Simulation of Business Systems

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Lecture - 22
Tecnomatix: Plant Simulation - Part 2 of 3

Good morning, welcome back to the course I am Dr. Amandeep Singh.

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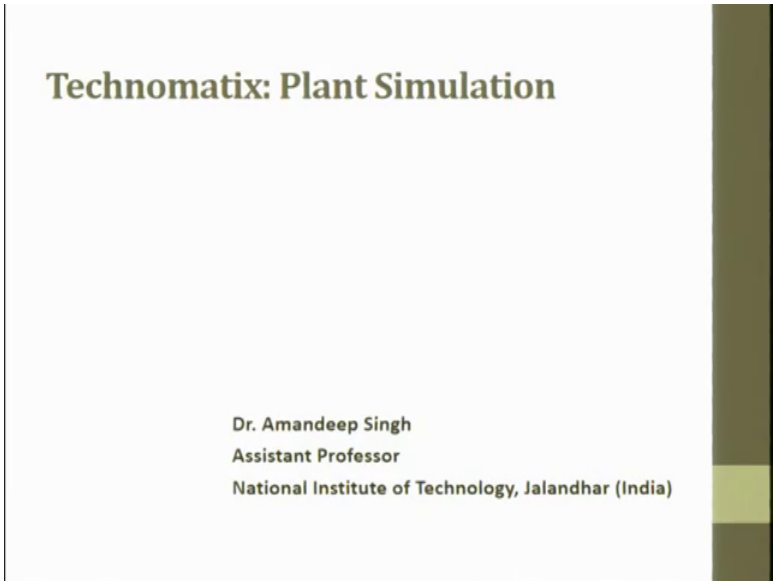

And I will take the Plant Simulation Tecnomatix in this lecture.

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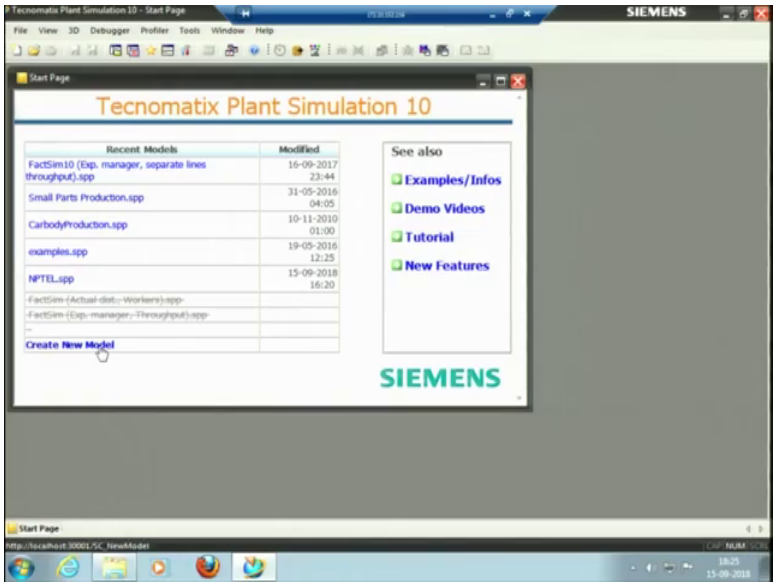

So, I will again to the start page view start page. So, we will create a new model and ok.

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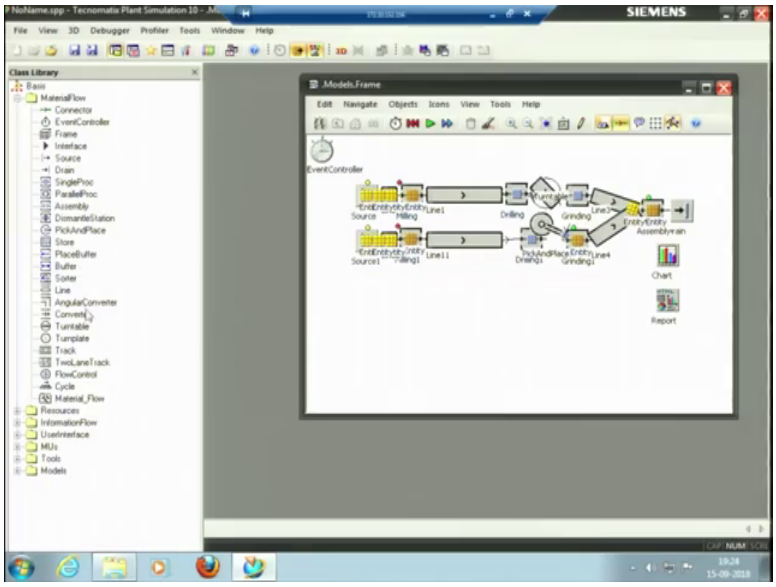

So, this is the model that I will I am trying to generate here. So, I will just open the class library and open the material flow. So, there certain objects here connector, event controller frame, interface all these objects are here. So, these objects have specific means this for instance this is model frame this is frame. Frame I can say a kind of a room one room in a factory ok. One room in a factory means factory in which one kind of specific process is happening. And I can move to another frame another room using

interface ok.

So, I will try to first tell you what are these objects frame as I said this frame is this is to create your simulation models in a frame. So, we create a simulation model then frame this is one frame, and it is located in the folder models in the class library. So, generally frame is located here and also another additional model I can or. So, generally frame is located here in the models ok. So, this is actually the primary location of the object, but it has been kept here as well sometime because, if we need to add a new frame we can add it from the material flow that is the most used class library here.

So, the frames are for the grouping of objects to build a radically structured models by inserting any of the built in objects, any of the built in objects from these. Or any objects that we can design because, we can design our own objects in the software as well; you know there is a code that is written for this software to design the object. So, if someone is conversing with the code it can also design the objects by itself.

So, the frame when we use frame with connectors, or plant simulation, it opens the dialogue select interface ok, when we open the frame it will open select interface. So, the there is a when we will open the frame it another frame it will save case select interface. Interface means from which frame to which frame do, interface is kind of a room ok. I will just put the source here.

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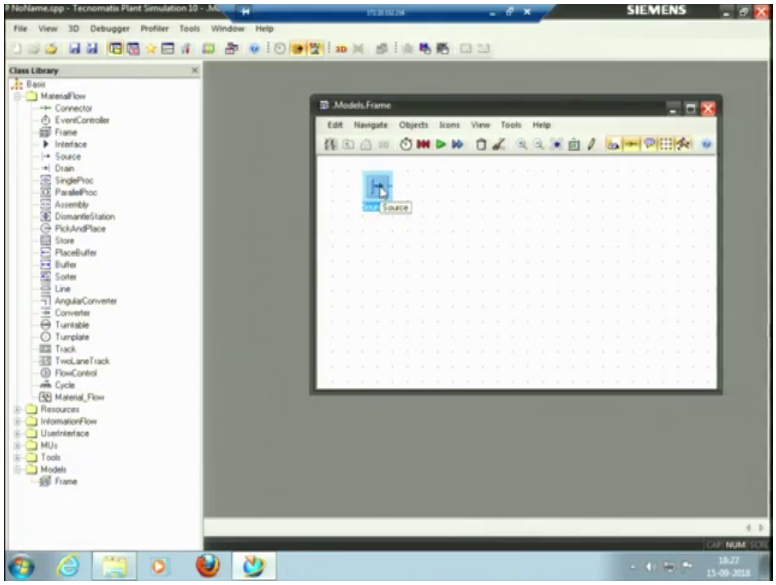

Source is to produce the part of the sequence which we specify in a sequence table. Source is a starting point or the entry gate ok, entry point from where the parcel coming. If the parcel coming in it has to go out so this is the drain source and drain has to be there when we design any layout ok. So, similar to source we have drain so the drain has a single processing station it moves the mobile units. Mobile units from the installation after setting up for it and after processing it moves it away. So, where does it take it to we can put an interface here and take it to the other room ok.

So, one important object here is this single process. What is single process? Single processing unit receives and processes a single mobile unit, it is known as MU mobile unit. So, single process is one process any one process, like I said in the cellular layout different operating for processing units over there ok. Tool processing units can be called as single processes.

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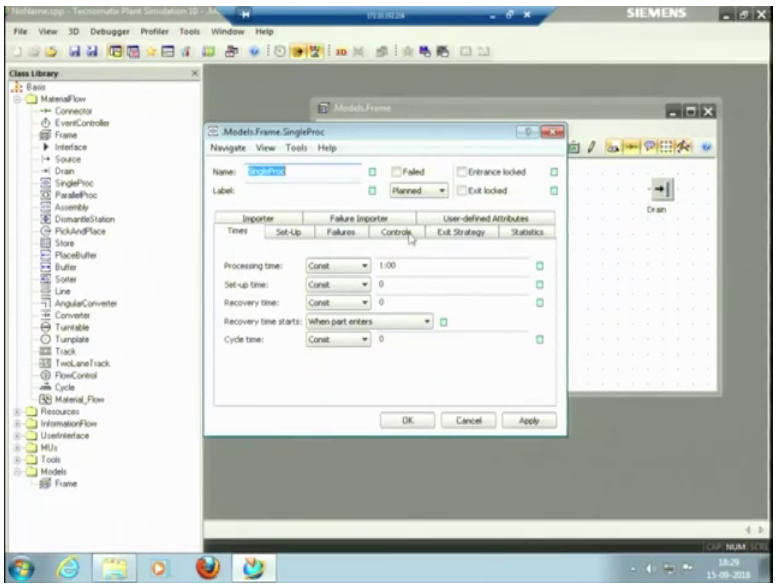

So, if I right click it and open it, this is the single process. So, I can change the name of the single process; let me say the single process is may be milling machine. So, their processing time is there.

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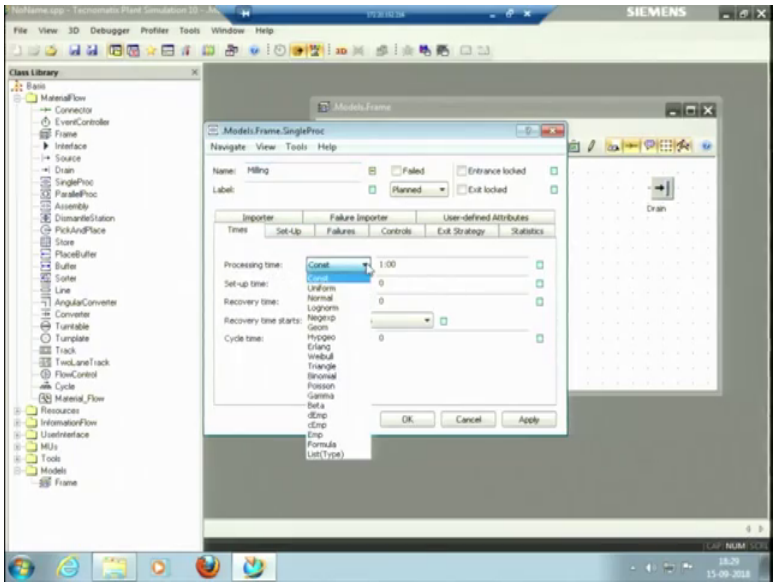

Processing time is we can select any of the distribution. I will talk about a distribution also like the probability distributions are the frequency distribution based upon certain past data that a specific flow follows, with a specific kind of a process follows ok. The constant mean it will constant just take 1 minute so, it is 1 minute.

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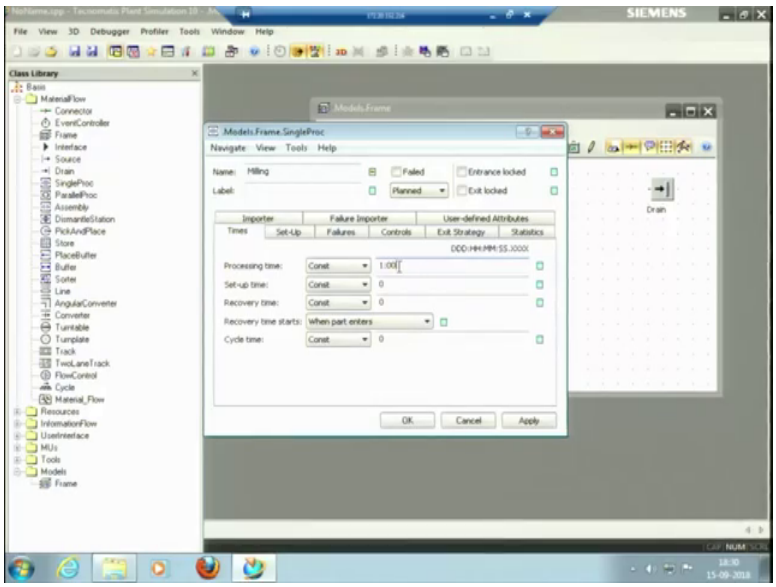

So, the constant format is kept here it is day's, hour's, month's, second's and microsecond's ok, so this is 1 minute the default time. If I pick a distribution uniform distribution which is also known as rectangular distribution, I will talk about this later. It

will ask us to put it in this formats; stream, start, and stop. So, I will just talk about this later, let me first pick any processing time. Processing time, setup time, recovery time and cycle time these times can be put, then also we have the availability.

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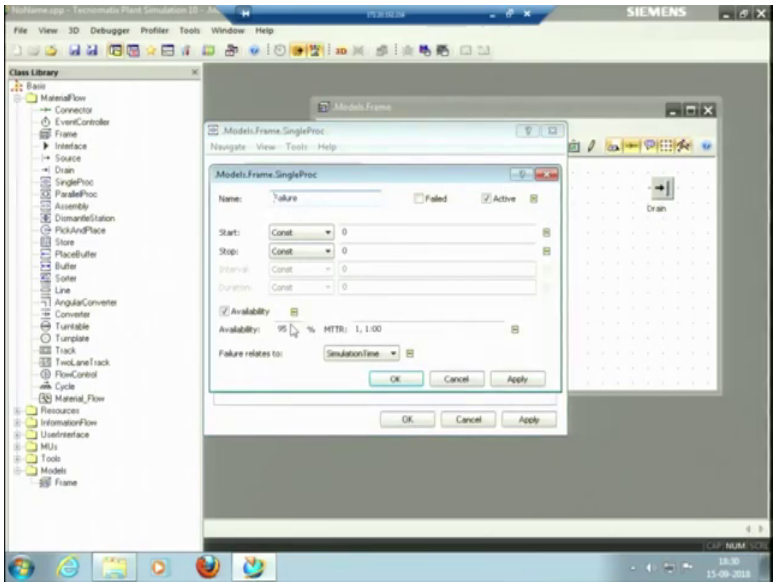

Availability of this process is 95 that is for the 5 percent of the time it would fail. Because in actual conditions for 100 percent of the time the things are not available. So, for the 5 percent of time it might fail, we can change the availability depending upon the process we are working on. For instance it is an automated machine, automated machine can be available for the 99 percent of the time. And if it is some manual operation let me say it is an operation where human is involved; for instance, it is a counter at the entry counter where the person is there person has to take some time off.

Or it has to take some time it takes tea while working or it is something it talk to where the person talk to the other people. So we can think that then the actual situation the availability of the person is not 100 percent, but for the 90 percent of the time it can be available so we can vary this as well. We will work on this, we will work on this I have changed this from 95 to 90 ok, I have change this from 95 to 90 ok. Let me kept default 95 only and I will just cancel let me just try to run a simple model.

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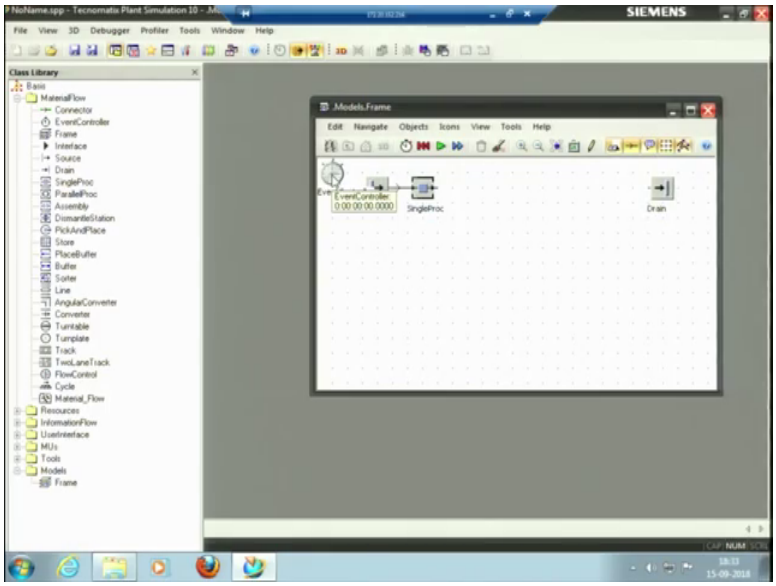

Then we have anything any process or any object we have here. If we need to find the flow at which flow does it follow? That it is a straight line u s, whatever the flow it has to follow it has to be connected using a connector. So, this is a connector the very first object here is connector. So, connector is used to connect n object to the other objects. So, I have connected source to a single process and a direction is showing the, this direction arrows showing the flow ok.

Now, an important point here is event controller. Event controller is a so whenever we need to model something we need event control. So, I can add event controller here or event controller you can also the event controller is just here in the tab here ok. So, event controller, what does it do when you are model needs require it; you can select settings of controlling the simulation done on the tab.

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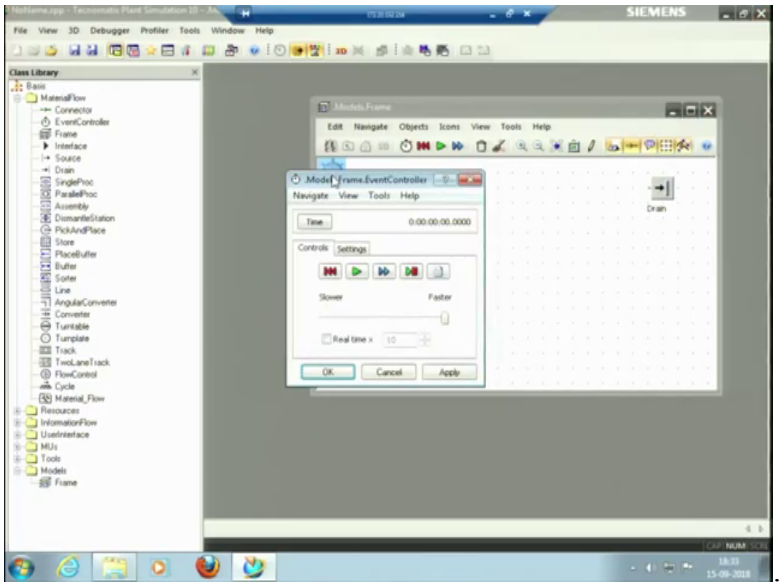

And this in this event controller for instance, this settings in the settings we can say when would the process send.

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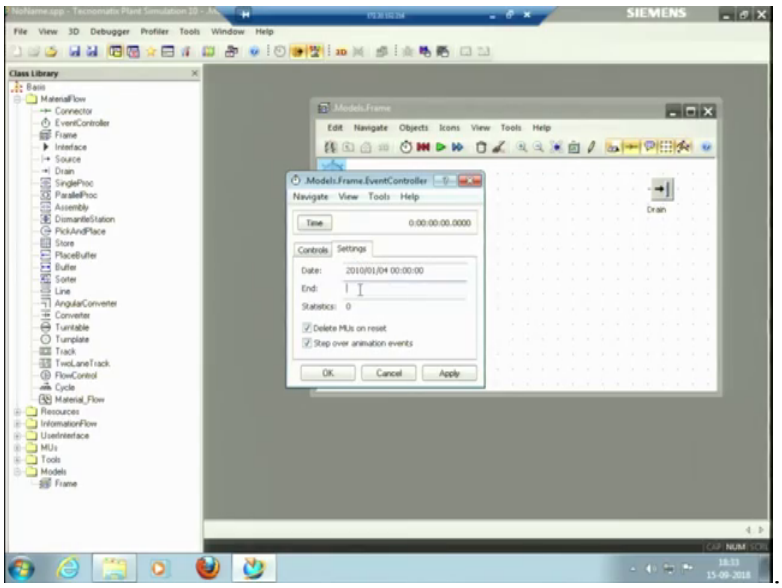

If we do not use event controller the process would go for infinite time. So, let me try to just put another source here or note another single process here. Let me consider they have 2-3 processes ok.

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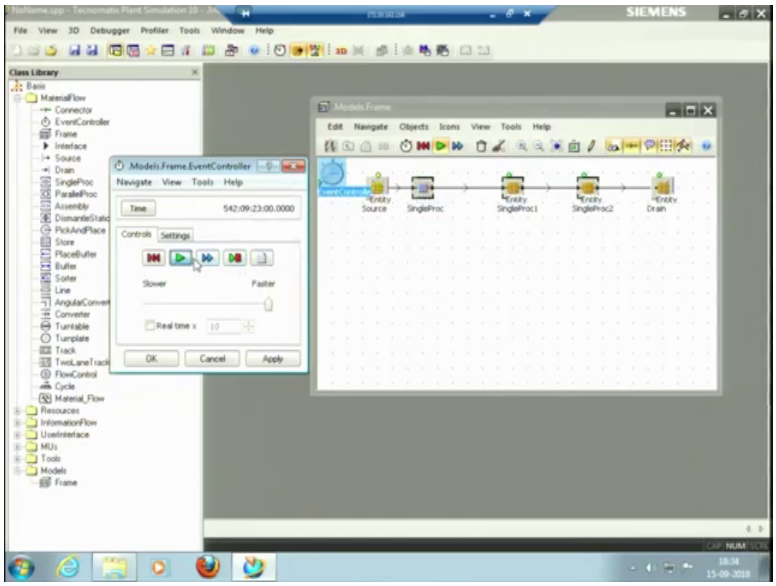

I will use connector to connect them ok, these are now connected, now this is the last one is not connected. If I now run this using my event controller you know there is a play button. Button for play button for the start or reset the simulation ok, this is fast forward if I run this, it is running at the fastest speed you know it is what is the time going on this time where the cursor is this time is 200 and 300 days these many hours. So, it is running the fastest speed ok, if I stop it here it has run for 566 days based upon the constant processing time it was 1 minute for single process 1. And for single process 2 it is 1 minute if single process 3 again it is 1 minute. If I right click here and open.

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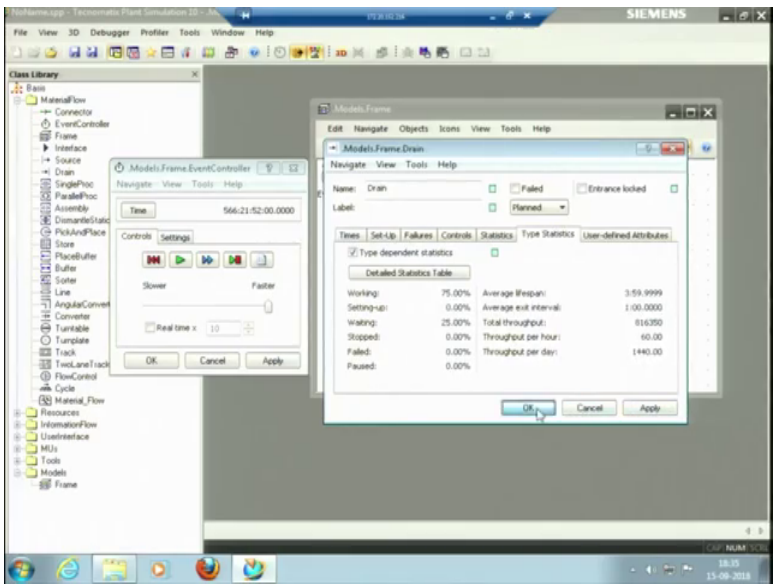

I can see my throughput here in a type's statistics in the type statistics. So, it has to do is 1440 pieces throughput per hour is also given. Throughput complete for 566 days it has run for 566 days ok. So, it has produced 816350 these many number of pieces ok, so I consider throughput. Now there is a big flaw in this flow line, we have just connected we have one thing is we have placed the drain and process 1 at some position. So, you can see these dots over here, this dots this is the dot 1, 2, 3. It is kept at about 3 meters away from this ok; it is kept at about 3 meters away.

You know when we put the machines in a workshop there is a span; for instance in your laboratory when people are sitting in an office this is span. One counter or not if it is a one cabin and another cabin there is a space designated for that cabin minimum space this is ergonomics. You know if we talk about plant layout this is work study. What is the minimum space that has to be kept? So, in case of manufacturing this space the distance between 2 machines not considering the width of the machine it separate. That other than the width of the machine the space between two machines is generally kept from 0.8 meter to like even more than that ok.

So, that the workers can move from in between ok so, this is the space in between; I have just kept it that random point here random location here. Now, it is not taking any time for the material to travel from the single process 0 to single process 1. I will name this, I will open I will call it process milling the examples which are picked, apply, ok; so this is my single process. I will name it after milling I can pick drilling ok; so this is process milling, drilling, and I can pick grinding ok.

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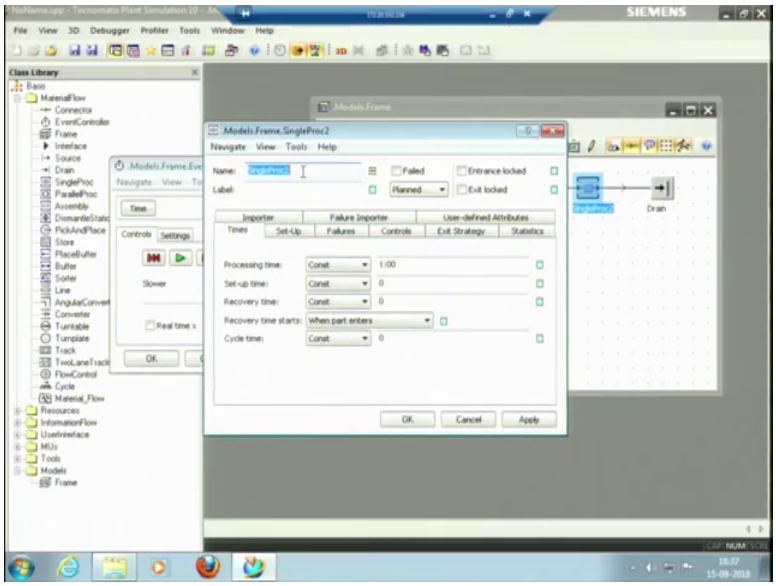

So, what is it doing? It is trying to move from milling to drilling in no time. The time taken in between here that here the time taken by this connector is 0, again the time taken by this connector is 0. Right way to do this is to use some material handling system; you know they are certain material handling systems here. We have turn table, we have line is kind of conveyer, then we have a pick, and place robot ok, I will try to use these and like to tell you that how do we use this. So, I will just pick line which is a conveyer and put it here ok.

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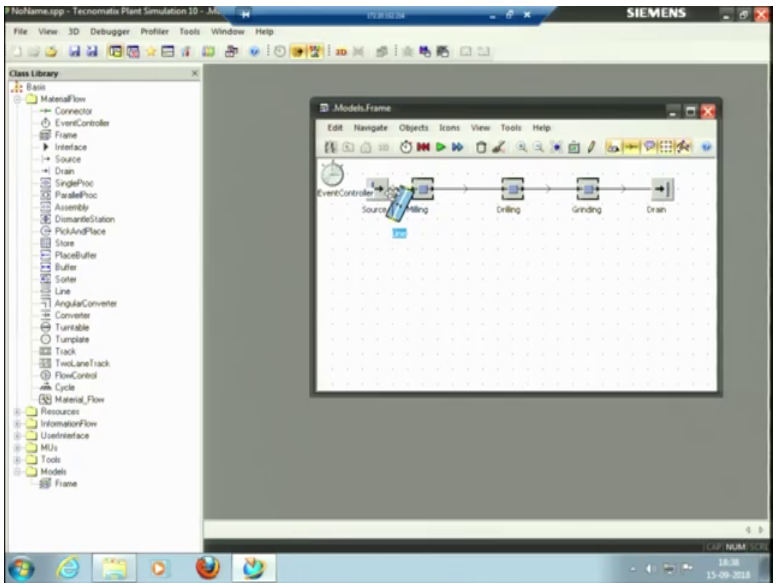

Line I can the shortened distance, but I have to make sure that this is connected. This is connected to process 1, but not connected to process 1 deleting. So, I am just selecting it and pressing my delete button so, this connector is deleted to this line, is now connected through. Sorry, connector has to connect the line to milling ok, I am so sorry for this ok.

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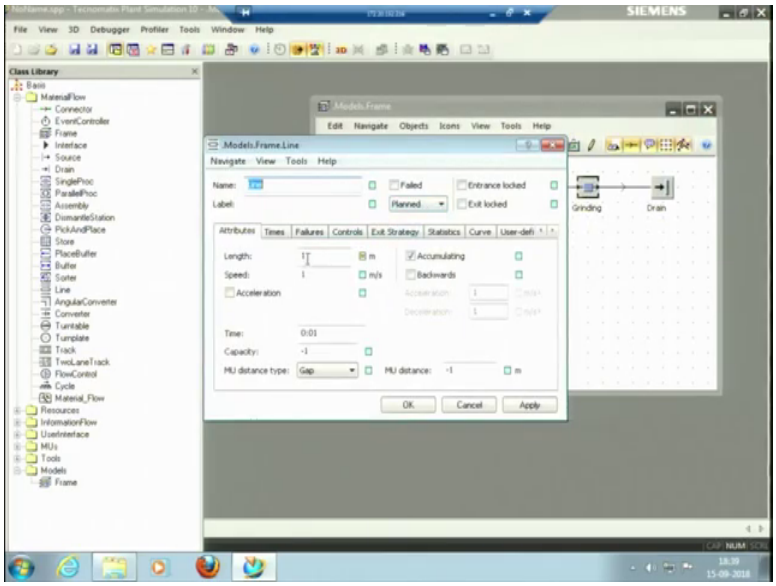

Now, if I right click here and open I see the length of the line is 1 meter. Length of the line is 1 meter that is and the speed is 1 meter again. What is this speed I will just let you know; if I put another line here, line is my conveyor ok. I will take this connector off first this connector I am taking off, delete, yes, put another line here.

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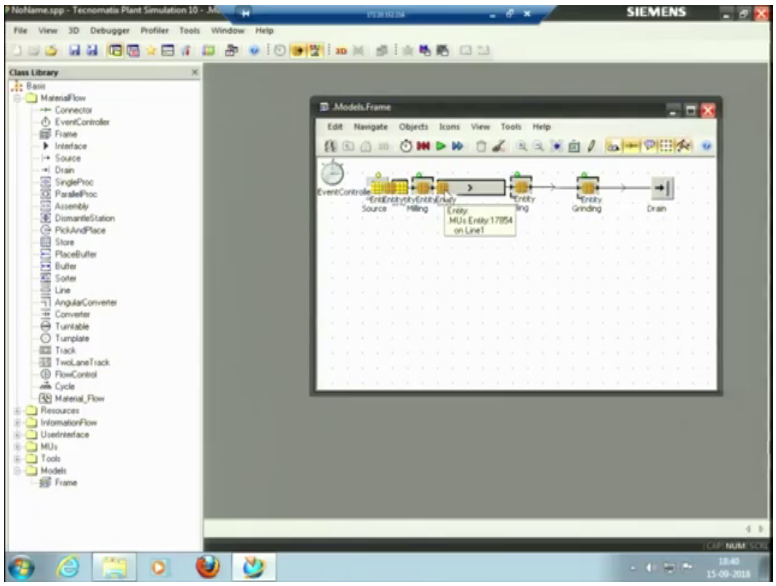

This connected, this is connected by itself. So, I will extend this line for I can if specifically put the length ok. This let me say the length of the conveyor is 4.5 meters ok, I have put it 4.5 meters ok. So, 4.5 meter actually the grid is on because the grid is on it will just snap if we think about know about this snap command it will just snap the specific point. Now the grid is taken off now it I can move it at any point ok, unless the if the grid on to just to series. So, it will take my mobile units; the units which we you can you could see here these entity. This entity is a mobile unit that is a 1 unit is being moved from 1 point to another ok. This mobile unit is moved in a speed that is mentioned on my line on my conveyor. The speed was, let me say what was the speed.

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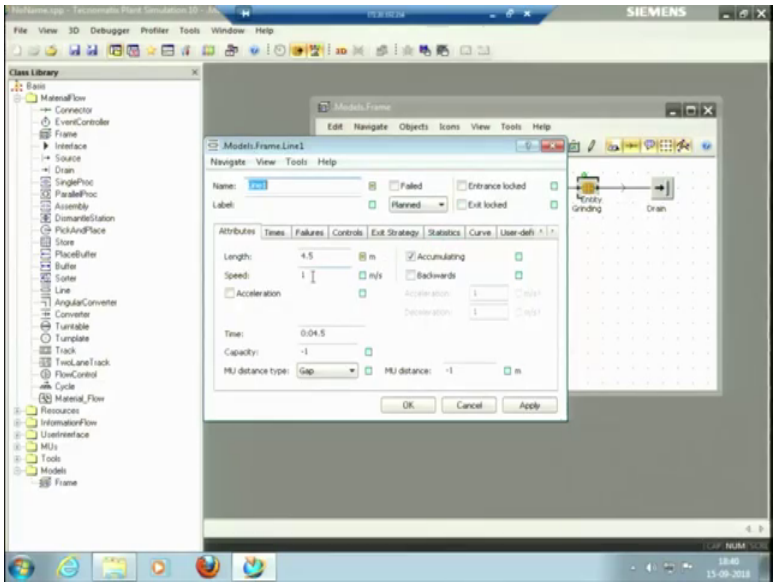

The speed is 1 meter per second ok, speed is 1 meter per second. If I try to see this at a lower speed in the given controller.

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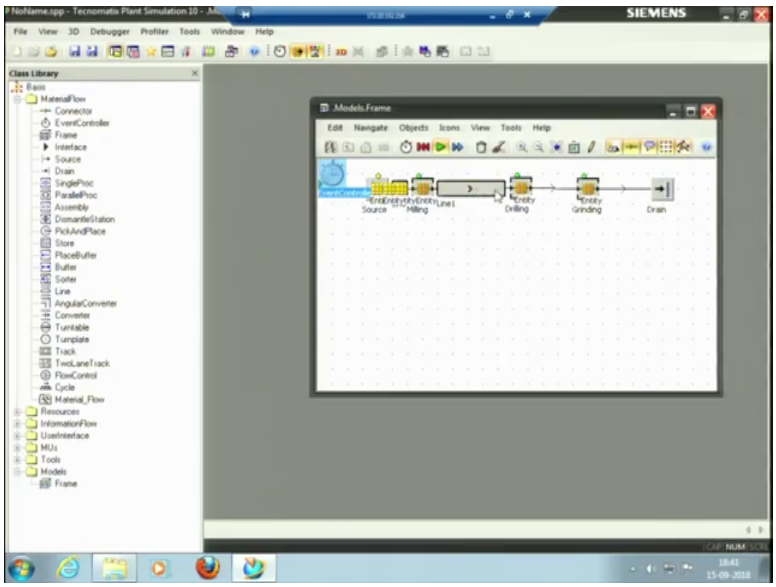

Let me say I like to just see that how the simulation running you can see it is going at 1 meter per second or I can just do with in real time it will take actually 1 will process with our own real time I will put a real time into 10 times. Then apply back and now enter real time into 10 times. So, in place of 1 minute it just taking 6 seconds here, because 6 seconds it has moved at a speed of 1 meter per second into 10 times, it has moved at a 10

meter per second ok; so, the capacity of the line is only one piece here if you can see.

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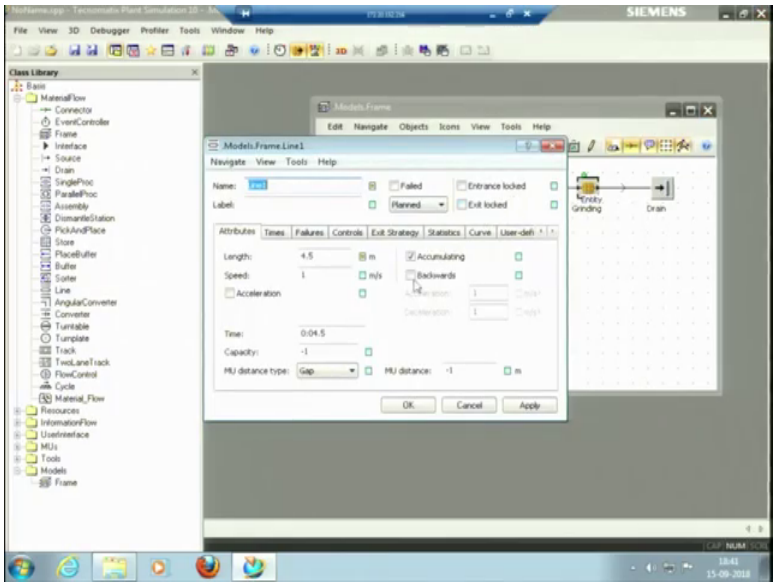

Capacity is put negative is not more than one pieces. I can put the capacity as may be this line can carry two pieces and distance between mu distance is distance between the mobile units. Mobile unit can be just kept like this or the distance can be so I can put the distance is 1 meter again. Apply, then back, and again run now you can see 2 pieces can come on this line. So, this is the capabilities of the short run of the processing is happening. The green colour here means, let me consider the dots, here this is yellow dot, this is green dot ok.

Green colour means processing is happening and yellow colour means it is being blocked. Block means that the successor the process is doing something successive conveyor is completely fail and the predecessor that is the our source here. Or the edge line one is blocked because, the successor is waiting successor is completely full filled and it cannot just transmit material from one point to from its own point to the forward process so, if this capacity is 2 now ok.

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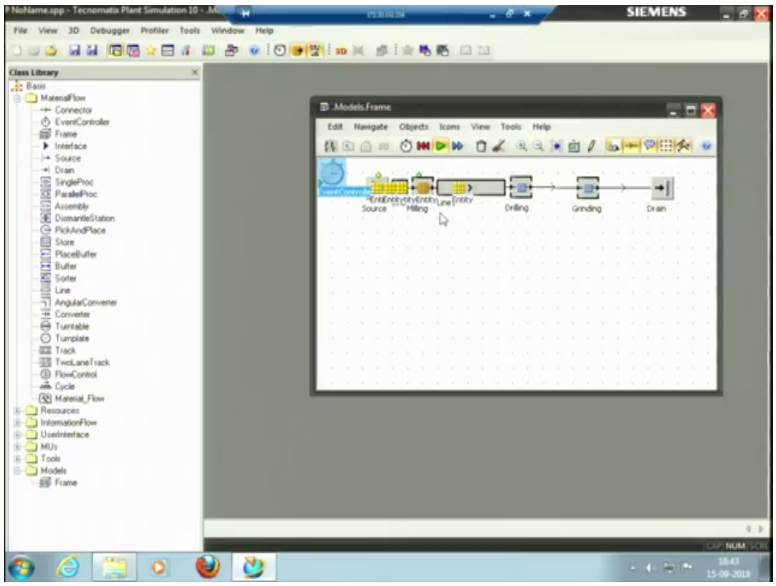

Now, why is it not connected to here, it is stopped here, it should not stop let me run this again with a given controller let me make it real time into 50 apply, ok run. The values you entered for capacity and mu distance into the object models frame line caused a deadlock. Do you want to stop the simulation? No.

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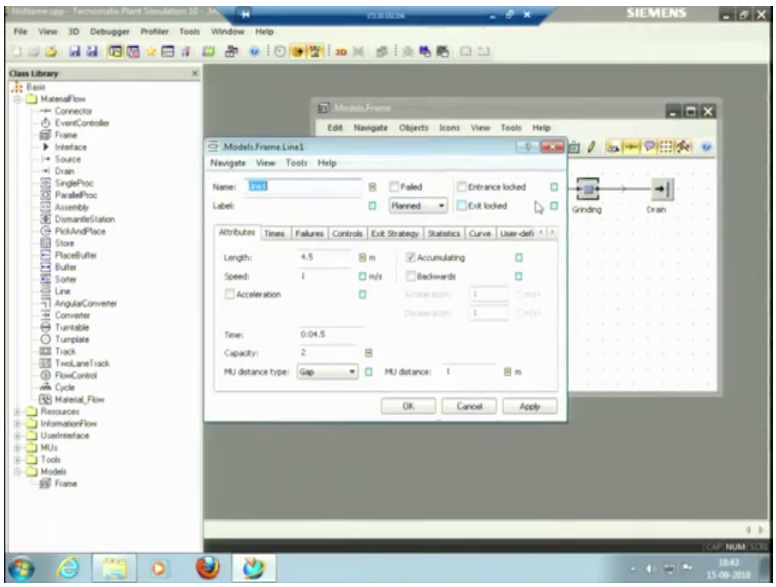

It has said the value which I have entered here so it is important to note the error. It has the capacity is 2 and the mobile unit distance is this 1 so it is not acceptable here. So, it has claimed of the created a deadlock where the process is would not. So, I will just keep

the mobile unit or I can just restart button I will just remove this line.

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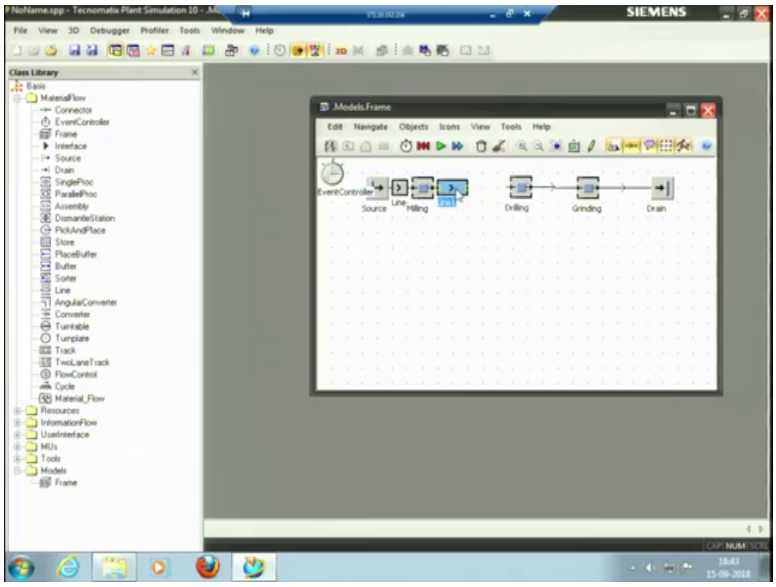

And add another line, because I have to change all the dimensions I will just try to pick the default values which are there ok. I connect using a connector.

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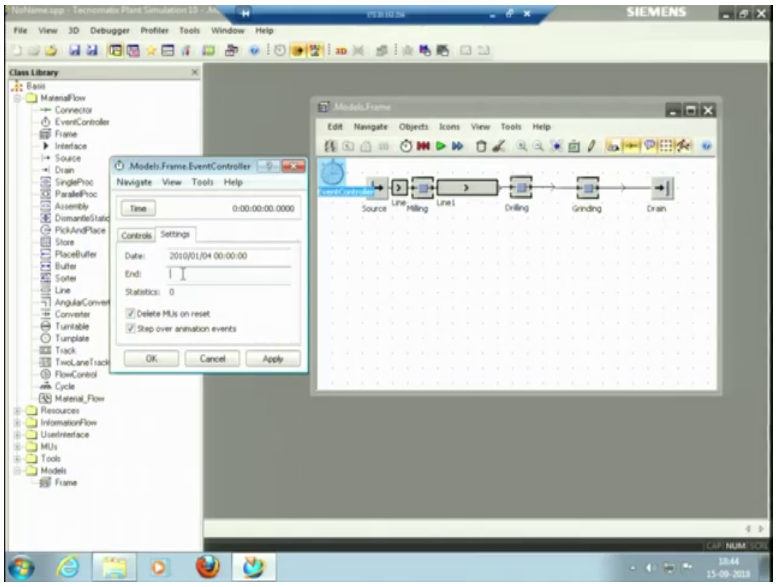

And in the event controller, in the settings I can put the end time when would my process end here. So, it is in the format this is days, this is this first 0 is days, second 0 is hours, then this is minutes, this is seconds. So, I can put in an 8 hour day it should be 0 8 colon 0 0 colon 0 0. So, it my simulation would now end at an 8 hour day if I put apply

here ok.

Now, let us run it is running best is one it is running in the speed that is mentioned here. Real time into 50, you can see in the real time into 50 time is running or let me try to run it in the fastest pace. So, I can see in the setting that time is kept 8 hours ok. So, if I need to see it in a fastest way so I will just apply and ok. So, let me start so, it has run for 8 hours at the fastest speed it has run for 8 hours. I can now see the throughput here.

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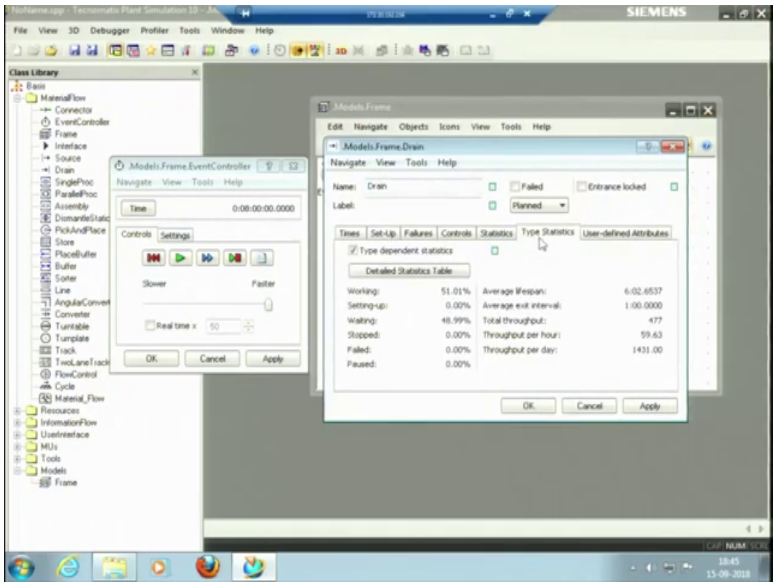

Open, right that this is 1431 pieces total throughput is 477 in an 8 hours 477, per hour is 59 pieces, and throughput per days 1431 ok. So, for an 8 hour it is telling this much, per day it is considering 24 hour day here ok. So, I can see the all these throughput and I can even see the reports, I can see various charts as well like at for how much percentage of time the process is blocked, for how much percent of time for the complete 8 hour day, for how much time my process is plot or waiting or actually processing.

Or for how much time the failure has happened in which process. Because you know failure is 95 percent so some at some point of time failure could also happened. So, all these thing can be seen. For that I need to use resources, before that I will have to make you to note that we have not even yet put anything between the drilling and grinding.

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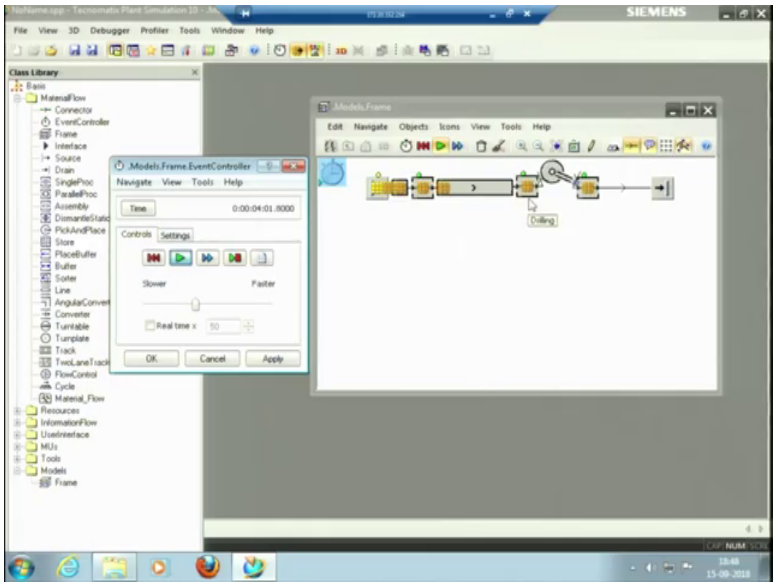

There is no material handling system. So, I like to put pick and place robot pick and place robot. I will these are the names if it is I will getting a little congested I can take this off using this command. So, delete this connector; now, I will connect using the pick and place robot.

Now pick and place robot would just pick the material from the predecessor that is this drilling and put it to the successor that is the grinding ok. How does this work let us see first of all let me try to reduce the speed just to make you people appreciate it in a better way and see how the simulation is happen. So, it is trying to now the processing is happening, it will now pick and place; you can see pick and place.

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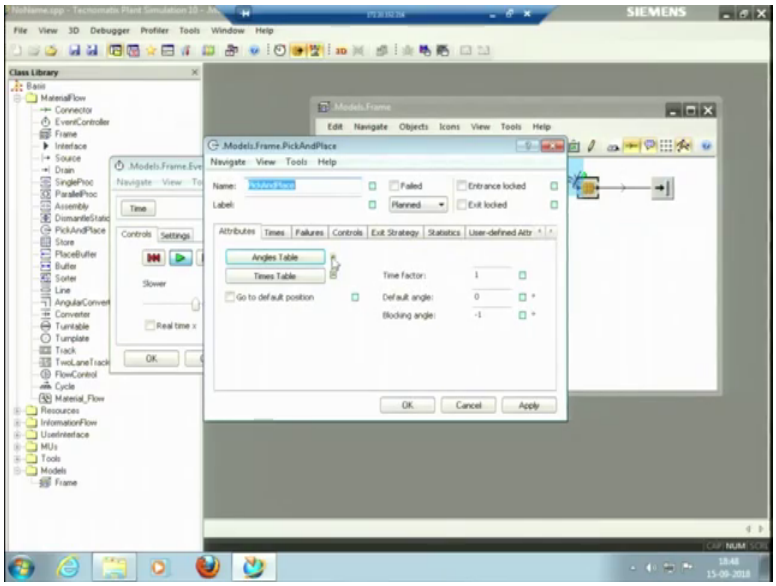

For pick and place robot also we have this speed; pick and pick and place ok. What are the controls here? Entry exit ok.

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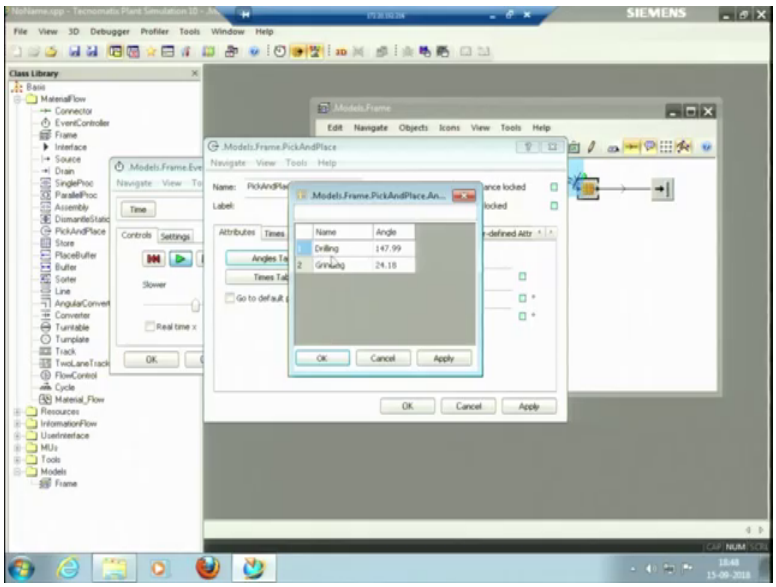

What are the angles? Angles between drilling and grinding all those things we can consider here, and it is times and failures.

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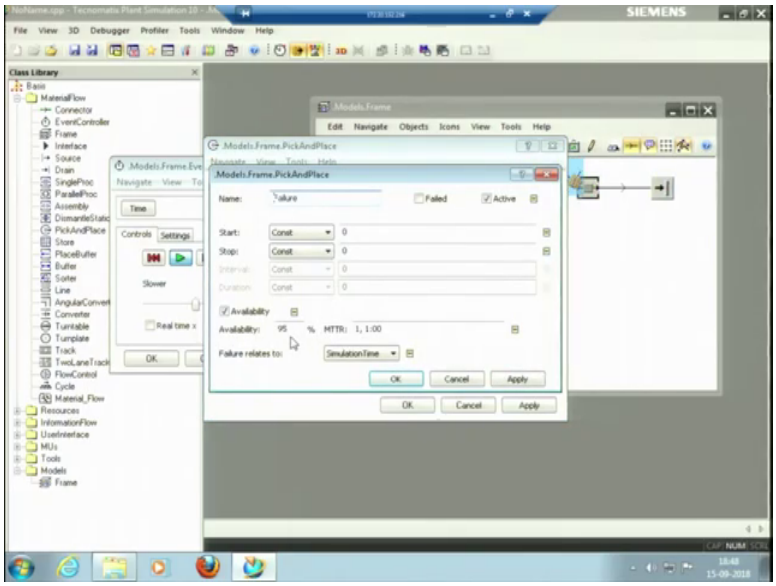

If we had this is also 99 percent failure which is MTTR is mean time to repair this is reliability engineering. In reliability engineering we have mean time to failure, mean time between failure, mean time to repair. So, if failure happens if actually the process is fail that is the it is stop it takes about 1 minute to repair that ok. So, these attributes we can select.

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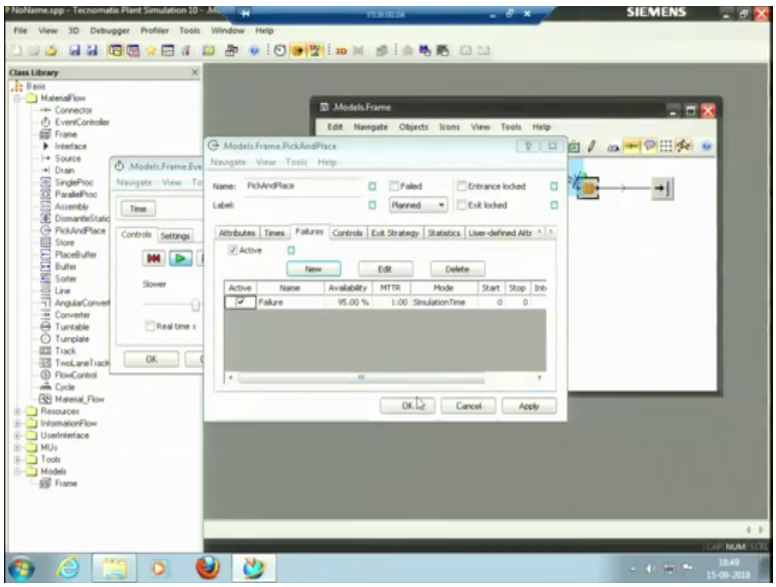

So, I will keep it default only, so it is still running it is run for 18 minutes and 28 seconds so this is pick and place robot. So, what I was talking is that let me put this and the grid

on here.

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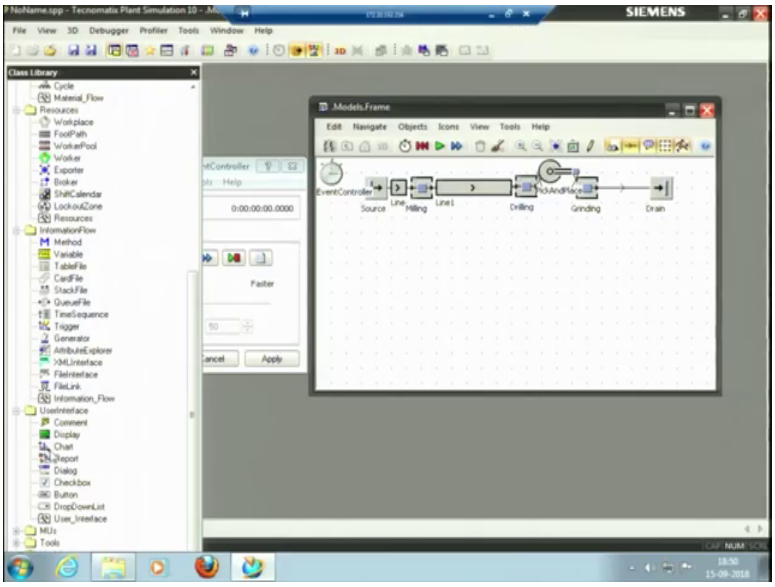

So, we can use some resources sometimes like the workers; if you are working on. And the broker is there; who was trying to distribute the work to the workers. Workplace is there, footpath , work pool is there. Like I could showed you in car body manufacturing, and information flow, if the information has from the methods specifically has to be defined sometimes, then generator, I will explain these objects later. Let me first try to show you a simple flow line. So, this is in user interface I have a chart, I think user interface means, I will put a report here and I will put a chart here.

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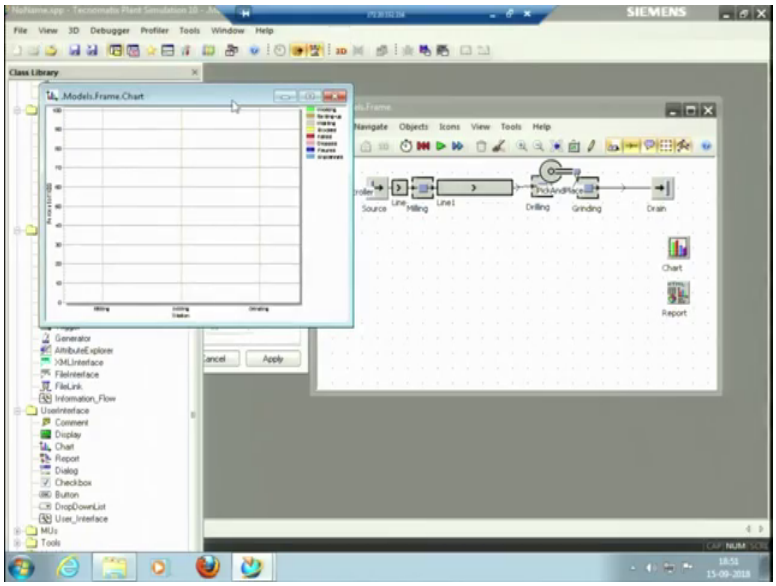

User interface means anything that the user could see after the process has run for one time. So, if this is I have a chart here and I try to just drag my process is here milling drilling so I am just trying to put the process is here ok. Now when I run my process it will show, you can see this chart.

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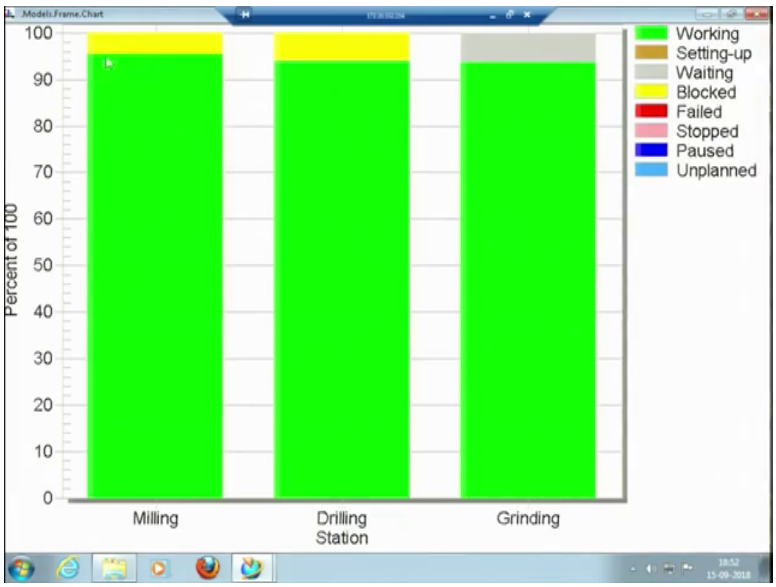

You can see this chart it is a different colours are there working setting up, waiting, block, failed, stopped, paused, unplanned all these times are there. So, when I run it for the 8 hour day, let me try to run it for an 8 hour day so it is run for an 8 hour day. You can

now see based upon the time which are put here the present times this process milling. Milling is working for about more than 95 percent of time and for the rest of time it is just blocked. Because the next process drilling or the next conveyor or line the line which was kind of a conveyor which is transform a material from one point to another machine. So, that is trying to block this one this a also block, but this is not block, but this is waiting for the material to come ok. So, it these are working for I can see the exact time; this is the graph, which is just showing this calibrated graph here. I can see the exact time as well using these processes.

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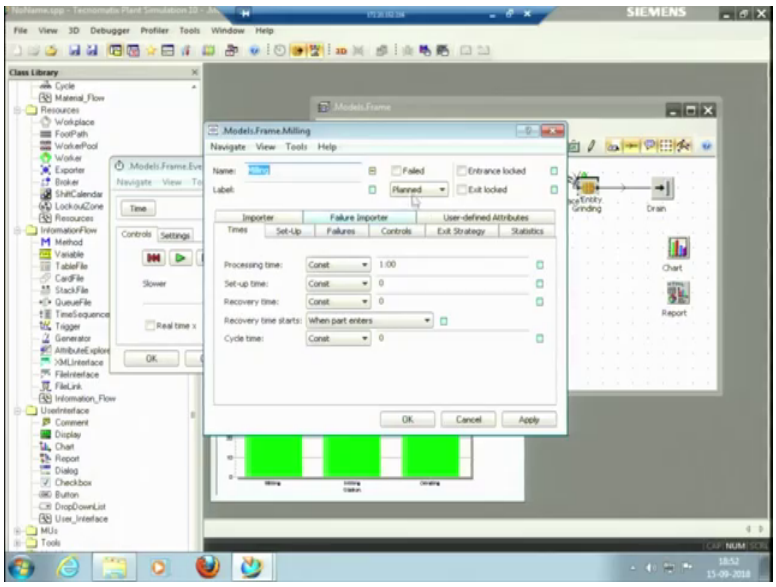

I can open the process; I have opened the milling process. Now I can just see the statistics in this process.

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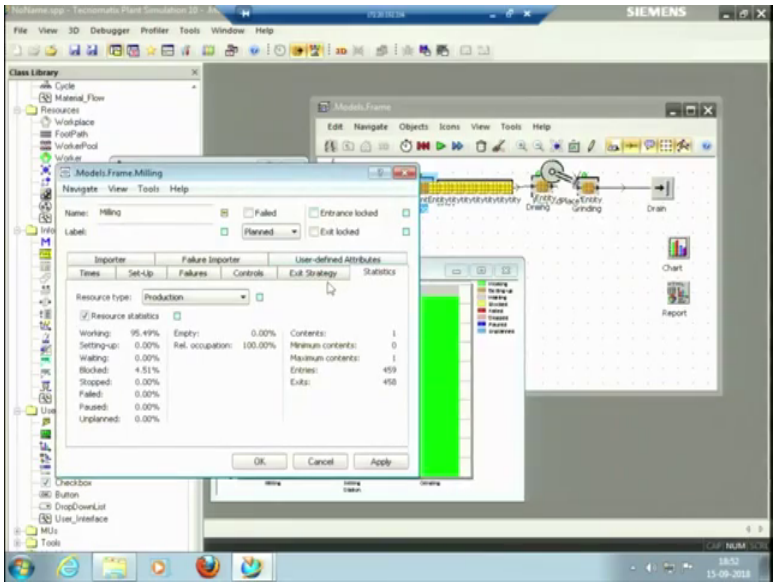

I can see that for 95 percent of time if you see here, 95 percent of time machine is working and this block for that about 5 percent which is 95.5 percent working and 4.5 percent block; which is represented in this graph as well ok. So, let me try one thing, I will say cancel let me try one thing let me try to change the failure rate of milling.

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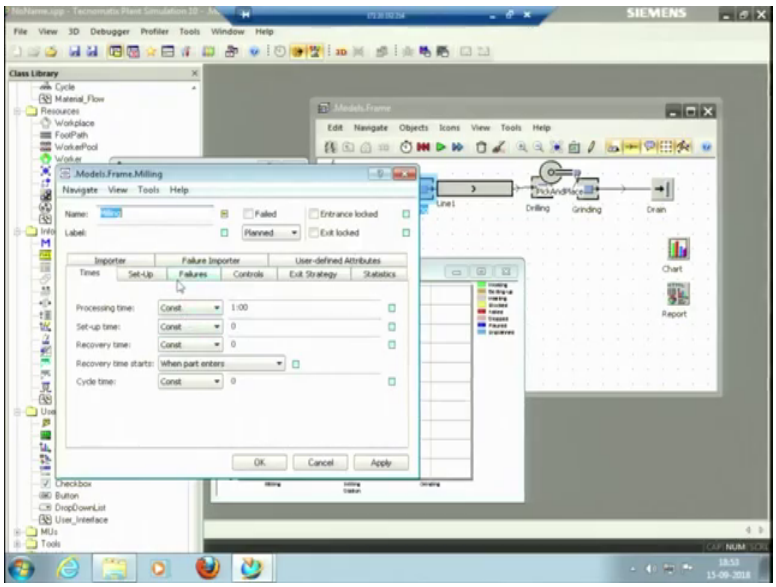

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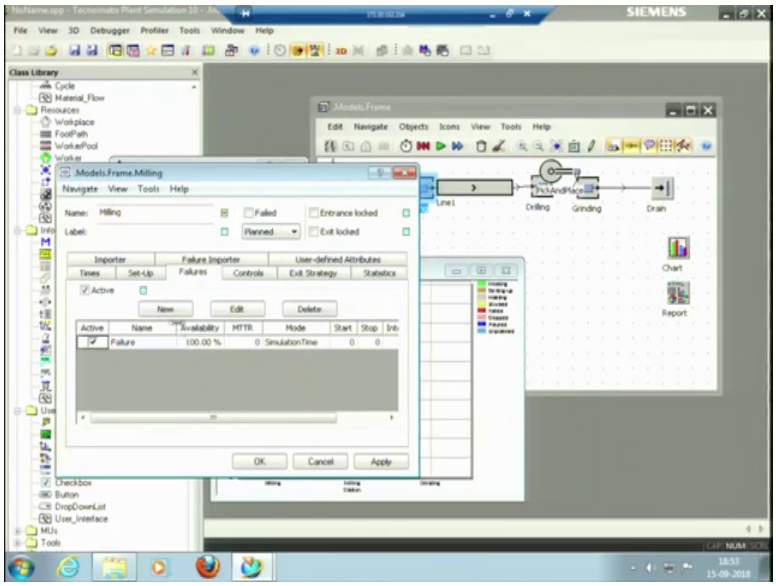

Failures, it is working available for the 100 percent of time so I will just change this.

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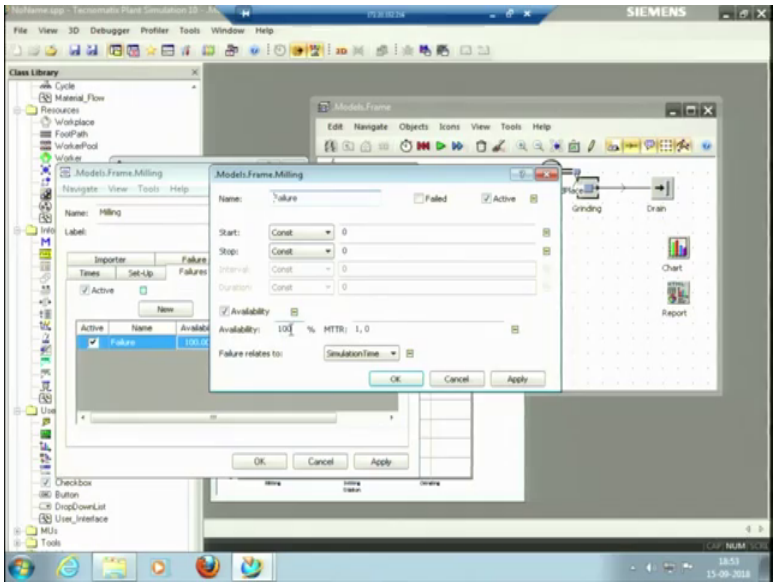

I will change this; it is written that is my none of the failures happen changed to 80 percent ok.

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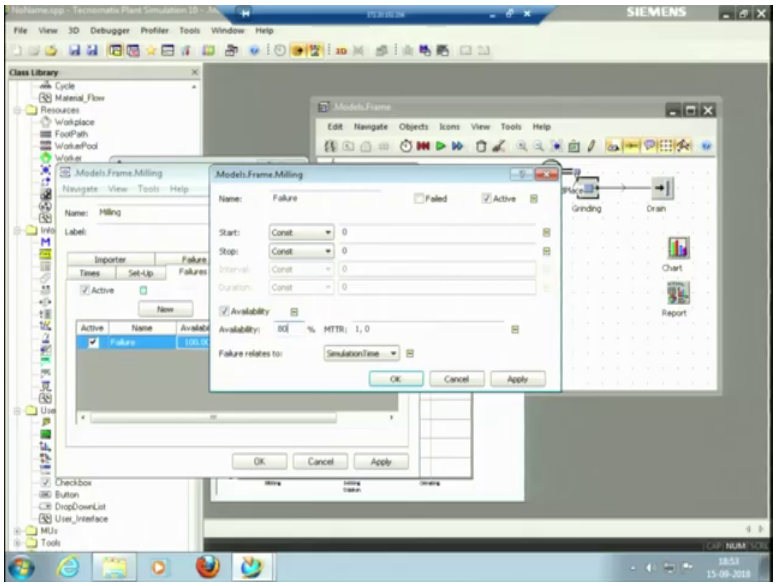

So, 80 percent of time it is available so the 20 percent of time it might fail. So, let me apply it and apply and ok. Let me run it again for the 8 hour day, now what is the statistics?

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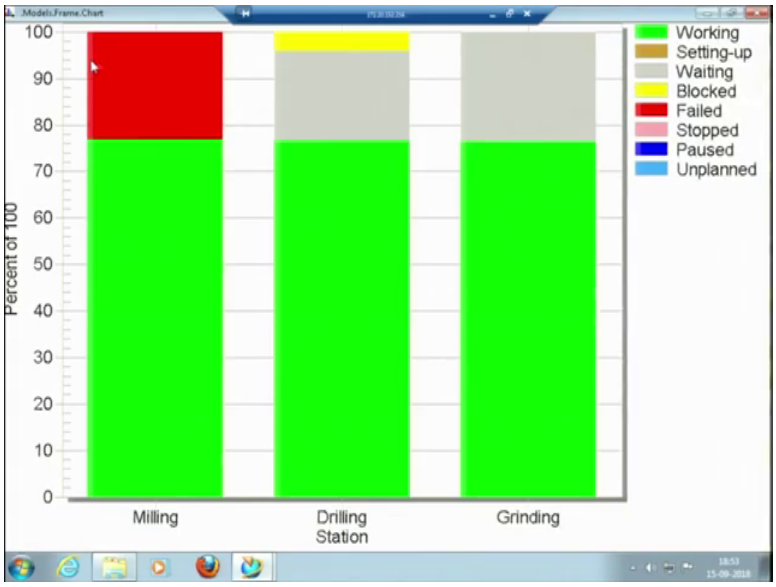

You know for the 20 percent of the time this process has failed, you can see the red colour here. So, 20 percent of time it has failed ok so it was not plot because you know had it the failure not been there it was working for about 95 percent of time ok. But 20 percent is the failure 20 percent of failure.

So, it has work completely for 80 percent of the time. And the previous process it is blocked because actually this drilling process is block because grinding process was not able to receive that. And this is waiting this grey colour this grey colour is waiting because it is not receiving anything from the predecessor from the milling drilling is not receiving anything from milling ok. So, this is waiting so I can see the statistics here.

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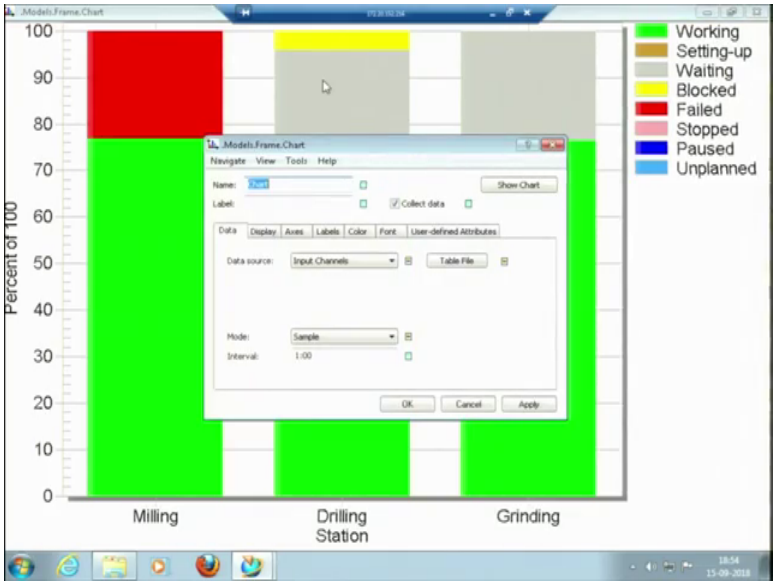

So, I can see the statistics for drilling.

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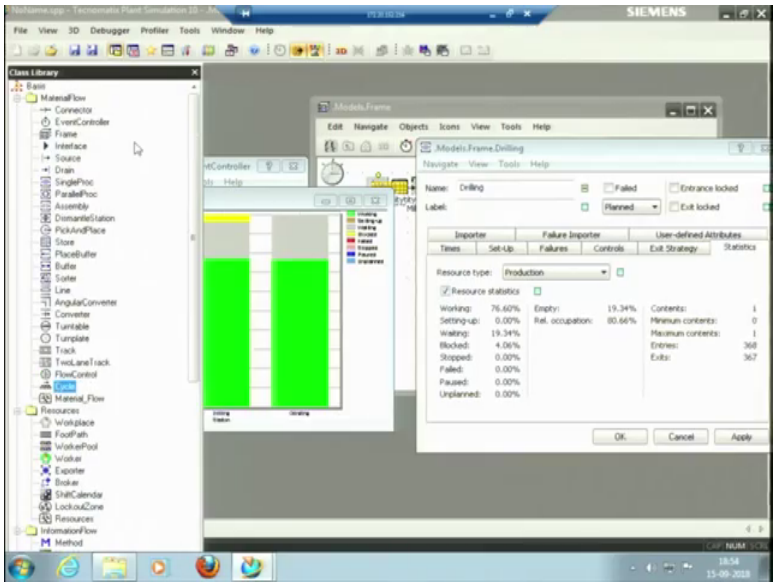

You know it is working for you can see the graph as well here. It is working for 76

percent of time waiting for 20 percent of time and it is block for about 4 percent of time 76.60 19.34 then 4.06. So, this is how broadly I am telling you, how the resource how the information flow we can use. And various kind of material flow, how the simulation can happen.

This is just one flow line, I have just picked 3 processes ok. This was a very you can say trivial example, but in actual processing we can use the simulation even we can use simulation experiment. So, before going further let me show you the different objects. So, I am not saving this model so, this was just a kind of a demonstration for you people.

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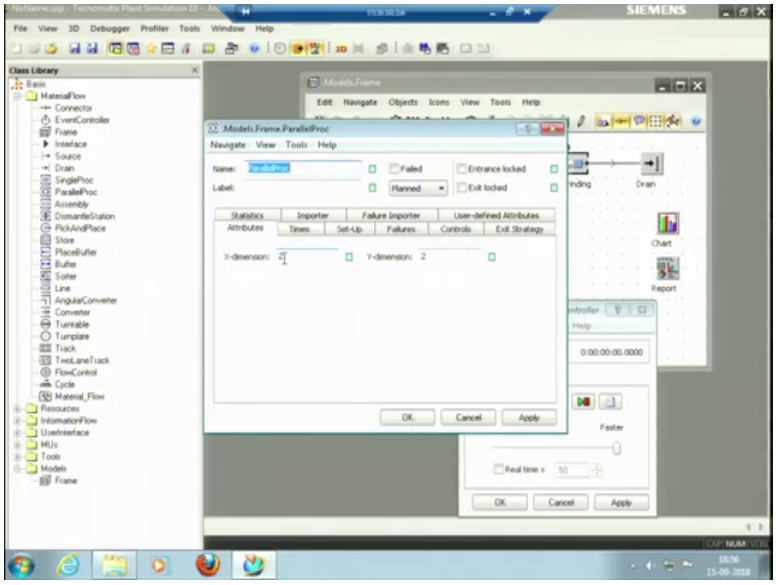

So, this is connector I have talked about this event controller is done, then frame is done, interface is done, source, then drain, single process is one process, parallel process. Parallel process you know if I put parallel process and right click here and open; parallel process is when we have very not similar we have parallel process is when we have exactly same machines.

For instance we have 4 drilling machines of same make which is having same processing time and same setup time. And what we need not put the 4 machines in parallel specifically 4 single process is in parallel. We can pick one parallel process because other parameters are same the attributes of this specific process is same. So, I can pick one parallel process and put there so this in parallel process it is shown in the form of a matrix here; this is X dimension and Y dimension ok.

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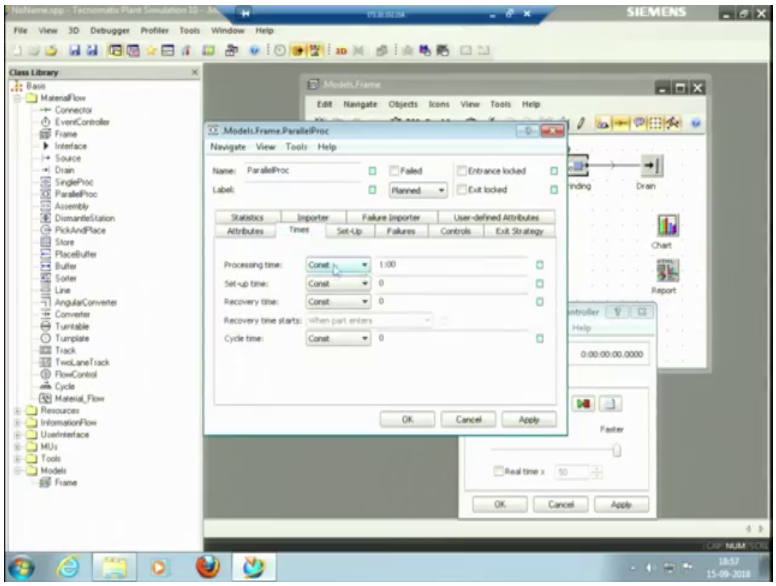

So, 2 into 2 there 4 machines and the times are exactly same processing time through all the 4 machine is constant that is 1 minute ok. Then also I can have it is the matrix actually if I put 3 here it would not make it 5. If we make it 6 machine 3 into 2 3 into 2 it will make a matrix into 2 6 machines. What if I need to have the odd number of machines? For instance we need to have 3 machines for to have 3 machines I have I what I will do I will put it 3 into 1 now it will bring 3 machines ok.

Now, where this parallel process is put I will just pick an example and let you know. For instance; this is one process that is being blocked for maximum number of 440 is block been block for 1440 percent of the time. It is being block 40 percent of the time; that means, the next process is taking more time for processing. It is in more time for processing or it is taking an extended time so this machine has to wait. So, what we can do? We can put if we can it by other as the technical aspects management aspects. If we can put another machine or we can double the capacity of the successive machine.

So, it was waiting for the 40 percent of the time, if we have we have put 2 machines here that this is as a point. Now this 40 percent of time reduced to 0, because now the processing is doubled here. So, in that case we can think of putting parallel processes. Now what does when there is a waiting, when there is a blocking, we can think of adding new machines, we can think of then taking the few machines off. And if there is a lot of waiting times sometime we can even think of doing some other processes like, I said in

case of the process layout. In case of process layout we have a specific set of machines in one section in a set of machines in one section.

If we see that if we see the overall machines time and we see in the specific this section for the 30 percent of time; there is a blockage or for waiting I would say for the 30 percent of there is a waiting. And we can must consider that since 30 percent of time it is waiting. We can give them some other job some other job could be given so, which is the kind of a process layout, it would be kind of a batch production and job production.

So, in case of batch production another batch could enter so that there is no idle time, there is no actually, not exactly no, but minimum idle time is there. The machines are completely working for the full capacity if possible. So, we can try that in simulation before actually doing in the scheduling, then rooting, all those things. That we have that we will learn in the production planning and control that can all be done using the simulation ok. So, this was just an example of I have just picked a parallel process I will just delete it. So, assembly is that when we have 2 lines for instance this is 1 line I can just pick it directly.

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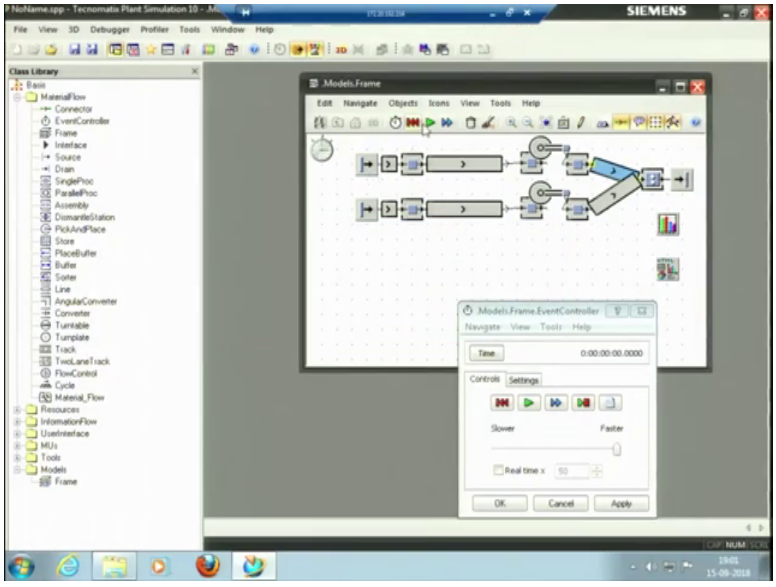

I have selected everything control C and control V ok. Now if they are 2 flow lines like this, I am deleting the drain, what I can do; for instance I am manufacturing nuts and bolts and I they need to assemble them. Nuts are manufactured in flow line 1 and bolts are manufactured in flow line 2 then we are assembling that. We can use assembly in this

case so, I can pick assembly and put it here, let me take this off assembly. So, I have to connect this using something a line as to connect this assembly I will put it very close to drain is it connected. Now it is still to be connected here connector would connect the line to assembly and another line ok. So, a connector would connect this to this already the side the connection is made let me say try to run.

Now, it is run for the 8 hour day and 2 process is 2 units are being manufactured. Now this is flow line 1 ok, this is flow line 1 this is flow line 2 and these are being assembled here. Similar to assembly we have dismantle section dismantle section is when something is manufactured or let me say something come from drain assembled part come from the drain. We have to dismantle that, for instance; a set of screws come from the source which are just screwed on some component and we have to dismantle them and then to we have to use them in some other purpose. So, that purpose we can dismantle.

So, this assembly and dismantle I have just showed 2 flow lines here, but we can have multiple flow lines. Like we can have a multiple flow lines different material coming for maybe 10 flow lines and different then different lines then those are being assembled. Like in the car body manufacturing example that we saw they were trying to assemble or they were actually trying to put the mirror on the side mirror, and the they were trying to tighten the nuts of the of the wheels; so those processing was being done so, this is dismantle section.

Next is pick and place, pick and place is a kind of a robot that is the picks and place from one place. So, it picks a part up at one station and places on to another station. So, next is store so stores the mu's mu's are mobile units these are the mobile units. It stores the mobile units you can define the size of the store by specifying it is X and Y dimension.

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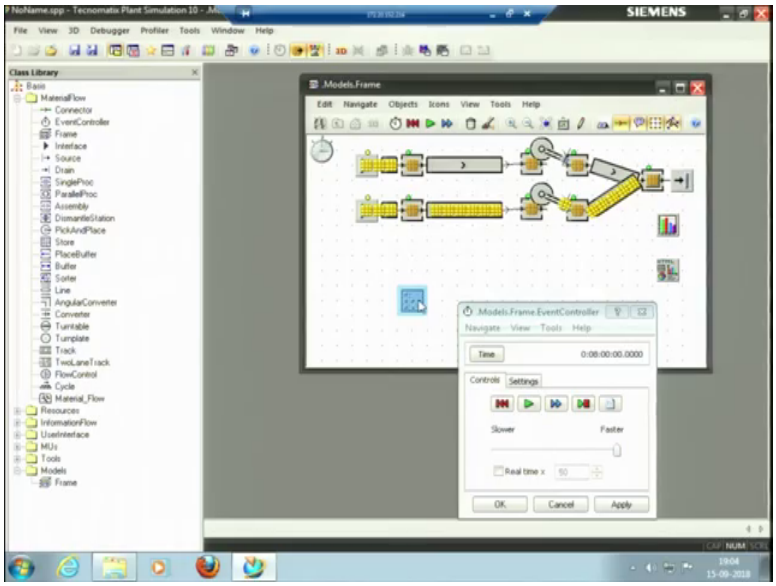

Like how many pieces for instance this is the store in between. We can also add the buffer in between for instance this is the big blockhead of the materials in one side we can add a buffer in between. If it has does not have the product process does not have to wait it can put a buffer it can the buffer capacity would be there buffer capacity that it can oh let me say 100 pieces in a day. So, whenever the next process is free to pick a piece from here it can pick the piece from the buffer so that buffer can be used here. So, just after store up we can have place buffer and buffer ok. Store is kind of a long time storage so you can see.

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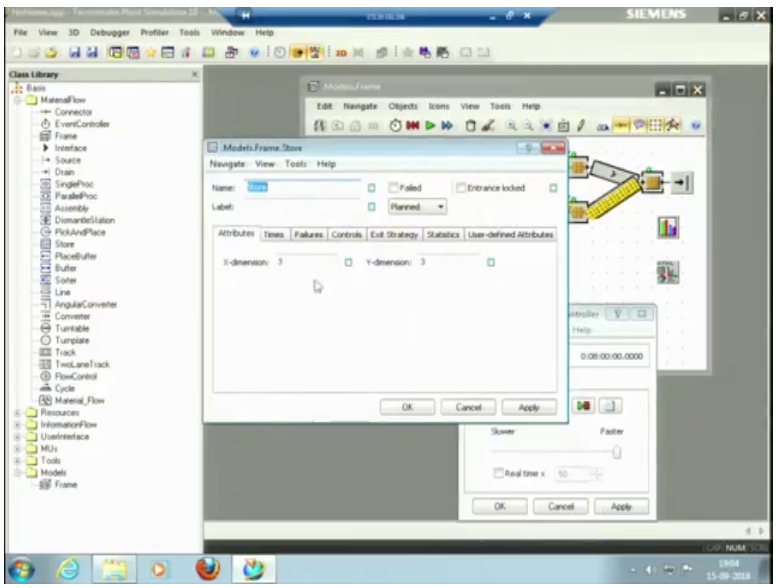

This is the capacity 3 into 3 9 pieces can be stored here ok. I can just change the capacity to the number which I like, not which I like which is actually required in the process so this is 2 I am deleting this one. So, place buffer, what is place buffer? This command place buffer, place buffer lines a several processing units of the same kind one after the other. The processing units are connected and the mobile units have to be process that each station does the cannot pass each other. So, a mobile unit may only leave the place buffer after it has reach the processing station with the highest number.

So, a model a buffer with the great capacity that requires high performance, we can use buffer like I said ok. So, place buffer is a smaller thing big buffer is a buffer is placed between 2 plant component that certain purposes. It temporarily hold parts when the following components fail when the successor is not able to receive the component. So, it passes the path from that the second function it does important function it does is it passes the path on, when the preceding components stop working. So, it slows so, dimensions of a buffer with a large enough capacity for covering all failures is to complete decoupling of the plant and the other attributes as well. So, next is sorter; sorter as the name suggest a sorter arranges the mobile unit by sorting the criteria we define.

We can define the criteria for instance if I having the nut and bolt assembly. Then nut we manufacture and bolt we manufacture and on 1 bolt I am trying to assemble 2 nuts on it ok. So, the sorter what sorter can do it can pick 1 nut where from the bolt line it can pick 1 bolt or it can sort it to the different lines. So, a sorter we have to define a criteria it can do that. So, line is a kind of a conveyor so to draw this straight line with active drawing colour, we select this then this is used I have just use this extensively in this example. Then it angular converter; so, what is angular converter? Angular converter changes the frame direction of the mobile objects from lengthwise to cross wise, it is a 90 degree ok.

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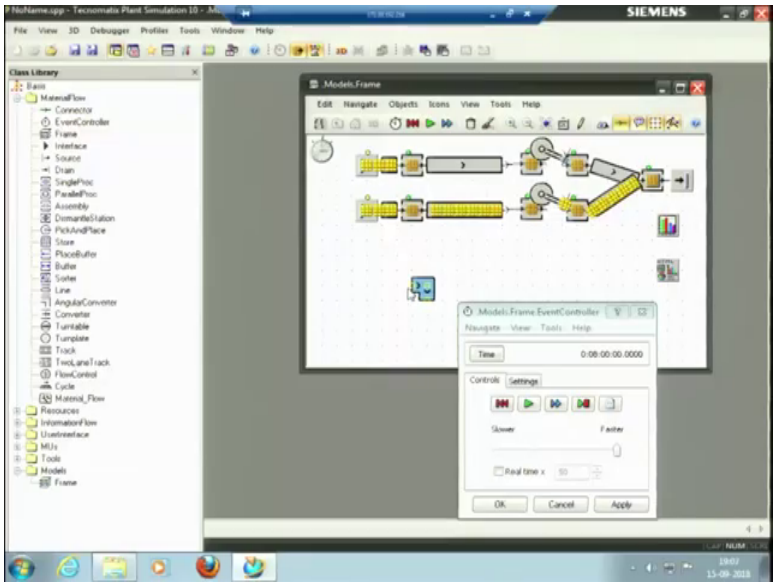

I can just put it here, angular converter.

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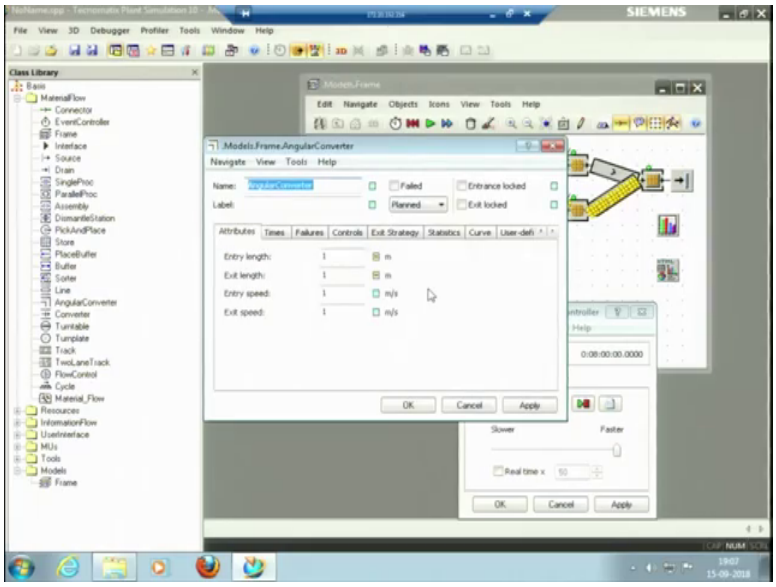

So, you can say entry length, exit length, entry speed, exit speed. So, it is a 90 degree when there is a for instance we need to have the kind of a U type of layout. U type of layout would be like this U you will have this direction, this direction, this direction. At this turn when we have to need to have turn we can use this angular converter it will convert from one line to the cross size. You know this direction is 90 degree here. So, angular converter move the parts to its successor within the flow of measurements like, it

moves the part on to the first length of angular converter.

When the booking point length has reached the entrance then angular converter the part drives along the entry length or entry speed all those things we can control. Entry point, entry speed, exit point, these things can be controlled like I just showed attributes of this specific object. The next is convertor. Now what is convertor? Convertors intended for modelling material handling equipment when the part moves onto convertor it either passes straight through the conveying direction. Or it is lift it on to a literally moving transport level, by lifting mechanism and then conveyer literally to the left or literally to the right.

So, angular convertor was just one thing, it is just convert direction from one direction like 90 degree its can just convert 90 degree. So, a convertor can we can pick whether to go straight or whether to change a direction so it can work in that end. So, turn tables here for modelling a rotating platform. It is rotating platform which turns a part around and moves on to the several connecting material flow objects turn table if similar to turn table turn table we can have turn plate.

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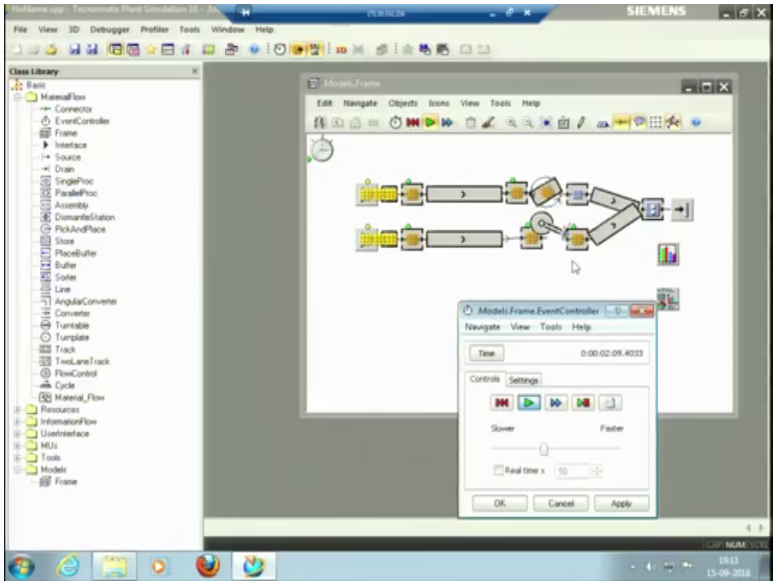

I will just try to put a turn table here I will delete this pick and place robot and try to put a turn table here, now how does this turn table work you see to let me fix this. It is connected sorry turntable I need to put the connector I need to put the connector here. I am just showing you some examples in between, why is not the place let me switch of

the grid now it will work ok. Now, let me try to run it is running in the fastest space, let me try to slow it down and then try to see how the turntable works ok. It is now moving at some speed that is defined now processing would happen. Now turntable would take it from one place and turn it to the other place ok.

Now, what happens sometimes we have to swap the work pieces this work piece on this side, this workpiece on this side, this workpiece on this side. So, turntable what it does it just pick the pieces from this point and then swap it like this ok. Similar to turntable we can have turn plate, we can just put one piece on each direction in turntable it is a single direction turntable that is being shown in the screen. Turn plate we can have one plate and we can have multiple work pieces put on the origin. It is like kind of a rotating dining table that we have we put the dishes over there and we can rotate it we can pick whatever got this we like from in between so next is turn plate it is done.

Next is track so, track can be used to model a part of a transport line with or without automated rooting. On which the transporter moves the part for example, you replace both the automated aided vehicle system and the model we can use this track. So, the distance which the transporter has to travel on the track is defined by tracks length. The tracks length can be defined then the transporter mobile unit length can be defined the speed can be defined. So, the maximum capacity unit track is defined by its length and the lengths on the individual transporter moving on it can also be defined that is the track that is 3 meters long, accepts 3 transporters of 1 meter each. So, this can be certain the capacities.

So, we can have certain kinds of track, we can even have the turned track or we can even have two lane track. Two lane track is one lane track is will only one direction two lane track is it can go in one direction and come back from the other side. It is kind of a two way road like we have two way track can be put in then flow control. What is flow control? Flow control allows the model common strategies for splitting up and for bringing together the flow of materials it is important to note that the flow control does not possess the mobile units. It only distributes them among the objects that it's succeeded in the sequence stations. So, flow control is like it does not store any mobile unit flow control is for instance I am having a central O here and O kind of layout and there certain lines here ok.

So, flow control can do it can just control that one piece here, another piece here, second piece here, third piece here. It can just control the flow whatever line this is my O the lines external to this ok. If the flow controller if I putting there it can control which of the line is requiring my material now ok so it can it control the flow in that way. So, after that we have cycle. So, I just cannot show you the actual demonstration for all the objects here.

Because you know in a 2 hour time we cannot just discuss all these things so I am just giving you important objects I will come to resources here. Resource is actually work place if we need to work with the workers we need to put the work place work place here. For instance in place of this line in place of this line I can use workers to transfer the material from process milling to process drilling. So, where the worker has to work would be the work place ok.

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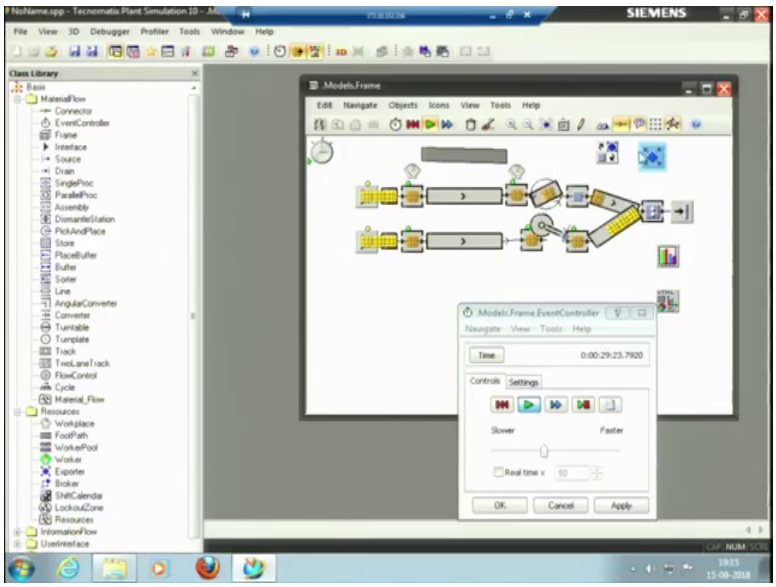

If some worker simulation has to be induced some work is there that is we have just taking the processing time ok. The machine is automated it is taking 1 minute processing time we are just considering it here. If the worker has to work here and the worker still the worker capacity the ideal worker time and the normal worker time those things are to be considered then this workplace is to be put there, between the workplace we need to put footpath you can see the foot footpath here I am picking footpath from here and putting here. Workers have to travel through this footpath to model with worker we need

to have a broker as well who would distribute the work to a workers, then we have need to have exporter as well ok. So, we can work with the workers as well I will just showed you a certain examples here. So, I am just deleting these one delete, delete, and delete.

So, some important points method I have said then card file stack file. This is the information flow all the information will flow, we can define the attributes here and see all the information could flow. Some of the information flow object would be method like then we have variable, variable is when we can work on this source code I can if I am saying that we can make our own objects if we can understand the code; so there we can add a variable. So, this variable we can declare a local variable anywhere within the source code. So, then we can start to declare our own variable with the keyword let me say the one of the variable sum is known as may be integer or track 1, track 2, we can name them anything like we like. Then we have table file table, table file is a list of list with two or more columns it is a kind of a table like normal table we have. So, we can access the individual cells by employing the index that is by their positions for instance the cell number 3 1 cell number 3 2 there can be accessed.

Then we have card file card file is the list with one column providing random access to the contents of the individual cells using the position .That is row number, or imagine the card file, as a file card box we can think of that so there certain things like this. So, next we have user interface, user interface we can have comment we can put some comments. We can chart as I have showed you report is the complete report when we run the computer simulation I can publish the report of the simulation as well. If I apply and try to run it, is run it for 8 hours day. So, in report we can publish the complete report, in the complete report we can have just the list of these machines different machines ok.

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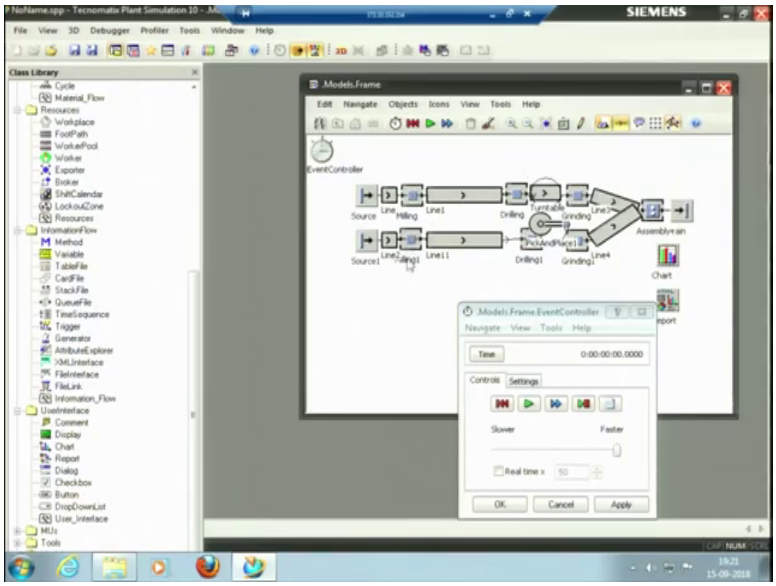

If I just show my comments here the machines milling 1 all the chart that are the same those can be put in there of the time for which the machines were working, those can be seen in the report; so these all these things can be produced. So, next these mobile units are there, mobile units the units which were being used are entity.

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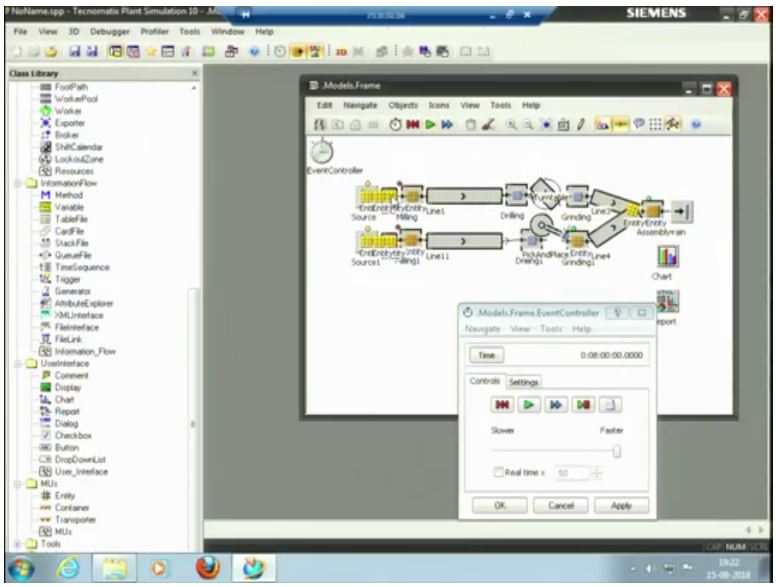

If I this mean this yellow pieces these are entity ok. So, similar to entity we have a container. Container has a capacity, for instance from the conveyor we are not taking one mobile unit; if conveyor is taking a container which is containing a few mobile units or

few entities actually. So, this entity here the entity is just a block just a box, this is the kind of box is here showing. The entity can be the car that we have just saw in the car body simulation model. So, then container is a transporter is there so, in place of container the transporter sometime the conveyor is fixed the transporter is kind of a small trolley.

Small trolley which has some capacity so, in this we can just put the pieces and take them along. So, then we have tools here, tools is bottleneck analyser, some bottleneck analyser like we have just visualised the bottleneck in the charts the in the example that we have just seen here. But bottleneck analyser is also that will show this is the primary bottle neck, this is another bottleneck. So, first work on these those things also those things can be done.

Then experiment manager; so, I will pick one of these bottleneck. I will pick experiment manager so I am try to explain you certain simulation ok. So, these are the some of the tools which are used in this software, these are some of the objects. So, now I will try to pick some examples and try to explain you how do we use certain tools. These tools are just to design the process, the material flow tool just to design the layout ok.

Then important tools resources are just tell you, resources are just the workers or exporter broker which I used. The information flow how do we use the information, then the tool which I have said experiment manager, what does experiment manager do. It can simulate the specific process, the various you can say box plots or we can have the simulation and the depth of simulation those things all could be done ok. So, I will have to stop here and thank you for being in the course. So, we will meet next time.

Thank you.