Advanced Green Manufacturing Systems
Prof. Deepu Philip
Dr. Amandeep Singh Oberoi
Department of Industrial & Management Engineering
Department of Mechanical Engineering
Indian Institute of Technology, Kanpur

Lecture – 42
Green Factory through Green Unit Processes (Part 2 of 2)

Welcome back to the next part of the lecture on developing Green Factory through Green Unit Processes. So, we have obtained the direction model for drilling process that is one of the processes that we have chosen that would go into green factory simulation. We have obtained the regression models now, we need to optimize the regression models for the threat force and for the roughness; that means, we need to minimize these values and for that we have chosen an algorithm it is artificial bee colony algorithm.

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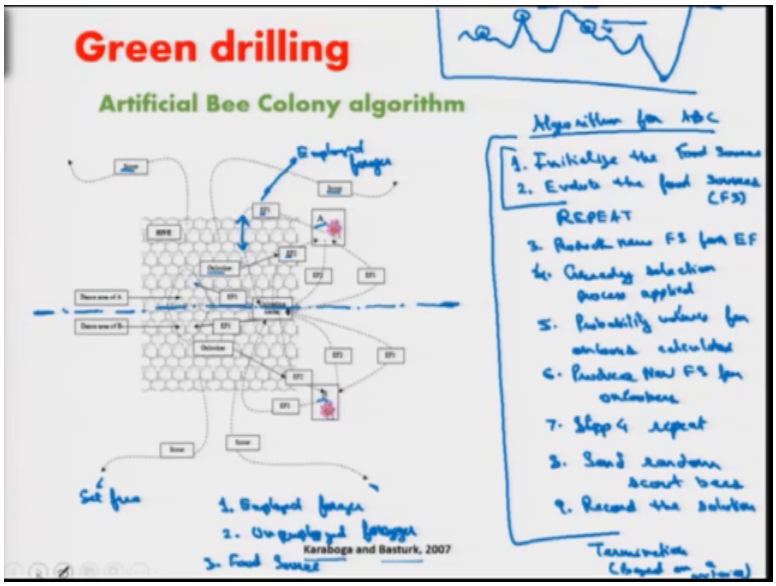

So, what is there in this algorithm? This is schematic of the algorithm that is given by Karaboga and Basturk in 2007. Karaboga actually introduced this algorithm artificial bee colony algorithm which is bee form optimization algorithms. This is an evolutionary computation technique that was as I had said developed by Karaboga in 2005 and it was later advocated by Basturk in 2007 and 8. This is based upon the foraging behavior of honey bees. How does this happen? You can see there is a scout here, and we have EF 1 and EF 2 and onlooker so, these are bees here.

So, these are actually two sections here, if I divided into sections at this point that two food sources A and B. They are trying to search for food sources at the very beginning what happens there is no information about the proper food sources, what are the food sources that the possible solutions.

We are trying to minimize our values, they will try to search the minimum value; for instance this is the chart that is obtained, this is a kind of a graph like this. It has to reach this value somehow, in the beginning they have no information, they will just pick one value. Then after this, this is a food source other two food source might be this, they pick one value let me say here and here.

You start searching for the solution for this to go minimum it can go either in this direction or in this direction. If I say it has pick this one, it can be go either in this direction or in this direction. For this it would definitely go in this direction to search the minimum value that is we call as the nectar value. So, there is no information in the beginning.

So, some scout bees are set free to search for some food sources that is why they are call scout, this scout bees are set free here ok; they are set free. So, when the scout bee finds a food source, it would become an employed bee now. It returns to hive unloads some nectar and performs a waggle dance, waggle dance at bees dance to attract the onlooker bees; onlooker bees are looking at the employed bees ok. These are EF 1 and EF 2, EF is employed forager. We put it here, this is employed forager who are EF 1 and EF 2 this I will discuss.

So, when the onlooker bees are attracted by the scout bees who have returned to the hive with some nectar some value. The change of information about bees happens which is the most important phenomena in the formation of collective knowledge within the bees. So, in that dancing area of a hive communication among the bees related to the quality of the food source occurs in form of a waggle dance.

Since information about all the current resources is available to the onlooker in that dance area, it would watch numerous dances and choose to employed itself at the most profitable source. For instance if this data returns and this data returns this is the lower value, this is lower, this is higher. So, onlooker first try to find the maximum nectar value. It will first trying to pick this value here ok; however, the minimum value is here ok. So, it will somehow reach this value.

Now, in this case for demonstration two food sources are there A and B at the beginning the potential forager would start as an unemployed bee. It has no knowledge about the food around the hive; it has two possible options, number 1 to be a scout for searching around the nest for some food sources or to be the recruit after being motivated by the waggle dance of the other forager for searching a food source.

So, attracted by the waggle dance of employed bees, some onlookers in gage themselves on the food sources A and B after returning to the hive for unloading nectar every time unemployed bees has now two options to be EF 1 or EF 2, What does employed forager one do? It just unload the nectar and then again go back to its own food source, it has just comes here and then go back for searching the lower value, this is one option employed forager one.

Another for option is, it can come to the food source then go to the dance area, so, as onlookers can be attracted by them. So, some other onlookers can be employed now. So, what is all these happening these are all random numbers, all random numbers some random numbers are put scouts, some are put onlookers. Important elements here are number of 1 is employed forager; number 2 is unemployed forager and number 3 is the food source.

So, for this an algorithm can be written, the pseudo algorithm that can be written might be the first initialize. Initialize the food source ok; I will write algorithm, algorithm for artificial bee colony ok. Then what we do? We evaluate the food sources, after this we keep repeating this. I will put repeat and keep repeating this and produce new food sources for employed bees, I will put produce new food source for employed forager ok.

This FS is food source, then we apply the selection criteria that is the greedy selection criteria one who has a maximum nectar that would be chosen, greedy selection process applied. Then we calculate the probability values for onlookers. Probability values for onlookers calculated and then produce the new food sources, produce new food sources for onlookers right.

Then again we apply the greedy selection process step 4 repeat, then we send the randomly scout bees, send random scout bees again, and we record or memorize the solution. So, we keep repeating this until that termination or the N criteria happens, termination criteria may be the number of cycles that we can give. In this case we have to given 2000 maximum cycles can happen or we have achieves the minimum value and multiple times the same minimum value is being repeated; that means, we have finally, gone to the solution. So, finally, we get the termination based upon some criteria based on a criteria I can put criteria.

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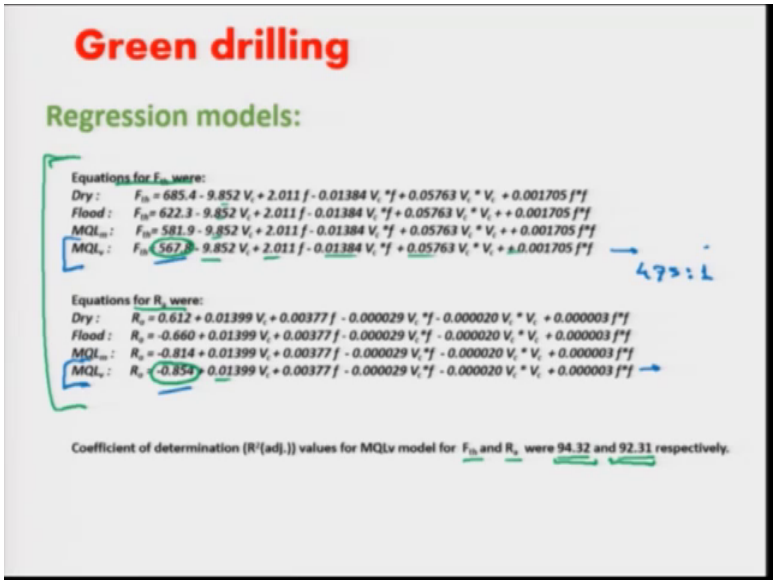

Now, this phenomena of artificial bee colony algorithm is used to minimize these two regression models. Now for these two data, we have observed that you can see this value is of the order of 567, this values of the order of 0.854. So, the ratio of the average values was 475 ratio 1 for them. So, for this weighted some method for artificial bee colony was conducted to combine an equations for that the parameters or the settings for the ABC algorithm was chosen in this way, this swarm size was taken 10.

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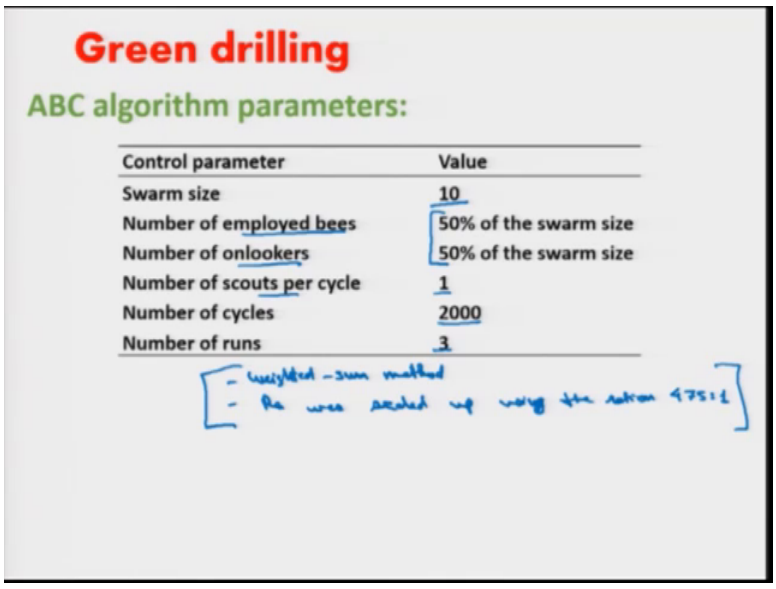

Number of employed and onlookers bees were divided into 50 percent each. Number of scouts per cycle was taken 1, number of cycle is 2000, number of runs is kept 3.

So, it will run 2000 times and try to search for the minimum value. So, the criteria has chosen is this. And we chose weighted sum method in which weights were given to the models to the two models and the ratio of the average. The coefficients of Ra were scaled up using this ratio; Ra was scaled up using the ratio 475 ratio 1. To bring the variables into a equivalent level in a way we have normalized ok. We have 475 is the ratio of the means of the thrust force to the roughness. Now these were chosen and then ABC algorithm conversion was obtained.

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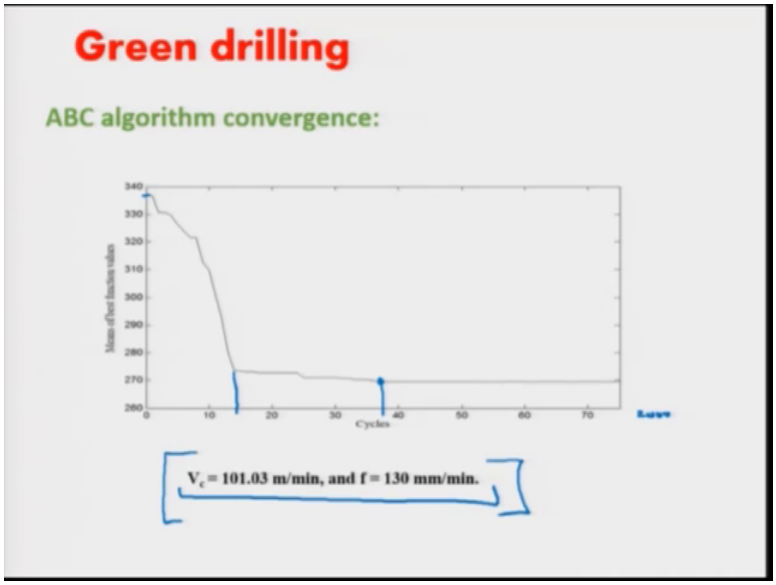

Now, number of best function values was it was chose a value that is around 360 and only in 15 cycles it reach this value. And after around 38 cycles, it attains this minimum value, after that is minimum value was only obtained and for 2000 cycle this could have been obtained. But it stopped after sometime because termination criteria is if you get this value 50 number of times it will stopped their ok.

So, finally, this setting for the machine that is cutting speed as 1o1 meter per minute, and feed as 130 millimeter per minute was obtained which will give us the minimum roughness and minimum thrust force. And we will have chosen MQL vegetable method as the medium, so, this is the way we have obtained the unit green process.

So, this is a setting that is obtained that will give us the green unit process, now, this is one process. Similar studies were conducted on the other process is which were grinding, milling and micro wire electric discharge grinding.

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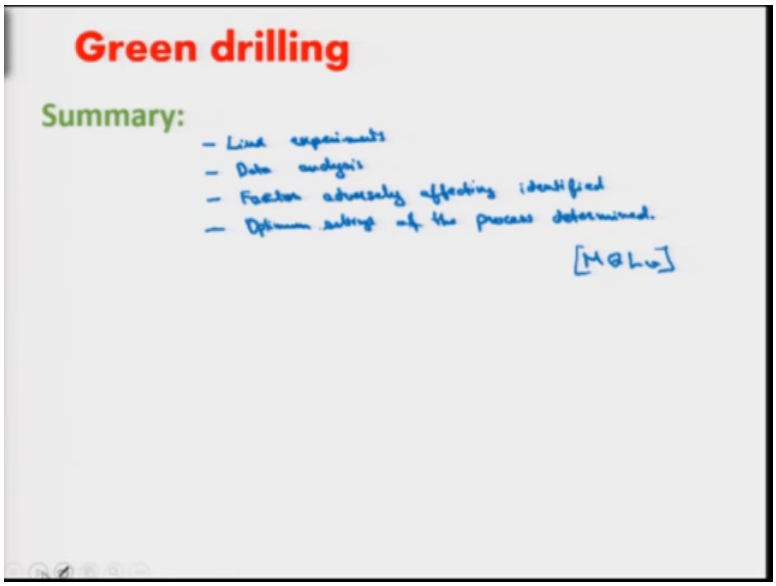

Then we can move to our green factory, before that I can put the summary here. So, we conducted live experiments, this is summary for the unit process that is the greening conducted life experiments, then experiment data was analyzed ok. Then factors identify were identified factors adversely affecting were identified right.

Then simulation ABC simulation is used to determine the optimum settings, of the process determined. So, in this optimum settings we have this specific settings and MQL v method which use vegetable oil was chosen ok. So, this approach was adapted for quantifying green index of a manufacturing facility though the results may not be directed transferable, but approach is transferable here. So, this is a summary for green trimming.

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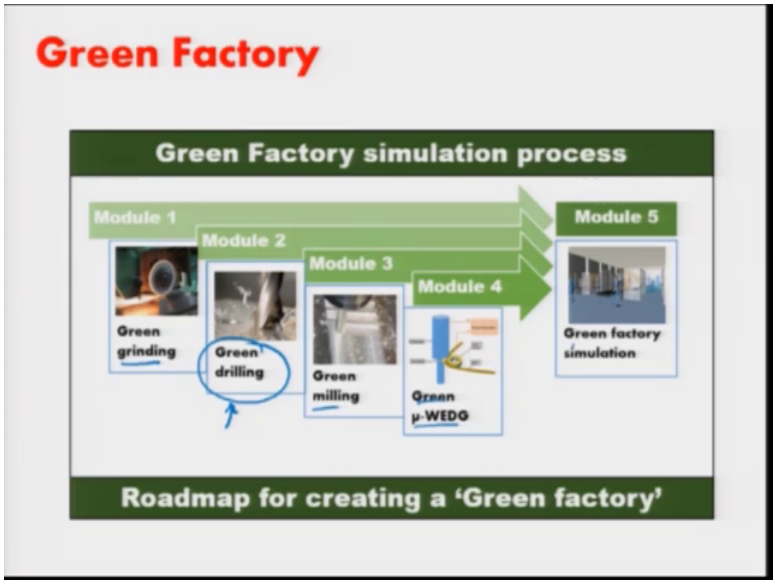

Then we went to the green factory, in green factory again this is the road map we did this one that we have demonstrated. Similar to this we did green grinding, green milling, green micro EDG and then we will move to the green factory simulation, how does green factory simulation happened?

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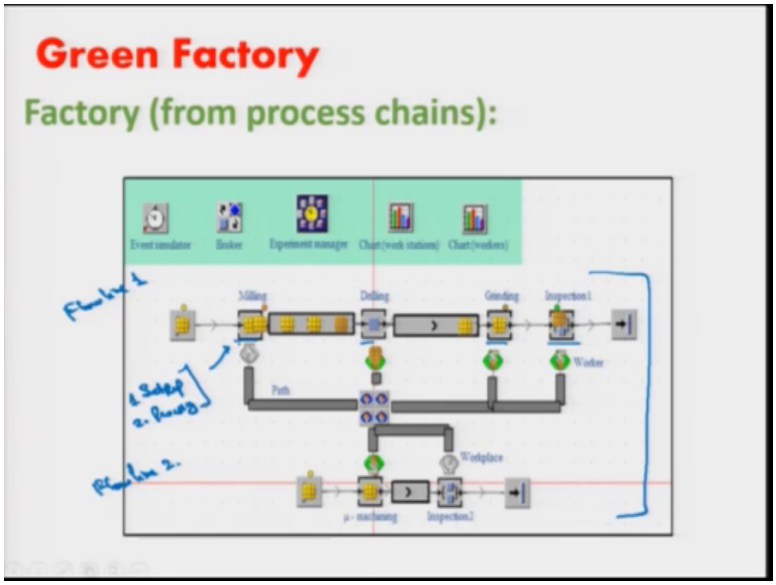

This will demonstrate in the next coming lectures, we will show you the demonstration on the technomatix plant simulation software. Also will tell you how product lifecycle management is important, and what are different modules when we talk about the total product lifecycle management. And what are the various objects and different software

tools in technomatix plant simulation. From plant simulation tells is software that we have with us in our laboratory at IIT Kanpur.

So, this is the set up that is made in this software, this is a virtual factory in which this milling, drilling and grinding and put in series and after that is instruction is there. And micromachining and inspection is another flow line, this is flow line 1 and flow line 2.

So, what are the inputs those are taken from this study that we have conducted the experiments that we have conducted, what are the inputs those go into this factory simulation? That is the time manufacturing time. Now, the settings that we have obtained we obtained specific settings this is 101 meter per minute speed and 130 millimeter per minute feed.

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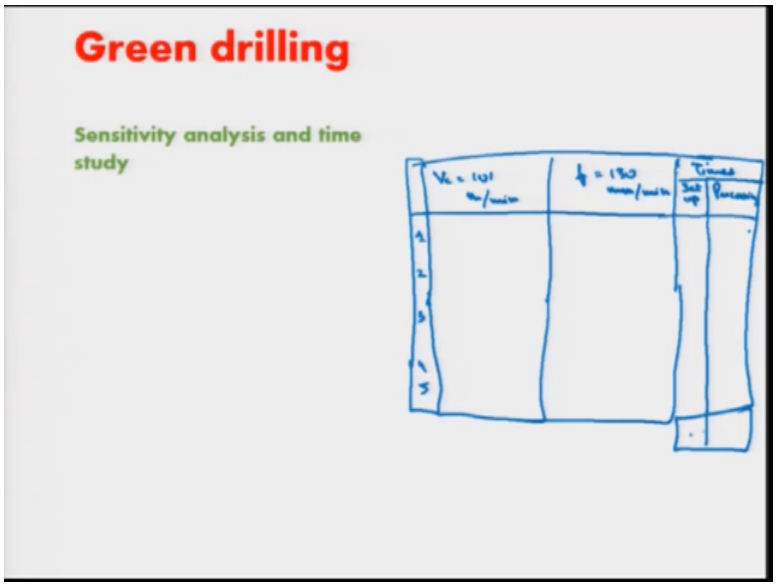

Now these were put in table and sensitivity analysis was conducted. So, we have speed is equal to 101 meter per minute and feed as 130 millimeter per minute. Now in these 5 applications were taken, 5 application were taken application number 1 2 3 4 and 5 to see the sensitivity of the results which are obtained. And it was seen that in this 5 applications 4 to 6 percent of variation was there which was acceptable.

And the times were noted, the times, the set up time and the processing time. These times were noted and average of these times were taken which is now input to my process is here. So, we have set up and processing time, setup, number 2 processing, these times were taken which comes goes as input.

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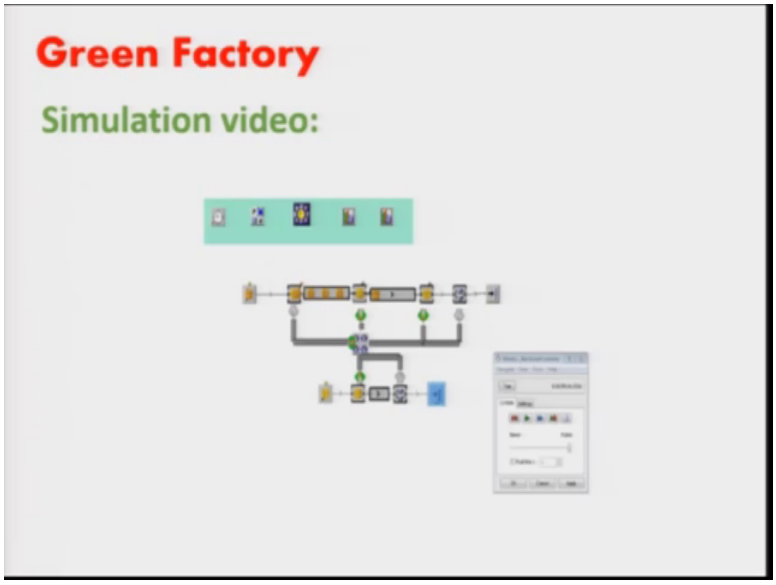

Now, just to give you a little feel that how this simulation look like that will conduct in the coming experiments. So, how did the simulation look like? We will obviously, do it in the coming lectures, but just to have a short video on this. This is when we start event simulator the worker has gone their it does this. It is not the real time it is actually running fast here.

This is a time going on we will tell you all these different features of the software 4 workers are working how do we select number of workers as 4 this things. And what are the setup times those are put here for milling, drilling, grinding because milling is the first process that is done.

And after milling generally holes are made after milling, milling is a major process that in which material is removed. After that drilling happens, after drilling grinding is a kind of a finishing process after that we have also used one is process that is inspection that is a pedal process. This factory simulation will definitely demonstrate in the coming lectures. First will give the demonstration of the software, then we will go to the factory simulation.

Also there is a there is energy analyzer which is not a feature that is available in our present version of the software, but I will definitely try to show you a video made from Siemens in which energy analyzer, that analysis is how much is a energy consumed during manufacturing, that also would be shown. So, let us meet in the next lecture.

Thank you.