Manufacturing System Technology - II
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Lecture – 08

Hello and welcome to this manufacturing systems technology part 2 module 8. We were talking about various; you know factors which were available with the designers like the variability control factor and the target control factor. Would just like to look at one practical example which has been proposed by Taguchi to sort of separate, what is the variability control factor from the target control factor by looking at a transistor circuit.

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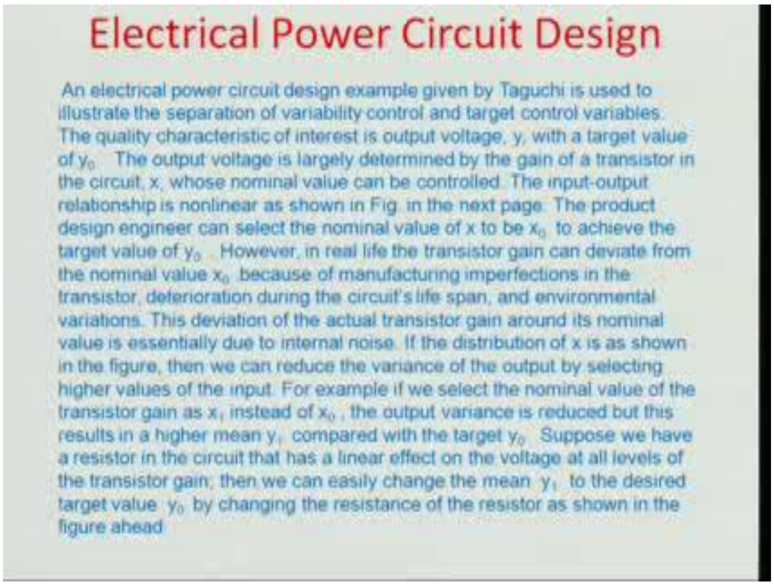

So, let us say there is an electrical power circuit that you are designing in this particular case, and you know if you look at the quality characteristic of interests, this circuit gives an output voltage y with a target value, let us say of y 0. So, the target value here is basically y 0, and the output voltage of the circuit is y.

And obviously, the output voltage is very largely determined by the transistor gain, which is again plugged into the system in the circuit, and the gain is represented by the parameter x whose nominal value can be controlled with in a certain range or whatever. And you know the input output relationship of the y versus x; that means, the level of the output voltage versus the gain voltage is a sort of non-linear relationship as shown in the figure here, in the next page here.

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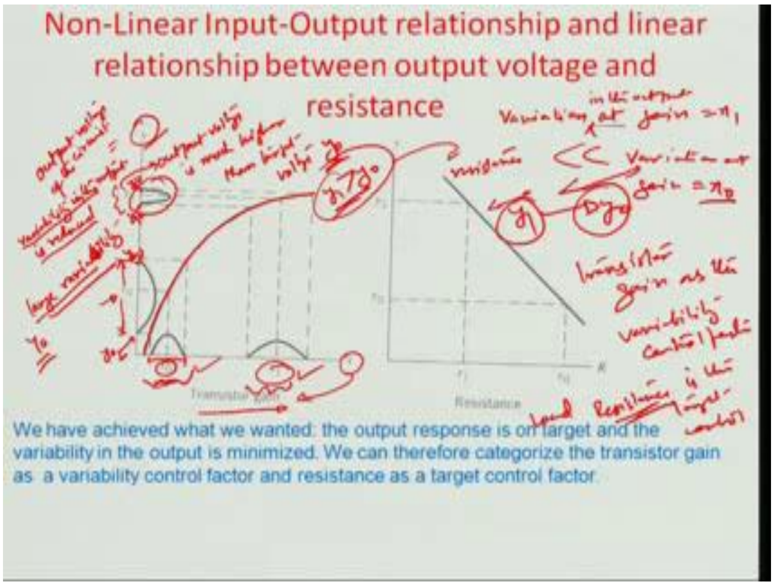

This is how you can vary the y which is the output voltage of the circuit, and this is the transistor gain. So, this is the gain voltage and you can vary, as you can see in a non-linear manner the y versus the gain voltage x. So, this is the transistor gain, and you know you can actually see here that the product design engineer can select the nominal value of x to be x 0, to achieve a target value of y 0, you can see in this particular graph. For example, this is the range of the transistor gain, which has been you know chosen the first instance by the by the designer, and that results in an output voltage y 0, as you can see here which has a large variability, so large variability. So however, if supposing the obviously the target level was y 0, you have to remember and the y 0 can only come when you are going equal to this particular transistor gain range of x 0.

However, as a designer if you to operate this circuit at different transistor gain. Let us say at x 1; obviously, the output voltage here would be much higher. So, output voltage is much higher than the target voltage, which was actually y 0. So, this y 1 apparently is quite higher than y 0; however, you can see here that the variability level here was very high, but the variability level here, because of the non-linear relationship between the transistor output voltage and the gain is reduce the lot. So, you can say the variability in the output is reduced. So, the variability here for example, starts from y 0; let us say lower limit to y 0, upper limit which is this, and this limit; whereas in this case, it is y 1 upper limit and y 1 lower limit which is this, and this limit. So obviously, there is a less variation in the range of the y 1's in comparison to y 0's. So, I can right this down as variation at gain equal to x 1 is much, much lesser, and this is variation in the output much, much lesser than variation at gain equal to x 0. So, designer you really have to choose how you would like to plan your circuit to operate; obviously, because the mean value reported here y 1 is much, much higher than y 0. You can probably give an resistive loss component by putting an additional resistance in the circuit.

So, there is a drop in voltage and y 1 can come to y 0, but the advantage you are getting is that the variability at y 1 is very, very small in comparison to the variability at y 0. So obviously, it would be y's idea to put a resistive loss in the circuit. So, that you know there can be little variation in the output, because this is a larger linear part of the circuit. Whereas this gain versus output voltage is a non-linear, you know characteristic. So, this is how you basically plug in the target control factor and the variable control factor. So, in this whole process you have you know the transistor gain as the variability control factor, whereas the resistance, you can say this is the load resistance is the target control factor. So, while the resistance ensures that the output value goes to a certain level y 0, which is the desired output value the gain value actually from a very, very different angle from a non-linear response of the gain with respect to the output ensures at the variability is closed on.

So, we will have to understand all engineering systems in terms of that variability control factor and gain control factor. So, it is very clear now that a gain voltage variation is resulting in a change in the variability of the output, whereas the resistance the load resistance is again tailoring that output back into the target value of y 0, which was otherwise intended for this particular power circuit to happen. So, the control factors now, transistor gain is the variability control factor, and the load resistance here is the target control factor. So, this is how you have to understand in analyze engineering systems.

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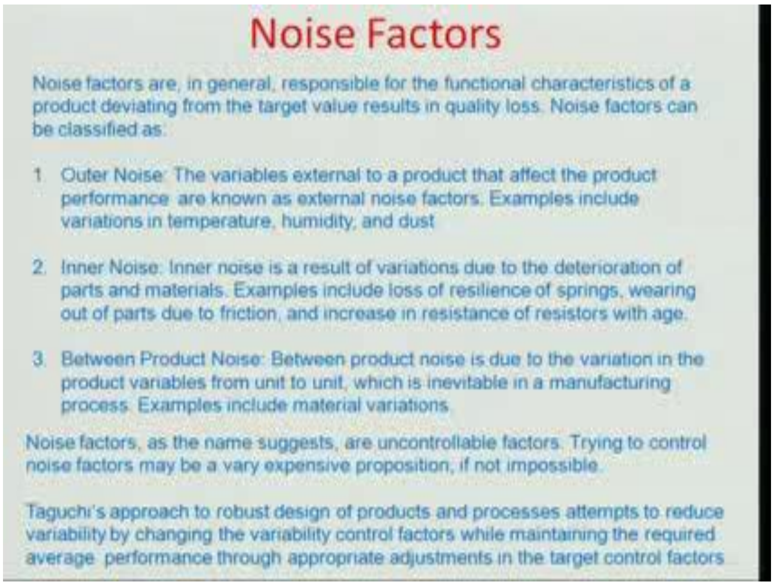

Let us now look at another aspect of the, you know the various engineering systems, and we will talk about noise factors, which are highly detrimental to the performance of the system, but they essentially although they have to be eliminated, but sometimes they are necessary evils which are present. For example, where in a transmission is a definite you know evil which is always going to be there, and you cannot avoid this from happening, and you can say that this is a noise factor. Obviously, there can be a noise which can be related to the external environment of a product, and there can be a noise which is related to the internal nature or characteristics of the product. And then there can be a variability between the different products which are produced the cross different production process.

So, noise factors in general are responsible for the functional characteristics of a product deviating from the target value. And obviously, the outcome is a change in the quality loss, and increase in the quality loss, because the target is not being met properly. And noise factors can be classified as outer noise; and outer noise basically means that the variables which are external to a product and that affect the product performance, which is known as basically the external noise factors. Examples can include, let us say variations in temperature and paint shop or humidity in a paint shop or dust level in a paint shop of an auto motive. So, this actually outer noise which you really cannot control, and you can control by probably developing an environment which is more sort of suitable, but again the environment has to also keep changing based on the outside environment condition, which are determining the final values of this closed environment that you have made around the particular process. So, this is outer noise.

Inner noise - inner noise is basically the variations due to the deterioration of parts and materials itself. For example, you can have a natural loss in resilience of springs as they are subjected to repeated cycles of use, because of fatty gore you know other engineering phenomena, you can a gradual wearing out of parts due to friction, because of multiple usage of the parts while in assembly. And then you can also have increase in resistance of resistors with age etcetera, which is beyond you are control and this is actually called the inner noise which gets generated, because of more number of cycles of usage, etcetera of a certain product. So, the outer noise is still to some extent controllable, but the inner noise something which is completely random, and you will have to design the system in a manner. So, this variability is always there you know as a part of the systems or the products life cycle, and towards the end of the life cycle at the product, you will have to accommodate a higher variability in this values, then towards the beginning of the life cycle at the particular product.

And then obviously, there are noises between the products where there is a huge variation between two different products of the same category in terms of their material characteristics, in terms of their manufacturability, you know it is basically material variability, etcetera. So, when you are having a production linear manufacturing unit, which is producing many products, there is obviously, going to be some variability between the item one, and the item two of the same manufacturing process. So, that is called the between product noise and is quite well as illustrated in the linguistically in this whole statement as well.

So, they are by an large uncontrollable factors all noise factors, and trying to control these factors may really be very, very expensive proposition, although it is not impossible to some extent, but obviously you will have to consider a lot of aspects, just because they are very random in nature their controllability becomes real problem particularly when you are talking about engineering systems. So, by large the whole Taguchi’s approach of robust designing is based on, you know attempts to reduce the variability by changing the variability control factor while maintaining the required, you know average performance through appropriate adjustments in the target control factors, you just see in an example problem before of the transistor, and how gain is able to influence the variability control factor. So, that is how by large you should design the system by studying, you know different parameters related to a system and trying to see is there a controllable basis which could actually introduce.

So, that the overall variability in the output level reduces, and you will have to go of the box sometimes out of the box sometimes to think like in the case of the transistor you saw. So, all the engineering systems now have to be classified in this particular manner as the controllable, and un controllable factors, the signals factors, the response factors in also learnt about variability control factors or target control factors or then again the neutral control factors, which were at one point of time with designer signal factors totally being with the operators, and uses, and the noise factors which are not really in control of anybody and controlling them may be a very, very expensive proposition.

So, this is in general way of classification of any particular engineering system, and you should be able to now, you know take any engineering system around you and try to classify them based on this concept, and see if you could do something out of the box. So, that the variability of the overall output level reduces and that could be a design improvement that a person can do on a product, if you want the output level to be at a certain value with very minimalistic variation as much as possible.

So, with this I would like to a sort of conclude this round or this module. And I would just like to probably do the next module where we will intensively work on how to you know really learn about failure modes, and how that effects system, and then can be really paradise certain aspects of the system. So, that we are able to minimize the failures or products as far as the quality you know basis of the system goes.

Thank you so much.