Advanced Green Manufacturing Systems
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Lecture - 46
Advanced Green Manufacturing Systems course summary

Good morning. Welcome to the last lecture of the course Advanced Green Manufacturing Systems. We were discussing developing green factory using your green effecting processes we have discussed how do we conduct the lab experiments one of the examples which I took on drilling green machining that is green drilling then we went to factory simulation. We picked that data and went to saw through simulation for you to appreciate; I have put certain points in the presentation here.

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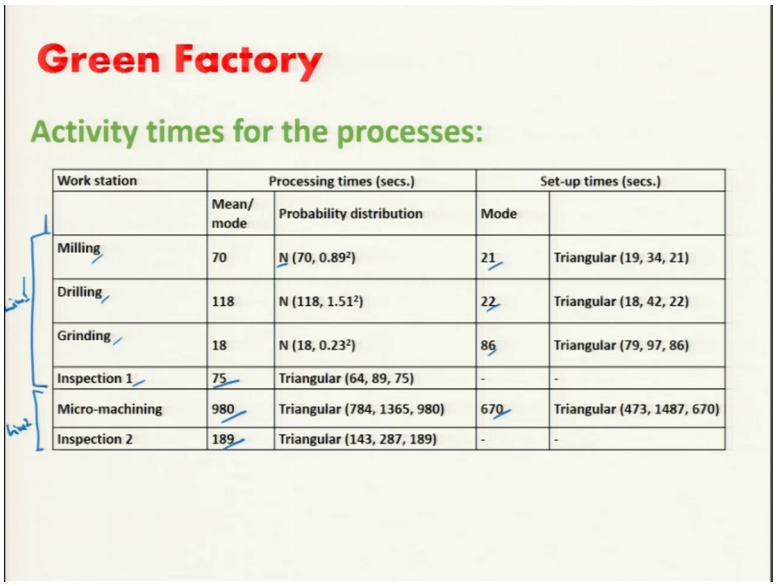

What we have here are the activity time for the processes, these are the activity times which were chosen for the processes, these times are recorded as I said in the previous lecture.

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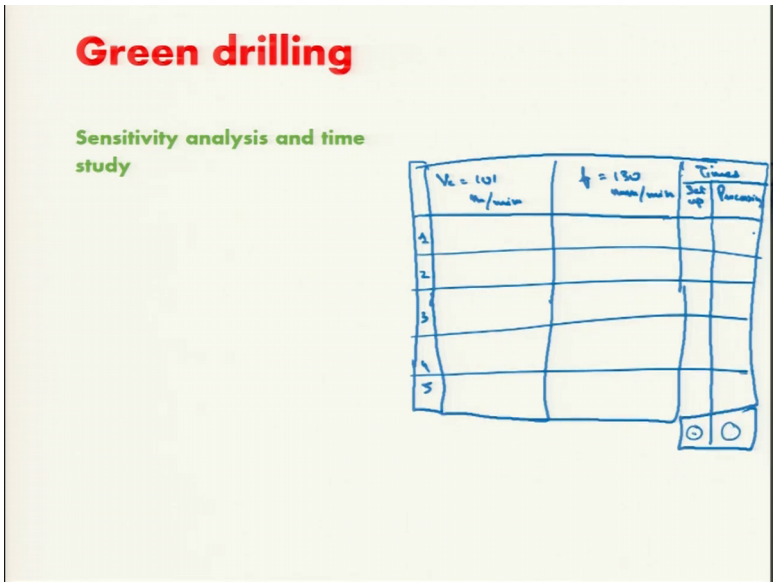

When we did the sensitivity analysis; we conduct five experiments and we noted the setup and the processing times for them and do were they were then averaged and these averaged values were taken here as input, for the process is milling drilling grinding inspection. This is our line 1 and line 2 had micro machining and inspection.

This N is for normal distribution you can see the mean or mode value in that triangular distribution we have mode value, this is mode value, this is mode value, this is mode value in the triangular distribution these are mode values. I have discussed a little when do we used normal distribution or when do we used triangular distribution because the processes were automated the machining processes we chose normal distribution We did not had a large amount of data or lack of knowledge distribution that is a triangular distribution is selected for the inspection and micromachining and any of the processes that is that involves human actually.

So, this is taken from the simulation experts like we there is a book by Law and Kelton; this is a book by Law and Kelton in this with distribution to be select and the usage of triangular distribution and some other distributions like beta uniform that is given here. So, when human operator dependent processes are there like inspection we chose triangular distribution these are the times which were put in the simulation that we saw in the recent lecture.

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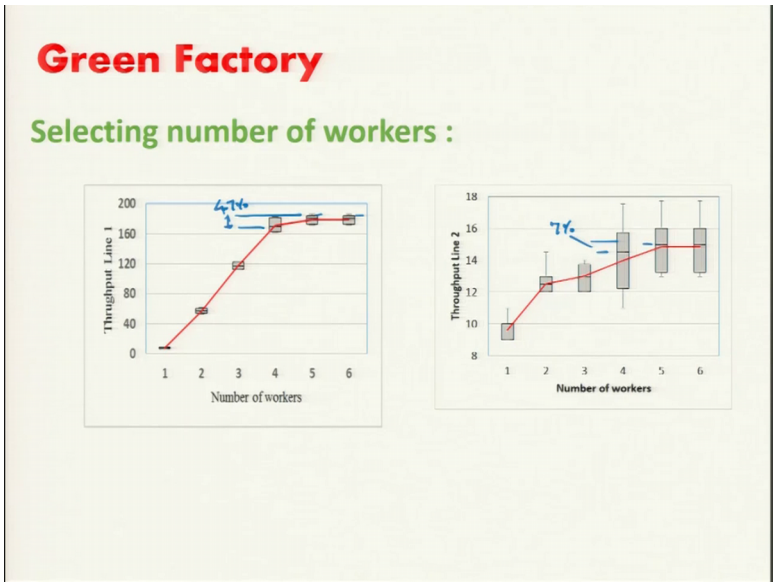

This is the criteria of worker selection I told you that we select 4 workers finally, we started with 6 workers that is 1 workers per process what we came down to 4 workers and I also told you that this difference, if we choose 5 workers this difference is only 4.7 percent in the productivity in line 1 and in line 2 this difference was 7 percent.

So, you can see 5 and 6 workers are giving exactly same throughput; exactly same throughput in 5 and 6 workers with 4 workers there is a little fall, but after 4 workers the fall is quite high. So, this might be around at 20 to 30 percent decrease if we get 3 workers here. So, 4 workers was the best alternative that is selected here. So, this is just the diagrammatic representation of what we saw or what we decided in the simulation that we conducted in the last lecture.

So, that was the experiment manager which runs and we saw the simulations and we had 25 experiments and 50 observations for them and we had this kind of throughput that we have seen.

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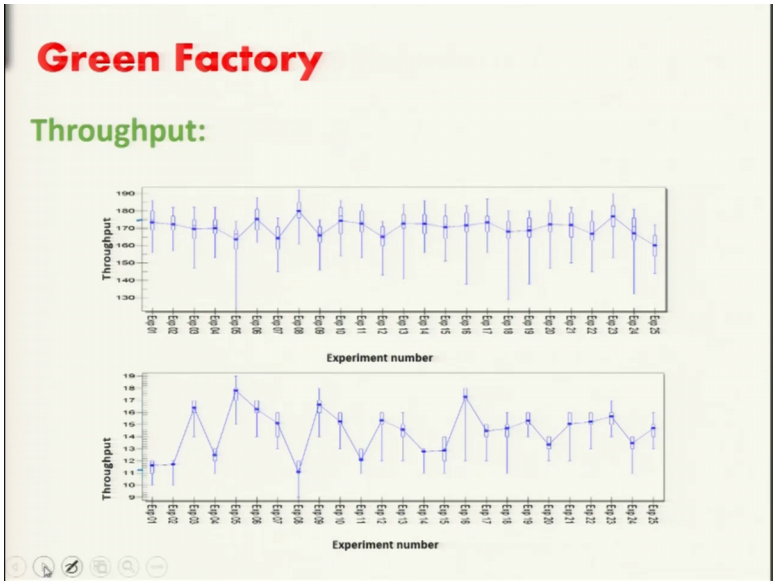

In this throughput we saw that the mean is higher in line 1 the mean is lower in line 2.

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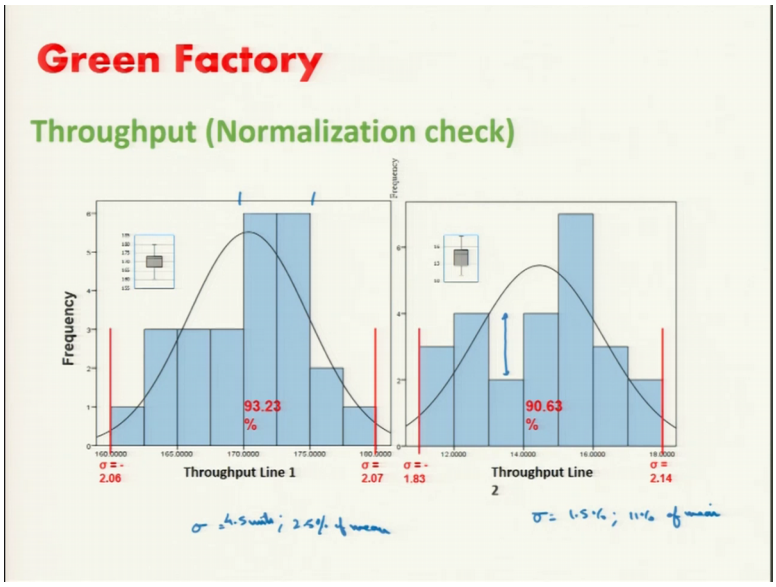

Another way to look at the throughput is like this we draw the normal curve for them this is normalization check. In normalizing check, we observe that as a data is left skewed you can see there is skewness; this is not in the center it has left skewed and if the data is behaving quite well in throughput line 1 and in line to the behavior was not that good like you can see this difference.

This was again due to the small number of components which was actually in line 2 and also as we discussed that the mean or the standard deviation. Standard deviation is here the deviation was around 4.5 units sigma equal to 4.5 units here standard deviation or I just put sigma here this is equal to 1.5 units which here was around 2.5 percent of mean. It was around 11 percent of mean, but this is normalization check for the throughput in green factory.

But, this is how we develop the green factory and also as I said we can take this data to team center to decide for the vendors and to from where we have to purchase from where to put up go those things that ERP Enterprise Resource Planning, can be taken in team center; tecnomatix just had the plant simulation unit.

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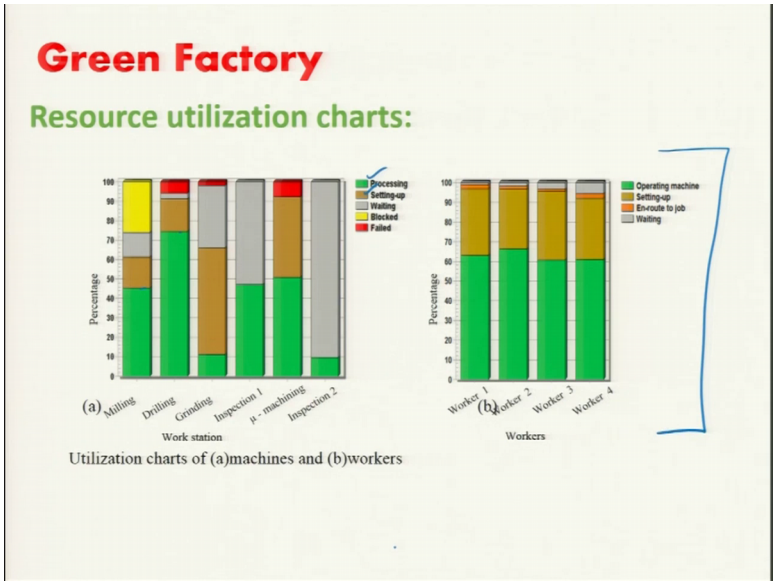

These are resource utilization charts that we have discussed in the previous lecture we had processing and setup times here this is the processing time this is ground is a setup time and also we can see the idle times are there when the thing is working.

So, the idle time for workers varied from 1 to 6 percent and the remaining time was production time that is distributed among the operating machine setting then approved and down route. So, those times over there; so these are the times these we have already discussed; so just to put in PPT for you to see this.

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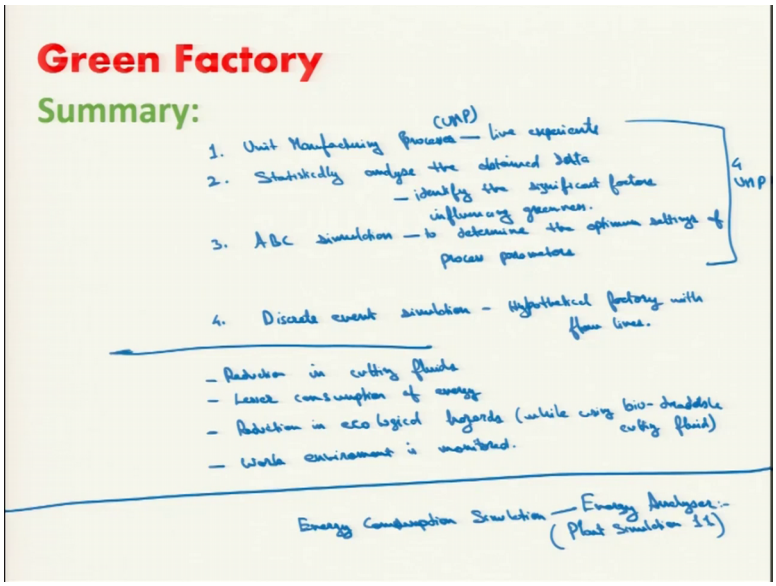

Now, I will summarize my green factory what did we learn or what did we do in developing this green factory. We conducted live experiments or we selected unit manufacturing processes and we conducted live experiment right now this experimental data was then statistically analyzed; analyzed the obtained data. So, why do we analysis data to identify these significant factors those are influencing the greenness.

We identified the significant factors influencing greenness right. Then we did optimization that is, I will directly put we did ABC simulation to determine to determine what to determine the optimum settings of the process parameters these were for the four; these are for the four processes for I would say Unit Manufacturing Processes; UMP I will put this is UMP in reflecting processes.

Now, step four was we developed a complete hypothetical flow shop with 2 lines and conducted discrete event simulation. This will be a hypothetical factory with flow lines. Now, this is what we did to develop a green factory. So, this is a kind of a Pseudo algorithm of the steps that we took to develop a green factory. Now, what did we get from this green factory we identified that the vegetable oil is suitable for this manufacturing for certain reasons human (Refer Time: 10:18) is not affected his health is not affected by this number 2 the machining quality was similar if not better it was similar to what we can obtain in flood.

So, these were the few observations for that and also we selected MQL which has lesser consumption of fluid. So, we had reduction in cutting fluids lesser consumption of energy, right then we reduce the ecological hazards that is disposal of cutting fluid and by while using biodegradable fluid then, I will put reduce or reduction in ecological hazards while using bio-degradable cutting fluid and also work environment is monitored.

So, at this juncture while in this specific study it cannot be claimed that the results are directly transferable because we have conducted in a specific environment a specific set of the specific combination of work piece and tool, but this approach is. Obviously, transferable this approach can be used in any set or any combination of the work and tool also this in this case we just picked the unit manufacturing processes we made them green and we then we took them to the factory we reduce the power consumption or we minimize the cap power consumption in the unit processes this is one of the ways.

In other way can be, we pick the machines take them to the factory and then we see the overall consumption after this also that is there is a feature known as energy analyzer. Energy analyzer, this is a feature I will put a line here; this is a feature in plant simulation version 11 and above we had plant simulation 10 with us. So, we did not have this module, but tempering plants energy analyzer the energy can be monitored which machine is consuming more energy like in line balancing as I discussed line balancing is when we balance or with the distribution of workers with a machine no worker should be idle no machine should be idle that is known as line balancing in this case we distribute the power to the machine.

So, at the overall consumption over the load capacity of the factory is lower for this I will just add a video just after this. So, you can watch this video that is given by Siemens that is just an introduction to how do we use energy analyzer the kind of feature or kind of the function they have in this software they call it as energy consumption simulation ok. This is done using energy analyzer in plant simulation 11 and above versions. So, let us try to see this video.

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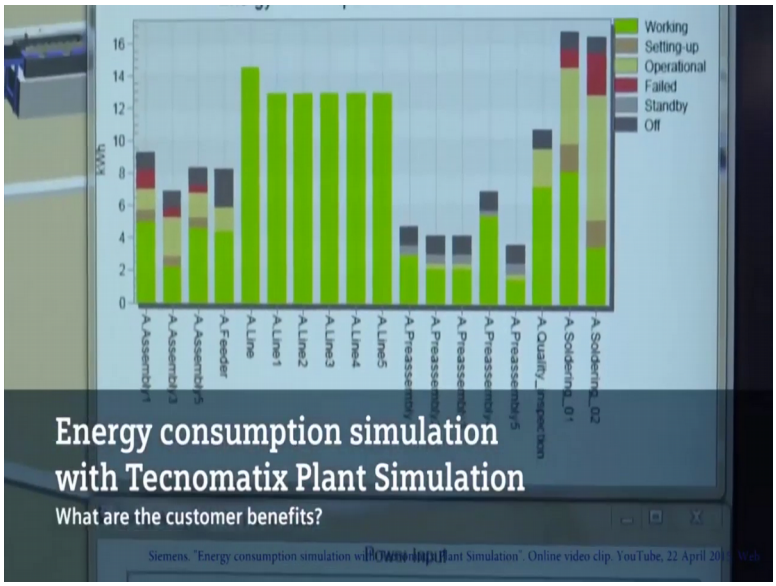

And see how energy analyzer and the tools like these can be beneficial and this is an add on to what we have learned in the previous lectures on green factory simulation.

So, let us watch this video [FL] energy consumption simulation with tecnomatix plant simulation one of the customer benefits do you know the power consumption of your toaster or that if your washing machine or your TV; how long are the on times on the devices does it pay off financially to buy a new energy saving device [FL]. And when is the return on invest industrial companies are wondering about these and similar questions as well and they have the same questions as most households do. Private consumers usually only know the total energy consumption of their household. However, you can only make the right decisions if you know the individual energy needs, peak loads in average values [FL].

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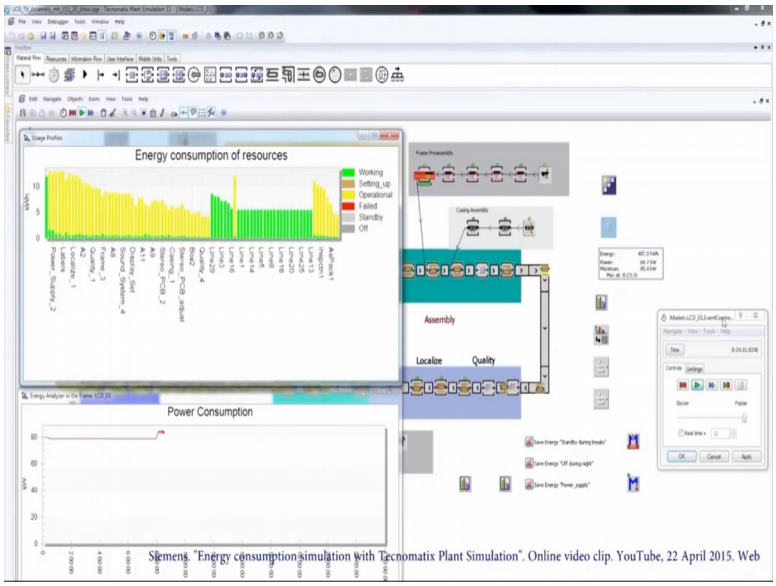

The classical material flow simulation mainly provides information on the output of a plant and shows bottlenecks as well as the influence of pranic variance on the output quality.

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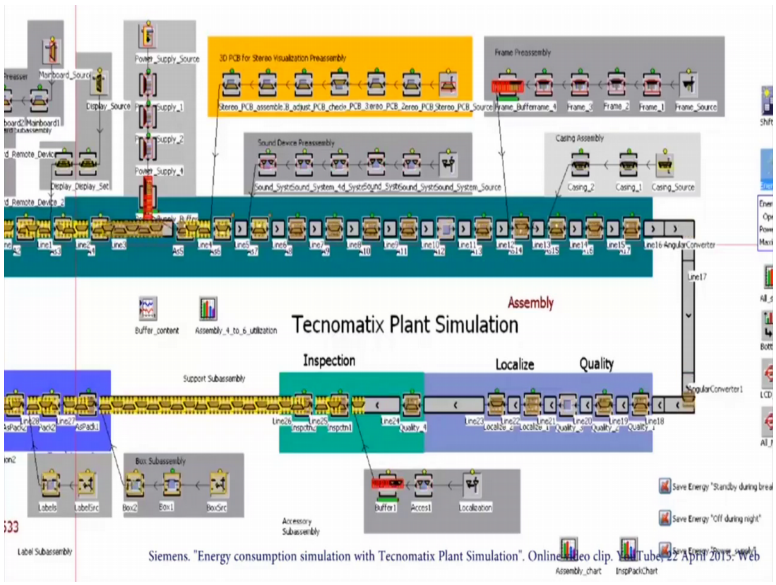

In our current version of the tecnomatix plant simulation software; however, a module is now available that provides information on the temporal dynamic energy consumption of the production plant.

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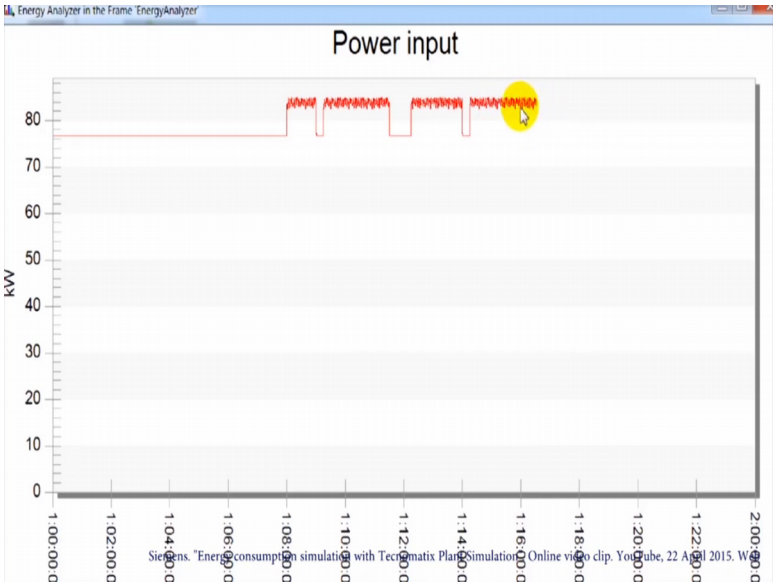

[FL] The advantage in existing production plants significant energy savings potentials can be revealed.

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BMW for example, has discovered energy saving potentials of 3 giga Watts per year.

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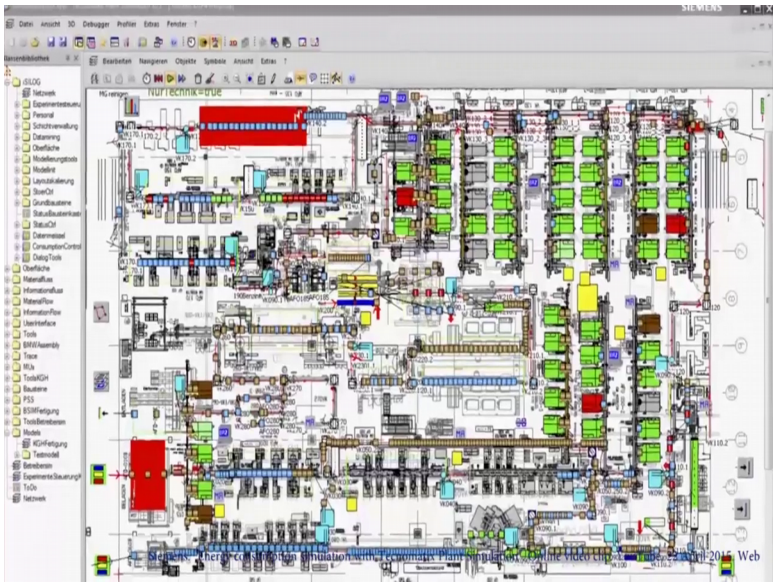

In its engine production near Steyr and Austria and was therefore, able to reduce the energy costs. [FL]

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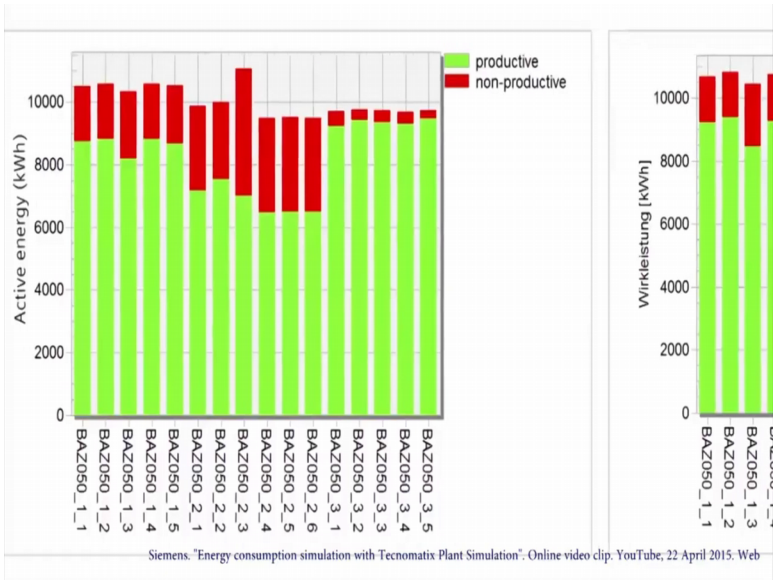

The fact is that the potentials were increased due to improve control logistics which means without the acquisition of new machines which is particularly elegant. The potential is even bigger with new plants, on the one hand new machines can be used more efficiently and on the other hand the supply periphery can be adapted more accurately. Large plants cannot simply be plugged in, but need complex reactive

compensation units transforming stations and electrical buffers against too high starting currents. [FL]

So, for these plants are mostly designed for a static load with so called simultaneous refractors.

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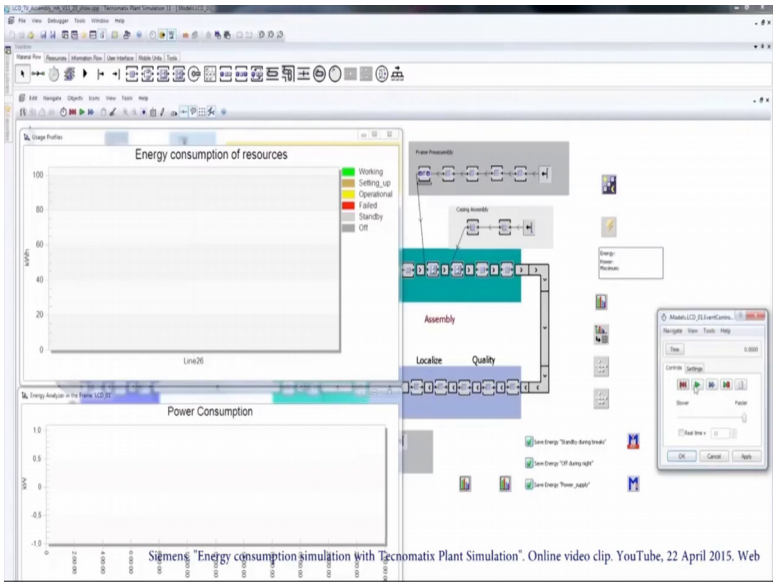

The dynamic plants simulation of Siemens displays the real energy consumptions dependent on their actual simultaneously needed resources. T herefore, the expensive over sizing of the power supply hardware can be avoided this is how our tecnomatix plant simulation software helps our customers to save energy and costs sustainably.

This was energy analyzer with this our course is complete. We have tried to develop or the teach the techniques to the use to develop the manufacturing systems the advanced techniques like plant simulation softwares and some statistical tools are taken this quantity Dr. Deepu Philip has mostly focused on engage statistical tools how to quantify the greenness, I have focused on the design and value agility qualitative aspects the subjective aspects.

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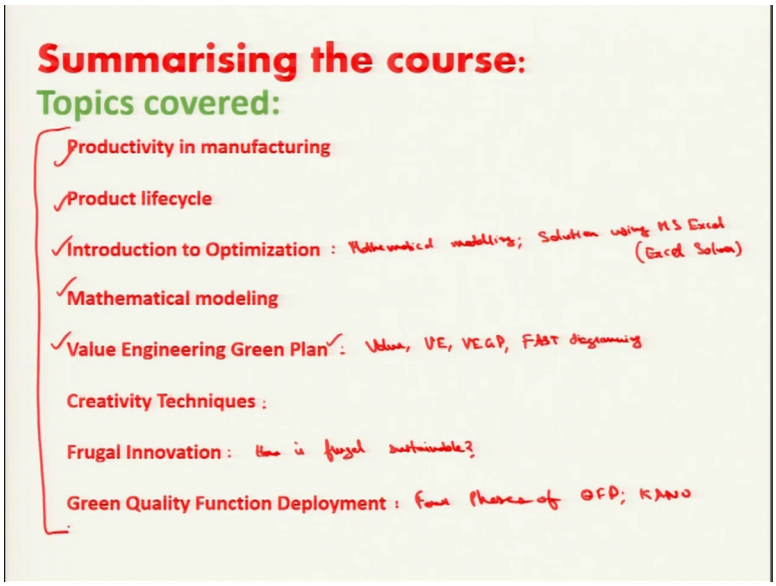

To summarize the scores I have just put what we have covered in the course in two slides here these are the topics that we covered in the first part we covered productivity and instruction this that was taken by Dr. Deepu Philip.

We saw what is product life cycle; then we went to introduction to optimization; introduction to optimization. We saw the mathematical modeling we saw mathematical and we saw the examples on this also we saw the solution using excel for the example solution using MS Excel in MS Excel we taught you how to install excel solver and how to use that and MS Excel solver then demonstration specifically I will put here, MS Excel solver it is known as excel solver actually excel solver demonstration of this was given then also we saw, the value engineering green plant in which we saw what is value what is value engineering and what is value engineering green plant.

So, what a ways techniques to conduct value engineering, what are the product at restricts, what is fast diagram that we saw, FAST diagramming then we went to creativity techniques in creativity things we saw the certain techniques like brainstorming, Gordon technique, check listing those techniques were discussed then after that we had a little discussion of frugal innovation how frugal is sustainable and frugal versus quality frugal innovation versus social entrepreneurship we saw how is frugal sustainable.

Then we went to green quality function deployment in green quality function deployment we saw how the voice of the customer can be converted to the manufactures

requirement. We went through the four phases, four phases of QFD and how to inculcate the greenness into this before that we saw what is KANO model and way can we put the green aspects into this analyzing voice of customers then product design specifications concept comparison preference rating these things were discussed.

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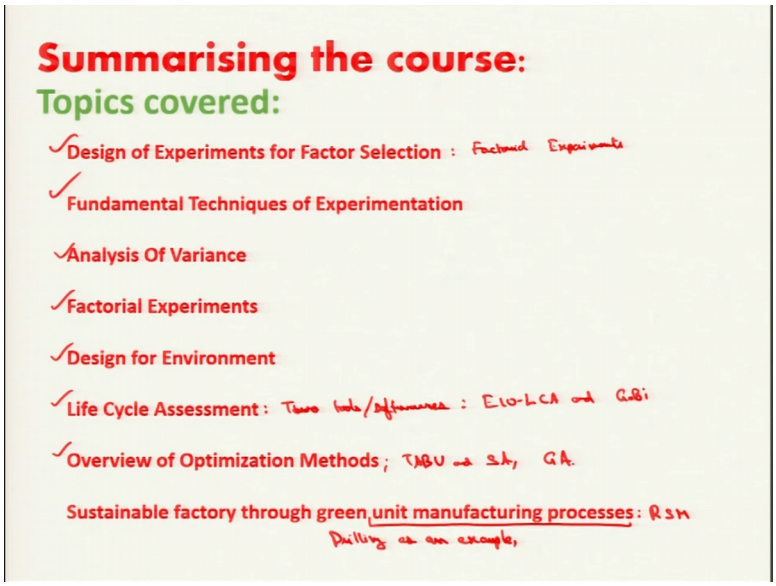

Then after this first part of the course we went to design of experiments for factor selection Dr. Deepu Philip took this.

So, here he discussed what are types of systems the variability in experimentation process then experimentation of process schematic, then observational study versus experiment and factorial experiments were discussed. And also I took response surface methodology RSM; here when I developed green unit factory using green unit factory processes before that we saw the fundamental techniques of experimentation in which we saw basic steps of experimentation then we saw what is ANOVA Analysis of Variance or what is use of that, the complex experiments simple example was taken randomization; randomization sequence then experiment data collection how to analyze the data using analysis of variance then step we step four this were taken.

Then I went to design for environment in design for environment we saw what is product life cycle that is from design for environment viewpoint and importance of design for environment then waste management which had a little light on that. Then we discussed about the levels of design and levels of design for environment and then we saw the

environmental and safety review with this we went to lifecycle assessment in lifecycle assessment we saw what is lifecycle assessment and two tools were discussed two tools or software which were EIO-LCA which was an online tool and GaBi.

Which was a process based tool that was discussed after that Professor Deepu Philip took the overview of the optimization methods in which he took the ANOVA table for two factors and then branch and bound search heuristic and optimization in which TABU and simulated leanings method TABU and simulated leanings in genetic algorithm. These were taken then I went to the sustainable factory in the last week in which we picked the unique construction processes we pick drilling as an example then we optimize this summary is already given in the recent lecture only and we developed the green factory this was the example that we took.

So, this is all in the course advanced green manufacturing systems with this I like to say thank you for being in the course we had an overwhelming response for you people we have an exam prepare well for the exam. We notes those are given in the PPT versions of the lectures is already available and also you can read more on these topics from the books or the suggested material that is there in the our course homepage prepare well for the exams ask any questions that you have in the forum; we will be happy or we will try our best to answer all of them and with this I will say bye and.

Thank you so much.