quality loss was used as a basis for selection of the right to strategy management strategy which would be applied to that condition.

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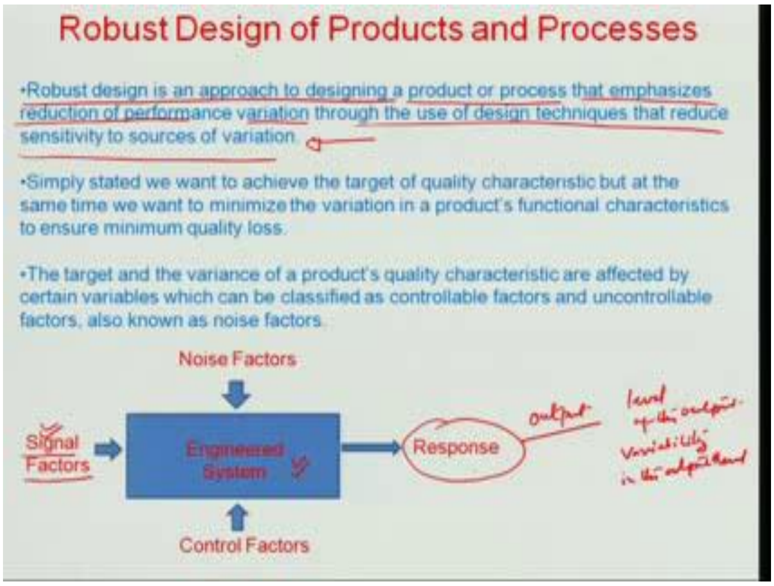

Today we are going to discuss a little more of this robust design approach particularly of products and processes. And; however, the systemic level these different you know quality issues related to engineering system can be studied. So, how robustness can be introduced into the picture by design by design you know process optimization and so on and so forth. So, robust design is an approach concerned with designing a product or process that emphasizes the reduction in performance variation through the use of design techniques that reduce sensitivity to sources of the variation. So, here is an engineered system for example, we just shown and there are different factors thus can be seen applied to these engineering system. So, the input factor is also known as the signal factor which is the by and large dependent user of the system, and because of the signal factor the engineering system gives response for an output of a particular type, which you know the engineer system is suppose to give.

So, monitoring the level of the output or variability in the output level is of significant concern while designing the system. And obviously, the response value as well as the variation would get influenced heavily by means of the noise factors which are probably beyond the control, they are uncontrollable. And for example, change in temperature, change in humidity, these kind of things if the process is setup in a particular manner it something that you cannot really do much about it. Or control factors, where by changing certain control aspects related to the engineered system, we can in way the able to vary the response level at least the output and the variation part can be substantially altered based on these control factors.

So, simply stating we want to achieve the target of quality characteristic, but at the same time, we want to minimize the variation in the products functional characteristics and that is typically because we wanted to have a minimum quality loss associated with this particular product. And the targets in the variance of the products quality characteristic are by and large affected by the variables which classified as controllable factors and uncontrollable factors. And uncontrollable factors are these noise factors has been illustrated uncontrollable factors can be many as I will probably illustrate in more details later on, it can be related to the user or can be related to even the designers choice of certain factors associated in the designing of the products.

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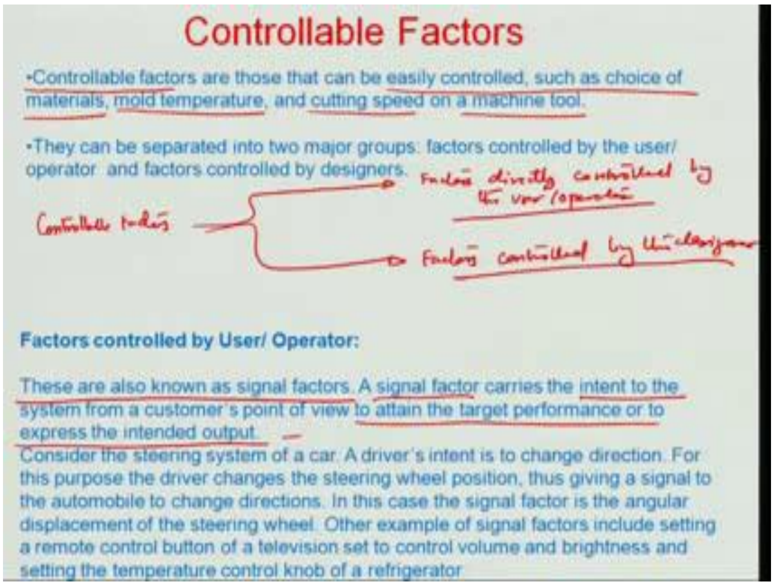

So, let us look at the controllable factors; what are really controllable factors. They are sort of factors which can be easily controlled such as choice of materials for example, let us say the mold temperature the cutting speed on a machine tool, these are something which are really in direct control of the operator or in direct control of even to some extent the designer who designs the process range for example, of operation things like that. So, by and large the controllable factors are two folds. So, I will just write this down here. So, the controllable factors can be really classified into those factors, which are directly controlled by the user or the operator of the product. And there are then factors controlled by the designer. We will try to understand all the engineering system by a I mean by sot of taking specific example cases where we can find out which are those which are controlled you know which are those factors we can be control easily by the use of the operator and which are the factors the really which are in the ambit of the product designer as such.

So, for example, let say when we look at any engineering system as I told you there is something called a signal factor which is the input response to the system that has been given by a user or a operator for the system. And obviously, because of this input response, there is output response which is generated also known as the response better known as the response. And the question is about controlling the level of that response or the variability in the output level of that response you know given the signal factor and so there are many controllable and noise factors which are associated in that process which would do all this. But the principles generator of this signal which would be associated with the function ability of the engineered system is the user itself or the operator itself.

So, the signal factors obviously are the controllable factors type and the intent that the signal factor really has is to attain a certain target performance or to express the intended output in some measurable form you know with some variability of an engineered system. So, let us look at the example for example, you are car driver, and you want to turn the car to the certain direction. So obviously, you will turn this steering wheel, and the steering wheel is basically this signal factor which you are sending into the system, we just creating the car or which is enabling the car to take a right turns. So obviously, the angle which you have to move your steering vice versa is the angle that the car really moves are quite different. And therefore there is something called the gain of or amplification the signal factor finally, resulting in an output response of the system etcetera.

So, if I want to understand this is an engineering system, we will see that the signal factor here is the angular twist or turn of the steering wheel generated by the user and the response of the system is the actually the amount of degrees that the car is able to bend its track from moving it linearly. So, that is how you can gauge what is the controllable signal factor in the more in the domain of the operators or the users. There can be other example of signal factor for example, in refrigerator if you want to take the control the temperature control knob to a certain level of temperature and obviously, there is going to be a fall of temperature based on whatever set values that you have incorporated. So, the signal that you are generating is that turning of the knob which is actually setting the value to a certain level, and the output of refrigerator of course is the time that it would I mean in sometime it would come to that particular temperature value that is the response of the system based on the signal that you are generating in terms of turning the knob.

Similarly there are other things like for example, remote control, when you are trying to change the volume or the brightness of a television, you basically generating the signal from the remote control and it is actually resulting in the influence on the screen in terms of the volume increase or in terms of the brightness or contrast change associated with this signal factor that you are generating through the remote. So, any engineering system for example, can be studied in terms of the user generated, the operator generated signal factor and the response or the output of that system. So, this is the first principle that you should follow in order to realize any engineering system for giving a systematic point of view to the quality of output of or the performance of the system.

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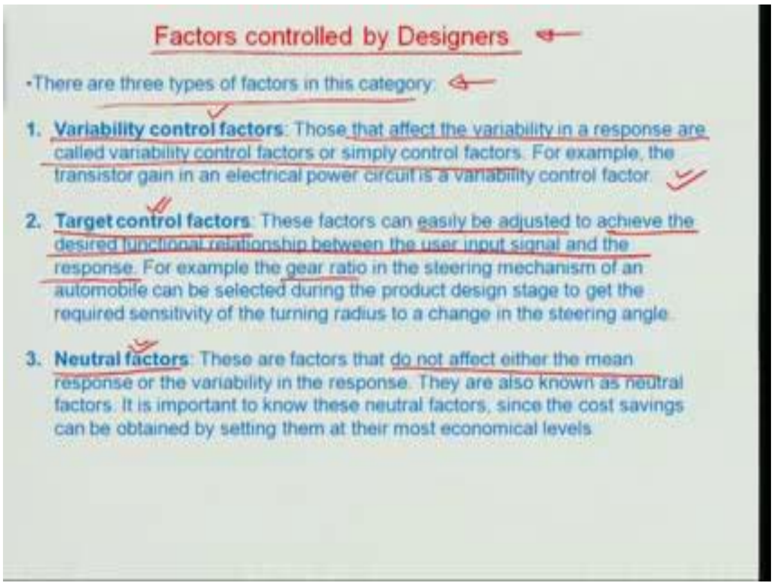

So, let us look at the factors which are controlled by designers we already did a very detailed analysis of the factors which are controlled by the operator or the user directly. So, there are principally three different types of such factors which falls in the category one is called the variability control factor. So, they affect the variability in the response you know and you can simply call them control factors and you can call variability control factors. For example, in a control circuit having a transistor and also the circuit is indented for transistor as an amplifier. So, if you increase or decrease the gain voltage, the output response of the transistor is also going to be change accordingly. So, the voltage if supposing the gain factors increase, then the output voltage of the response would go high, and it will scan over a different range and you know vice versa. So, this called a variability control factors.

So, the output range of the voltages that can be achieved of the transistor is simply higher if the gain voltage in this particular case is high and vice versa. If voltages lower in the output way which you know gets sort of initiated or under which the transistor is bound to operate that that range reduces and I am going to illustrate this little more closely in one of the next examples that particularly Taguchi talks about when he changes the gain and sees what is the variability in the response. The other important factor which is in the control of the designers is called the target control factors and these are so called factors which can be easily adjusted to achieve the desired functional relationship between the user inputs signal and the response.

For example, let us go back to the case of the steering wheel and the customer who is the driver of the car. Now if he actually a turns the steering wheel by angle theta, obviously the amount of angular turn or bend of the car would be would be very pertinent and the designer can give a additional factor within by giving a gear ratio where the steering mechanism of an automobile with certain gear ratio may amplify the signal given by the operator which is the certain angular twist in the steering wheel in terms of overall angle the car executives. So, the gear ratio which is about the way that you know the rack-pinion assembly would move which would enable the car to steer right or steer left based on the angular rotation of the steering wheel, this is again a designer's control domain. And the designer can give a very sensitive steering by having comes into gear ratio or vice versa. So, this is again target control factors. So, once you have controlled the variability level giving a range, you also control how quickly the output response of an engineering system achieves a certain particular level as in the case of car steering you already saw it is call the target control factor.

And finally, there are certain other factors which the designer has which are also known as neutral factors. And why they are call neutral is that they do not really affect either the mean response of the variability in the response. So, either the output level is not influenced or even the variability of the output level also is not influenced in these particular cases. So, they are known as neutral factors. And obviously, it is impotent no this neutral factors, since you know you may basically change the levels of those factors to do an overall cost saving unknowingly in the design you may put something which is not really related to the output level or the variability of the output level, but still it exist in the design because of some other reasons. The reasons could be related to for example, over designing of the products unknowingly because of the iterative process through which the design is carried out. And if such factors can be isolated and such factors can be eliminated it may obviously, lead over all to some kind of cost saving you know, and can help the product to operate at the most economical level those are the neutral factors. So, we will try to identify some of these factors in a realistic sense probably in the next lecture where I will give you one example of transistor gain or transistor circuit, and I will show you the that how you can change really the target control factors in the variable control factors in such a circuit. As of now we would like to conclude this module.

Thank you.