Computer Integrated Manufacturing
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Lecture 46
Laboratory Demonstration Plant Simulation software (part 2 of 3)

Good morning, welcome back to the course. I am Dr. Amandeep Singh and I will take the Plan Simulation Technomatix in this lecture.

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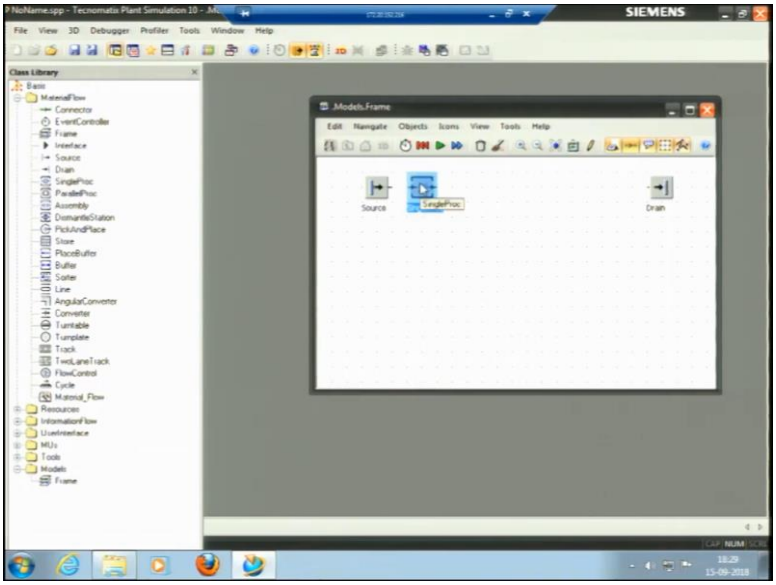

So, I will again go to the start page new start page so, we will create a new model and so, this is the model that I will, I am trying to generate here. So, I will just open the class library and open the material floor so, there are certain objects here, connector, event controller, frame interface all these objects are here, so these objects have specific managers for instance this is model frame.

This is frame, I can say a kind of a room, one room in a factory, one room in a factory means. A factory in which one kind of the specific process is happening and I can move to another frame another room using interface. So, I will try to first tell you what, are these objects frame, as I said this frame is this is to create the simulation models in a frame. So, we create a simulation model in a frame, this is one frame and that it is located in the folder models in the class library, generally frame is located here in the models.

So, this is actually the primary location of the object but, it has been kept here as well sometime because, if you 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 for the grouping of objects to build a radical structure models by inserting any of the built-in objects and in the built-in object from these or any objects that we can design because, we can design our own objects here, in this software as well, you know, this is a code that is built for this software to design the objects.

So, if someone is conversing with the code, you can also design the objects by itself. So, the frame when we use frames with connectors or plant simulation, it opens the dialogue select interface, this interface means from which frame to which frame. I will just put the source here; source is to produce the parts in the sequence which we specified sequence table, source is a starting point or the entry gate.

The entry point from where the parts are coming if the parts are coming in it has to go out so, this is a drain-source and drain has to be there when, we design any layout, 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, it moves it away. So, where does it take it to? We can put an interface here and take it to the other room.

So, one important object here is this single process. What is single process? Single Processing Unit receives, and processes single mobile unit that is known as MU, mobile unit so, single processes is one process, anyone process. Like I said in the scheduler layout different operating producer processing units were there, tools processing units can be called as Single Processes.

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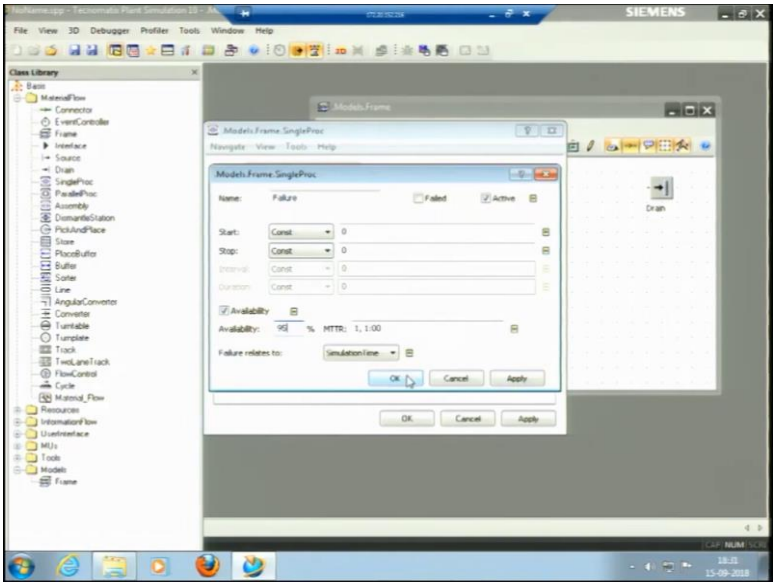

So, if I right-click it and open it, this is the single process so, I can change the name of the single process let me say this single process is maybe milling, milling machine. So processing time is there, processing time is, we can select any of these distributions. I'll talk about the distributions also, like the probability distributions are, the frequency distribution based upon certain past data that specific flow follows the specific kind of a process follows.

The constant means it just takes 1 minute so, it is 1 minute so, the constant format is kept here, it is days, hours, months seconds and microseconds. So, this is one minute, the default time, if I pick a distribution, uniform distribution which is also known as the rectangular distribution, it will talk about this later, it will ask us to put it in this format, stream, start and stop. So, I will just talk about this later, let me such, first pick any processing time, processing time, setup time, recovery time, in cycle time, these times can be put.

Then also we have the availability, availability of this process is 95 percentage, for the 5 percent of the time it would fail, because in actual conditions for the 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, if 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. The person has to take some time off or it has to take some time, it takes tea while working or eat something, talk to, but the person talk to the other people. So, we can think that when the actual situation the

availability of the person is not 100 percent, but for the 90 percent of time it can be available; so, we can vary this as well. We will work on this, we will on this I have changed this from 95 to 90, I will change this from 95 to 90, let me get to default 95 only and I will just cancel.

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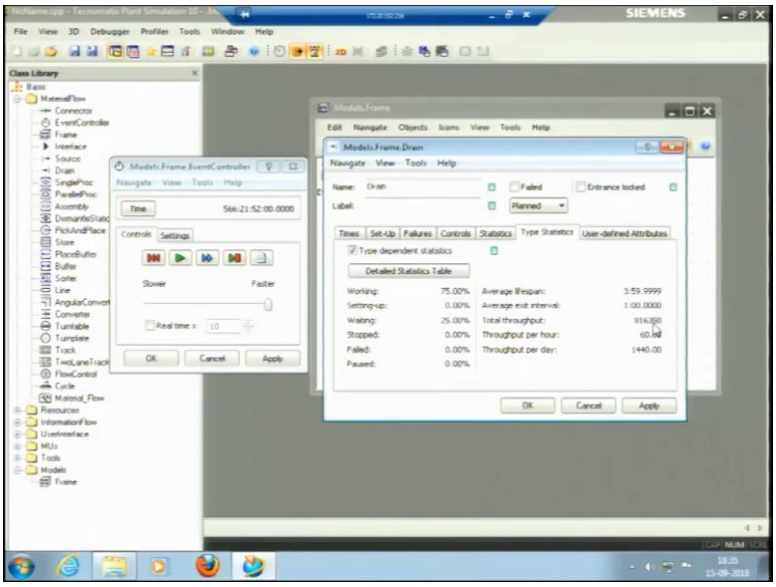

Let me just try to run a simple model then, we have anything, any process, or any object we have here. If we need to define the flow that which flow does it follow? Was is it that is a straight line, U, S whatever, the flow has to follow it has to be connected using a connector so, this is a connector the very first object here is connector; so, connector is used to connect an object to the other object so, I have connected source to a single process, and the direction is showing the this direction arrow is showing the flow. Now, an important point here is event controller.

So, whenever we need to model something, we need event controller so, I can add even controller here or event controller you can also event control it is just here, in the bar in the tab here, so event controller. What does this do? When your modelling needs require it, you can select settings of controlling the simulation run on the tab and this event controller for instance the settings in the settings, we can say when would the processing. If we do not use event controller the process would go for infinite time.

So, let me try to just put another source here, another single process here, let me consider there are 2-3 processes, I will use connector to connect them, these are now connected. Now, 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, this is fast forward if I run

this, it is running, running at a fast speed you know it is what is this time going on this time with a cursor is, this time is 200 and over 300 days these many hours.

So, it is running the fastest speed, if I stop it here, it has run for 566 days based upon the constant processing time, which was 1 minute for single process 1, and for single process 2, it is 1 minute, for single process 3, again it is 1 minute. If I right-click here and open, I can see my throughput here, in the type statistics, in the type statistics. So, it has 1440 pieces, throughput per hour is also given throughput complete for 566 days, it has run for 566 days. So, it has produced 816350, these many number of pieces. So, I can see the throughput.

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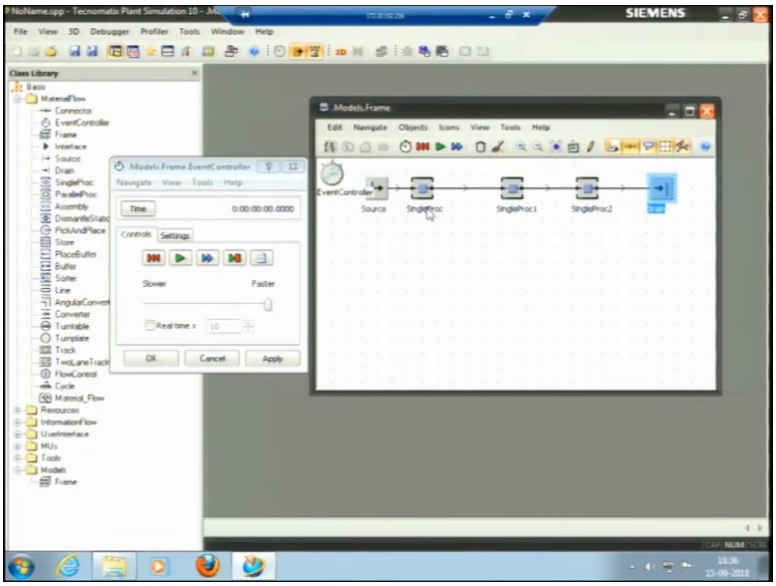

Now, there is a big flaw in this flow line, we have just connected, we have one thing is we have placed the drain and processed one at some position. So, you can see these dots are here, these dots, this is the dot 1, 2, 3, it is kept at about 3 meters away from this, it is kept 3 metres away, do you know when we put the machines in a workshop there is a span.

For instance, in a laboratory when people are sitting in an office, the span 1 counter or not if we could say a one cabin, another cabin there is a space designated for that cable; minimum phase, this is economics you know, if we talked about plant layout, this is work-study, what is a minimum space that has to be kept? So, in case of manufacturing, the space, the distance between 2 machines not considering the width of the machine if the separate; other than, the width of the machine the space between 2 machines is generally kept from 0.8 metres to like even more than that.

So, that the workers can move from in between. So, this is a space in between I have just kept at to the random point here, a random location here. Now, it is not taking any time for the material to travel, travel from the single process 0 to single process 1.

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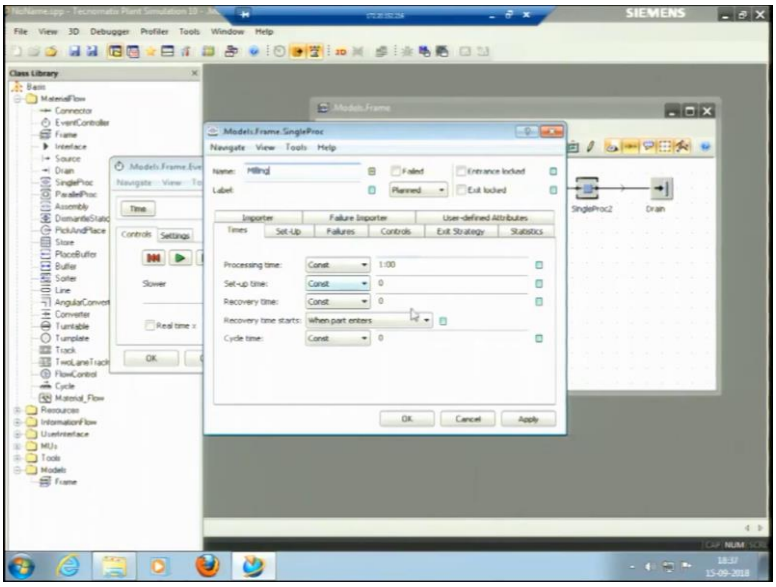

I will name this, I will open I will call it process milling, the examples which are picked, apply so, this is my single process I will name it after milling. I can pick drilling, so, this is process milling, drilling and I can pick grinding.

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 may this connector is 0, again the time taken by this connector is 0. Right way to do this, is to use some material handling systems you know, there are certain material handling systems here, we have turntable, we have line, line in the kind of a conveyor, then we have Pick-and-Place robot.

I will try to use these and I will like to tell you that how do we use this. So, I will just pick line, which is a conveyor and put it here, like I can just shorten the distance, but I have to make sure that this is connected, this is connected to process 1 but not connected to process 2, I am deleting, I am just selecting it and pressing the delete button; so, this connector is deleted to this line is now connected through, sorry, connector has to connect the line to milling.

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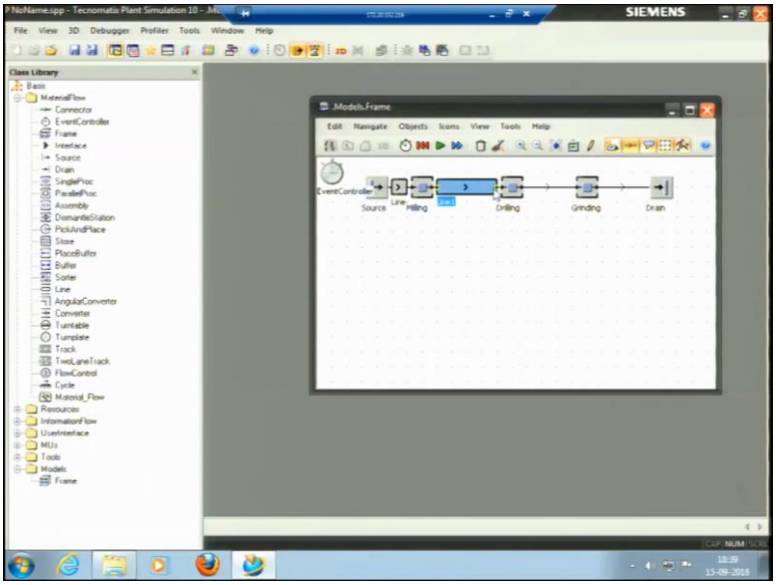

Now, if I right-click here and open, I can see the length of the line is 1 meter, length of the line is one meter that is and the speed is 1 meter again, what is the speed I will just let you know. If I put another line here, line is my conveyor, I will take this connector off first, this connector I am taking off, delete, yes, put another line here, it is connected, this is connected by itself. So, I will extend this line.

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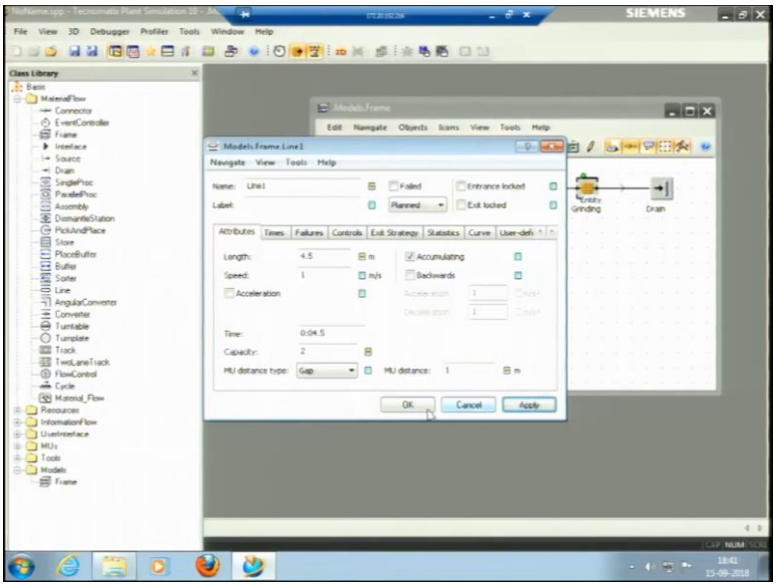

But, I can, if specifically put the length this page let me say the length of the conveyor is 4.5 meters, I have put it 4.5 meters; so, 4.5 meters, the grid is on but because the grid is on, it will just snap, if you think about the, know about the snap command, it will just snap at a specific point. Now, the grid is taken off, now if, I can move it at any point. Let us keep the grid on to just to see this.

So, it will take my mobile units, the units which you could see here, this entity, this entity is a mobile unit that is a 1 unit is moving move from one point to another this mobile unit is moved in a speed that is mentioned on my line on my conveyor that speed was. Let me see what was the speed? The speed is 1 meter per second, speed is 1 meter per second.

If I try to see this at a lower speed, is event controller 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 it, in real-time it will take at least 1-minute processing, what I would put real-time, I will put a real-time into 10 times. Then apply, back and okay now, enter real-time into 10 times so, in place of 1 minute it is taking 6 seconds here, the 6 seconds it has moved at a speed of 1 meter per second into 10 time, it has moved at a 10 meters per second.

So, the capacity of the line is only 1 piece here, if you can see, capacity is to put negative, negative is not more than 1 pieces, I can put the capacity as maybe this line can carry 2 pieces and distance between, MU distance is distance between, the mobile units, mobile units can be just kept like this or a distance can be serve I can put the distance is one meter again, apply ok then, back and again run.

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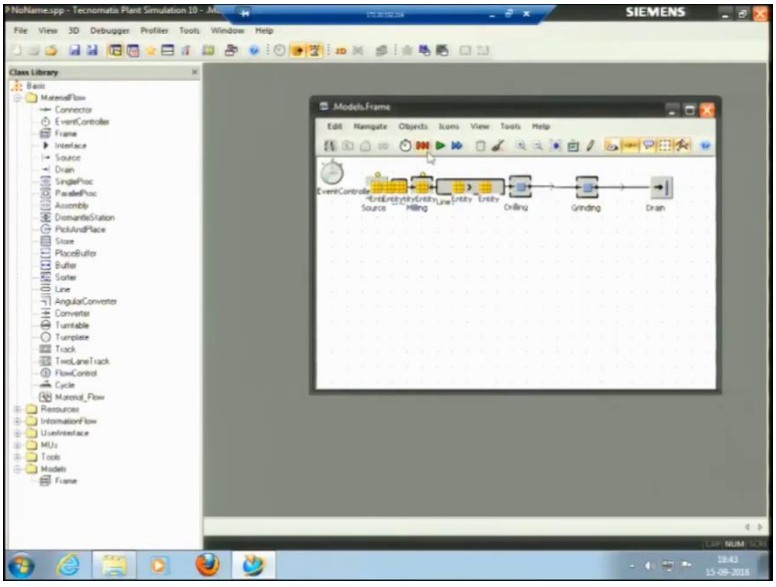

Now, you can see 2 pieces can come on this line. So, this is the capability of this popular and the processing is happening, the green colour here, means that you can see the dots here, this is yellow dot, this is green dot, green colour means processing is happening and yellow colour means it is being blocked, blocked means that the successive process is doing something to succeed conveyor is completely filled, and the predecessor that is the our source here or the

entire one line is blocked because the successor is waiting, successor is completely fulfilled and it cannot just transfer the material from 1 point to from its own point to the forward process.

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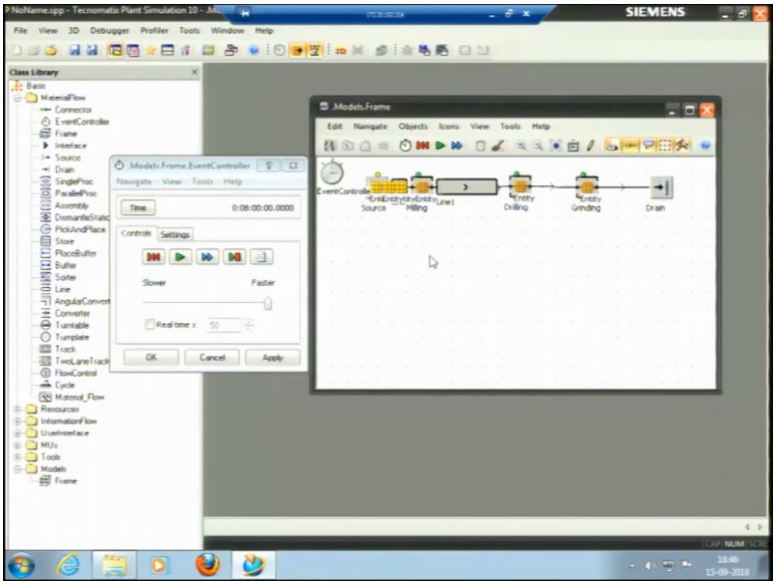

So, if this capacity is 2 now, restart throughput 2 in between. I will just remove this line and add another line because I was to change all the dimensions I will just try to pick the default values which are there, I will connect using a connector, and in the event controller in the settings, I can put the end times when would my process end here. So, it is in the format this is days, that is this first 0 is days, second 0 is hours and this is minute, this is seconds so, I can put in an 8-hour day, it should be 08:00:00.

So, it might simulation would now end at an 8-hour day if I put apply here. Now, let us run, it is running. Capacity is 1 it is running in the speed that is mentioned here, real-time into 50 you can see in real-time into 50 time is running or let me try to run it in the fastest space. So, I can see in the setting that, the time is kept 8 hours so, if I need to see it in a fastest way so, I will apply and okay. So, let me start so, it has run for 8 hours it at the fastest speed, it has run for 8 hours. I can now, see the throughput here, open type statistics 4931 pieces total throughput is 477 in an 8 hour, four seventy-seven, per hour is 59 pieces and throughput per day is 1431.

So, for an 8 hour it is telling this much, per day it is considering 24-hour day here. So, I can see all these throughput and I can even see the reports, I can see various charts as well and like, it for how much percentage of time the process is blocked for how much, the percent of time for the complete 8 hour day for how much time my process is blocked or waiting or actual 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 happen so, all these things can be seen for that I need to use resources.

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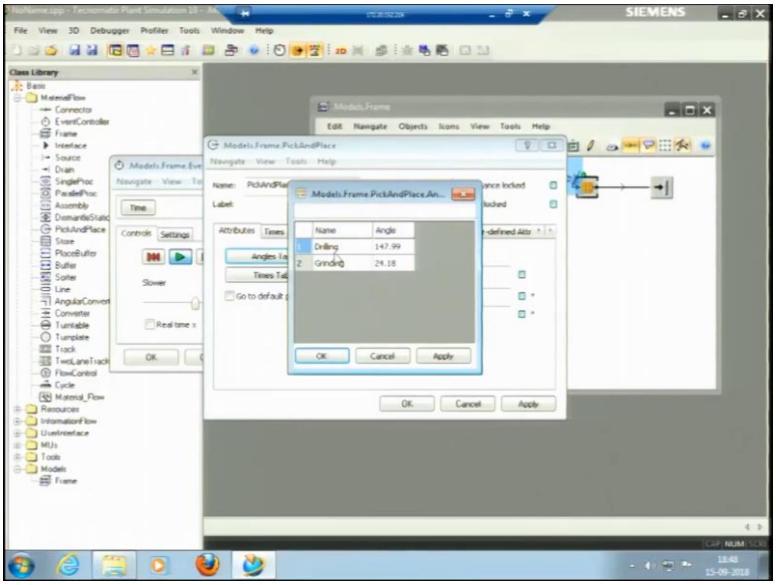

Before that, I will like to make you to note, that we have not even yet put anything between the drilling and grinding, there is no material handling system. So, I like to put Pick and place robot, these are the names, if it is as getting a little congested I can take this off using this command so, delete this connector now, I will connect using the Pick and place robot.

A 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. How does this work? Let us see, first low fall, let me try to reduce the speed just to make you people appreciate it in a better way and see how the simulation is happening now, the processing is happening it will not Pick and place you can see Pick and place. For Pick and place robot also, we have Pick and place. What are the controls here? Entry-exit. What are the angles? Angles between drilling and grinding all those things we can consider and various times and failures.

If we had this thing is also 99 percent failure MTTR is mean time to repair, this is reliability engineering, in reliability engineering, we have a mean time to failure, mean time between failures, mean time to repair. So, if failure happens, if actually the process is failed, that is the, it is completely stopped, it takes about 1 minute to repair that. So, these attributes we can select, so, I will keep it default only if it is still running it has on foot 18 minutes and 28 seconds. So, this is Pick and place robot.

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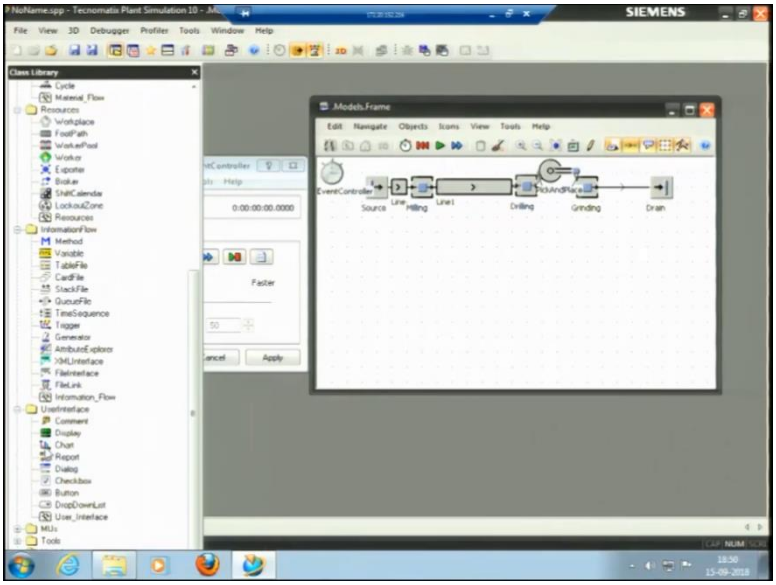

So, what I was talking is that, let me put this end grid on here. So, we can use some resources sometimes like the workers if they are working on and the broker is there who is trying to distribute the workload workers, workplace is there footpath were pool is there, I had showed you in the car body manufacturing then, information flow if the information has been the method specifically has to be defined, sometimes the generator.

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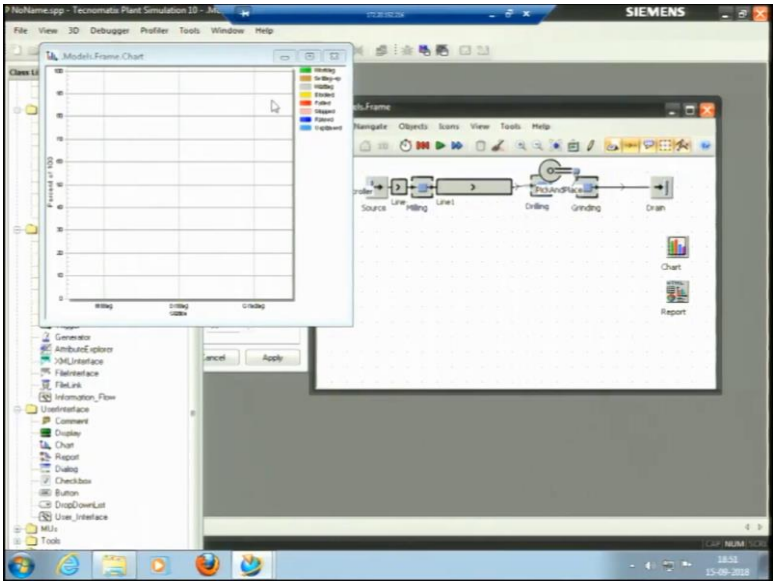

I will explain these objects, let me first try to show you a simple flow line so, this is in user interface I have a chart as user interface means, I'll put a report here, and a chart here. User interface means anything that a user could see after the processor is run for one time. So, if this is the have a chart here and I try to just drag my processes here, milling, drilling so, I am just trying to put the processes here.

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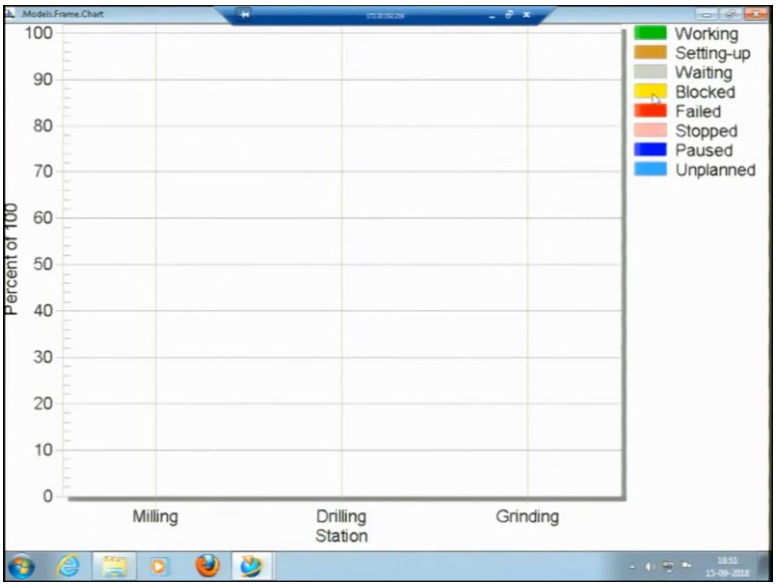

Now, when I run my process it will show you can see this chart, it is different colours of the working, setting-up, waiting, blocked, failed, stop, pause, unplanned all these times are there so when I run it for the 8 hour day.

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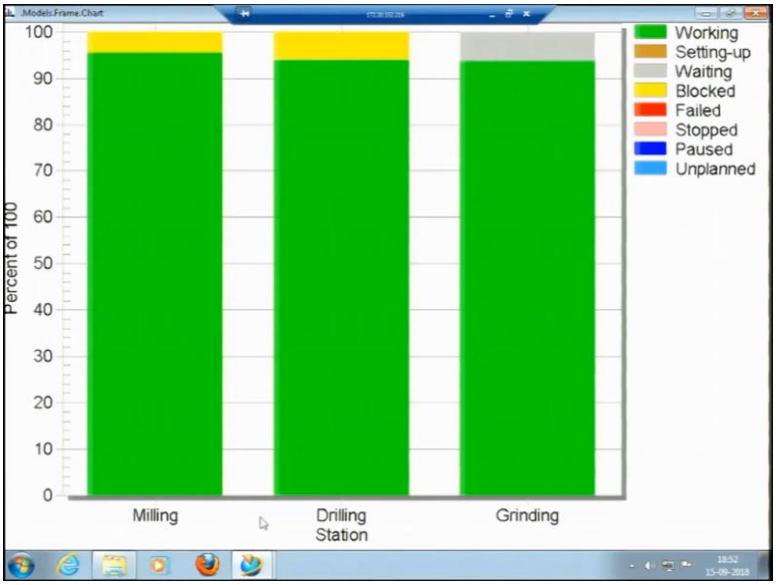

Let me try to run it for an 8-hour day so, it is run for an 8 hour day you can now, see based upon the times which are put here the present times, this process milling, milling is working for about more than 95 percent of time. And for the rest of time, it is just blocked, because the next process drilling or the next step conveyer or line the line which was kind of a conveyor which is transferring the material from one point to another machine. So, that is trying to block this one, this is also blocked but, this is not blocked but this is waiting for the material to come. So, it is these are working for I can see the exact times this is the graph it is just showing this calibrated graph here.

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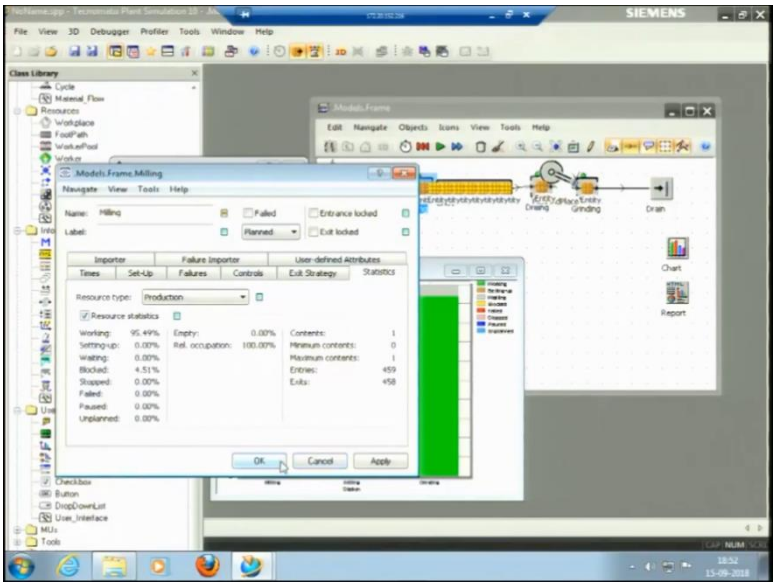

I can see the exact times as well, using these processes if I open the process, I have open the milling process now, I can just see the statistics in this process I can see that for 95 percent of time if you see here, 95 percent of time machine is working and is blocked for about 5 percent, it is 95.5 percent working and four-point-5 percent blocked which is represented in this graph as well. 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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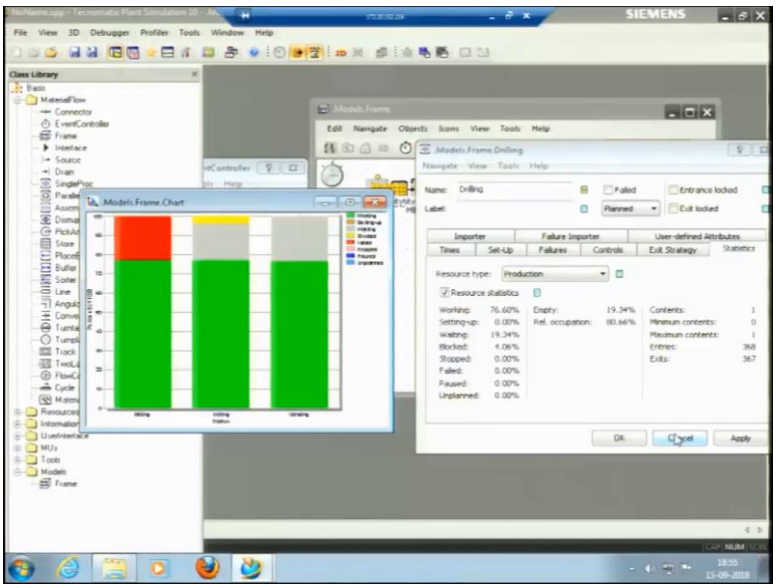

Failures, it is working available for the 100 percent of time so, I will just change this, I will change this, it is working that is why the numbers the failure happen change to 80 percent for 80 percent time it is available for the 20 percent of time it might fail. So, let me apply it ok and apply and ok, let me run it again, for the 8 hour day now, what is the statistic is you know, for the 20 percent of the time this process has failed, you can see the red colour here, for 20 percent of time it has failed.

So, it was not blocked because you know had it the failure not been there, it was working for about 95 percent of time, but 20 percent is the failure, 20 percent of failure so, it has worked completely 80 percent of the time, and the previous process it is blocked because the actually, this drilling process is blocked, 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 so, this is waiting so, I can see the statistics here.

So, I can see the statistic for drilling, you know it is working for, can see the graph as well here, it is working for 76 percent of time, it is waiting for 20 percent of time and it is blocked for about 4 percent of time, 76.6, 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.

This was a very we can say trivial example but, in actual processing, we can use this 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 this was just kind of a demonstration for you people 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.

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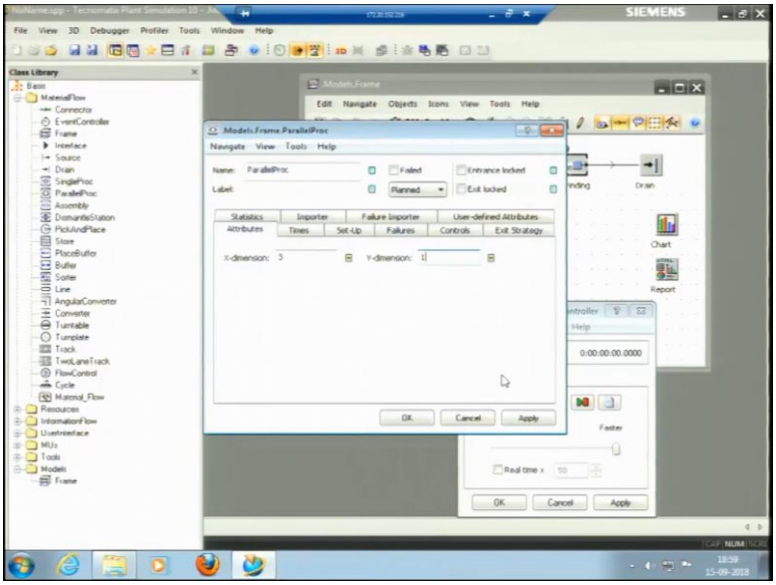

Parallel process you know, if I put parallel process and right-click here and open parallel process is when we have exactly same machines, for instance, we have four drilling machines of same make which is having same processing time and same setup time and we need not to put the four machines in parallel with specifically four single processes in parallel, we can pick one parallel process, because other parameters are same the attributes of this is with specific process is same so, what can, I can pick one parallel process and put there so, this in parallel process it is shown in the form of matrix here, this is X dimension and Y dimension.

So, 2 into 2 there are 4 machines, and the times are exactly same processing time for all the 4 machines is constant at is 1 minute. Then, also I can have, it is the matrix actually if, I put 3

here, it would not make it 5, it will make it 6 machines 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, I will need to have 3 machines, for to have 3 machines I have, what I will do, I will put it 3 into 1, what we bring 3 machines.

Now, where is parallel processes put, I will just pick an example and I will let you know. Now, for instance, there is one process that is being blocked for maximum number of value for it was it is broad blocked for 40 percent is the time it is being broad over 40 percent of time that means, that next process is taking more time for its processing, it is taking more time for his 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 apply other as per taking considering other 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 you have put 2 machines here, in that it has 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 machine few machines off and if there is a lot of waiting time, sometimes we can even think of doing some other processes like, I have said in case of the process layout in case of process layout, we have a specific set of machines in one section, another set of machines in one section.

If we see that, if we see the overall machines time and we see it in the specific this section for the 30 percent of time, there is a blockage, or waiting I would say for the 30 percent there is waiting and we come was consider that says 30 percent of times is a waiting we can give them some other job some other job could be given so, which is kind of a process layout it would be kind of a batch production of job production so, in case of batch production another batch could enter.

So that, there is no idle time there is mini 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 routing all those things that we learn in the production planning and control that can all be done using the simulation so, this was just an example, I have just picked a parallel process I just delete it.

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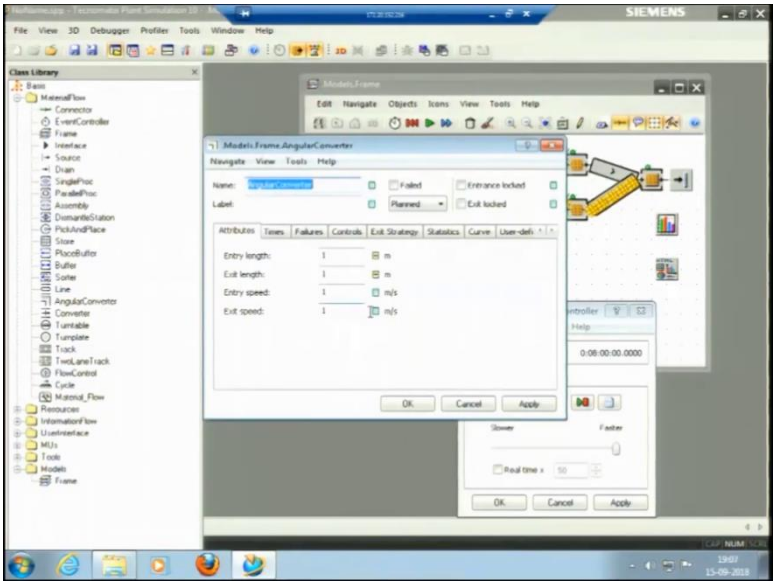

So, assembly is that when we have 2 lines for instance this is one line, I can just pick it directly I have selected everything control-C and control-V. Now, if they are 2 flow lines like this, I am deleting the drain, what I can do, for instance, I am manufacturing nuts and bolts, and I did not need 2 men assemble them, nut some are manufacturing flow line 1 and bolts are manufacturing flow line 2 then, we are assembling them we can use assembly in this place so, I can pick assembly and put it here. let me take this off, assembly so, I had to connect this using something, a line has to connect this assembly I will put it very close to drain, is it connected?

No, it is still to be connected here, connector would connect will line to assembly and another line so, a connector would connect this to this already exists is as the connection is made let me see try to run now, it is run for the 8 hour day, and 2 units are being manufactured, this is flow line 1, 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, assemble part come from the drain we have to it dismantle that. For instance, a set of screws come from the source which are just screwed on, on some component and we have to dismantle them, and then to you have to use them in for some other purpose for that purpose we can dismantle.

So, this assembly and dismantle have just showed 2 flow lines here, but we can have multiple flow lines like we can have multiple flow lines, different materials coming from maybe ten flow lines, and or different and different lines and 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 on and they were trying to tighten the nuts of the wheels. So, those processes were being done so, this is dismantle section.

Next is Pick and place, Pick and place is kind of a robot, they had just picks and place from one place so, it picks a part up at one station and place is on to another station. So, next is store. So, store the MUs, MUs are mobile units these are the mobile units. It stores the mobile units you can define the size of the store by specifying its X and Y dimensions like, how many pieces, for instance, is a store in between we can also add the buffer in between, for instance, there is a big blockage of the materials in one size.

We can add a buffer in between, it has does not have the product process, does not have to wait you can put a buffer it can the buffer capacity would be there buffer capacity that, it can hold let me say a 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 cannot place buffer and buffer.

Store is a kind of long-time storage so, you can see this is the capacity, 3 into 3, 9 pieces can be stored here. I can just change the capacity to the number which I like, not which I like, not which is actually required in the process so, this is store I am deleting this one. So, place buffer; what is place buffer? This command place buffer, place buffer lines up several processing units of the same kind of one after the other.

The processing, processing units are connected and the mobile units have to be processed at each station thus, they cannot pass each other a mobile unit may only leave the place buffer after it has reached the processing station with the highest numbers so, a model of buffer with a great capacity that requires high performance we can use buffer like, I said. So, place buffer is a monitoring the big buffer is a buffer is placed between 2 plant components that certain purposes it temporarily holds paths when the following components fail when the successor is not able to receive the component.

The second function it does, important function it does is it passes the path on when the preceding components stop working. So, it was your third dimension of a buffer with large enough capacity for covering all failures these to complete decoupling of the plant and the other

attributes as well so, next is sorter. Sorter as a name suggest sorter arranges the mobile units by sorting the criteria we define; we can define the criteria for instance.

If I having the nut and bolt assembly, they are nuts being manufacture and bolts being manufacture and on 1 bolt I am trying to assemble 2 nuts on it so, a sorter what says? Sorter can do, it can pick 1 nut or from the bolt line, it can pick one bolt or it can sort it to the different lines. So, a sorter, we have to define the criteria it can do that. So, line is a kind of a conveyor so, to draw the straight line with active drying colour, we select this then, this is used I have just use it extensively in this example.

Then, is angular converter. So, what is angular converter? Angular converter changes the main direction of the mobile objects from lengthwise to crosswise, it is a 90 degree. I can just put it here angular converter so, you can see 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, a U you 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 moves a parts to its successor within the flow of measurements like it moves a part on to the first leg of the angular converter when, the booking point length has reached the entrance then, angular converter the part drives along the entire length and entry speed all those things we can control, entry point, entry speed, exit point these things can be controlled like I just showed the attributes of this specific object.

Now, next is converter. Now, what is converter? Converters intended for modeling material handling equipment when the part moves on to the converter it either passes straight through the convene direction or it is lift it on to a literally moving transport level, by lifting mechanism and then, convey literally to the left or literally to the right. So, angular converter was just one thing it just convert direction from one direction like 90 degree this can just convert 90 degree.

So, a converter can we can pick whether to go straight or whether to change direction so, it can work in better. So, turntable subs for modeling a rotating platform it is rotating platform which turns a part around and moves on to the several connecting material flow objects, a turntable if similar to turntable we have can have turn period.

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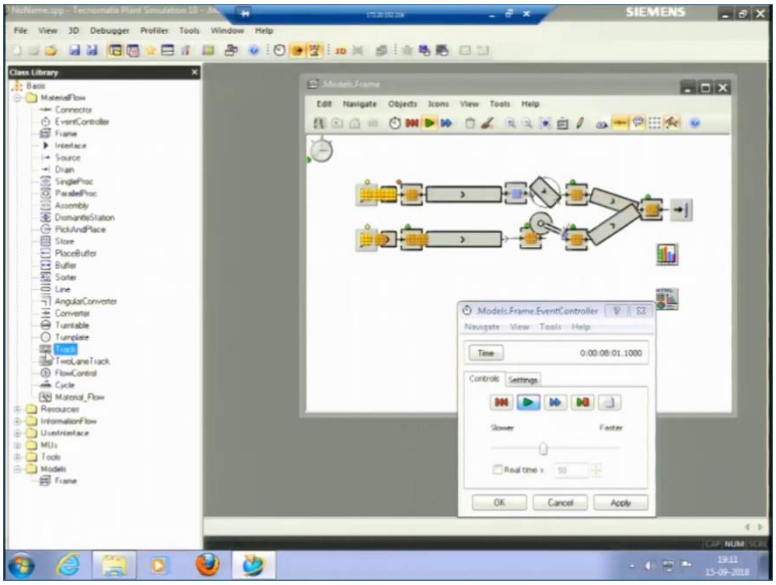

I will just try to put a turntable here, I will delete this Pick and place robot and try to put the turntable here, now, how does this turntable work, you will see, first of all, let me fix this, it is connected sorry, turntable, I need to put the connector I need to put the connector here, I am just showing you some examples in between. Why is not, paste here, let me switch off the grid now, it will work. Now, let me try to run it, it is running the fastest pace, let me try to slow it down and then try to see how the turntable works, it is now moving at some speed, speed that is defined.

Now, processing would happen now, turntable would take it from one place and turn it to the other place, now, what happens? Sometimes, we have to swap the workpieces, this workpiece on this side this workpiece on this side so, turntable what it does it just pick the pieces from this point and the swap it like this, similar, to turntable we can have turn plate we can just put 1 piece on each direction in turntable, it is a single direction turntable that is being shown in the screen turn plate we can have 1 plate and we can have multiple workpieces.

But, put on the, there it is like, kind of a rotating the dining table that we have, we put the dishes over there and we can rotate it we can pick whatever, workpiece 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 automatic routing on which the transporter moves a part. For example, to utilize both the automated guided 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 it then, transporters mobile unit length can be defined, the speed can be defined it so, the maximum capacity of track is defined by its length and the lengths on the individual transporters 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 2 lane track, 2 lane track is; 1 lane track is again with only 1 direction, 2 lane track is it can go in 1 direction and come back from the other side, it is kind of a 2-way road like, we have 2-way track can we put in and 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.

So, flow control is like, it does not store any mobile unit, flow control is, for instance, I having a central O here, O kind of layout and they are certain lines here so, but flow control can do it can just control that of the 1 piece here, another piece here, a second piece here, third it can just control the flow whatever line this is my O, there are lines external to this, the flow control, if I putting here, it can control which of the line is requiring my material now, so it can 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 here, I will come to resources here, resources next is, workplace if we need work with the workers.

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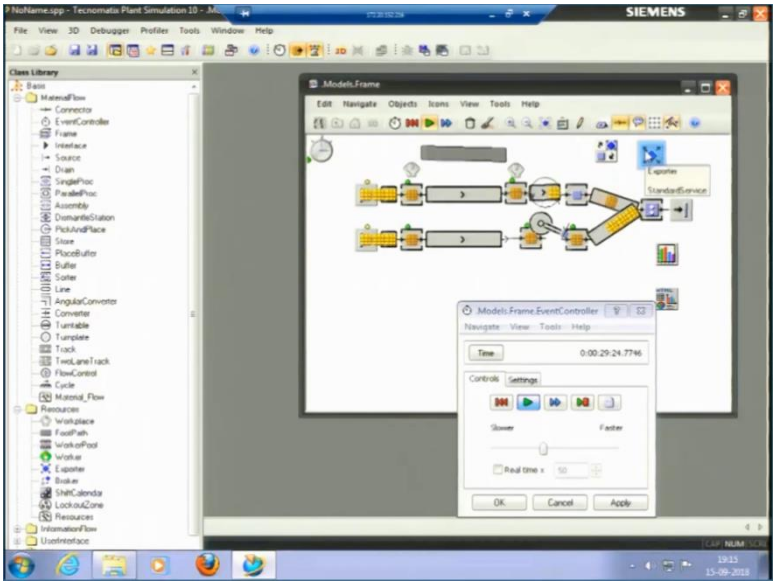

We need to put the workplace, workplace here, for instance in place of this line in place of this line I can use workers to transfer the material from process milling to process drilling so, where, the work has to work would be workplace. If some worker simulation has to be induced, if some work is there, that is, we have just taking the processing time 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 workers kill the working capacity, the ideal worker time and a 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 footpath here, I am taking footpaths from here and putting here, worker have to travel through this footpath to model with worker we need to have a broker as well who would distribute our work to a workers then, we have need to have exporter as well so, we can work with the workers as well I will just show you a certain examples here so, I am just deleting these one.

So, some important points a method I have said then, card file, tag files this is the information flow how the information flow, we can define the attributes here and see how the way information could flow. some of the information flow objects would be method like then, we have variable, variable is when we can work on the source code I can, if I am saying that we can make our own objects if we can understand the code there 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 a keyword let me say then one of the variable 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 file is a list with two or more columns so, it is kind of a table like the normal table we have so, we can access the individual cells by employing their index that is why they position, for instance, the cell number 3-1 cell number 3-2 that they can be accessed.

Then, we have card file, card file you the list with one column providing random access to the contents of the individual cells using their position, that is row number or imagine the card file as a file card box, so, we can think of that so, they are certain things like this. So, next, we have is user interface, user interface we can have comment, we can put some comments we can chart as I shown you report is the complete report when we run the complete simulation I can publish the report of the simulation as well.

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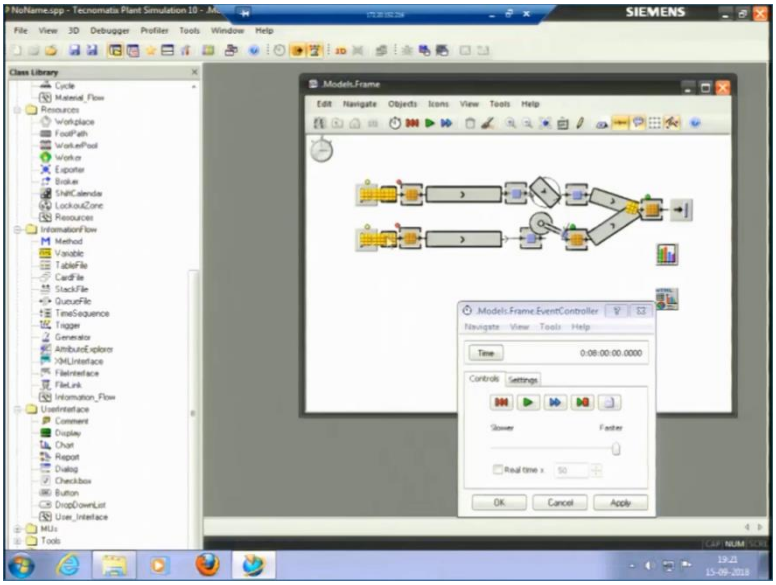

If I apply and try to run it, it has run for 8 hours a day, so, in report, we can publish the complete report in the complete report we can have just the list of these machines different machines.

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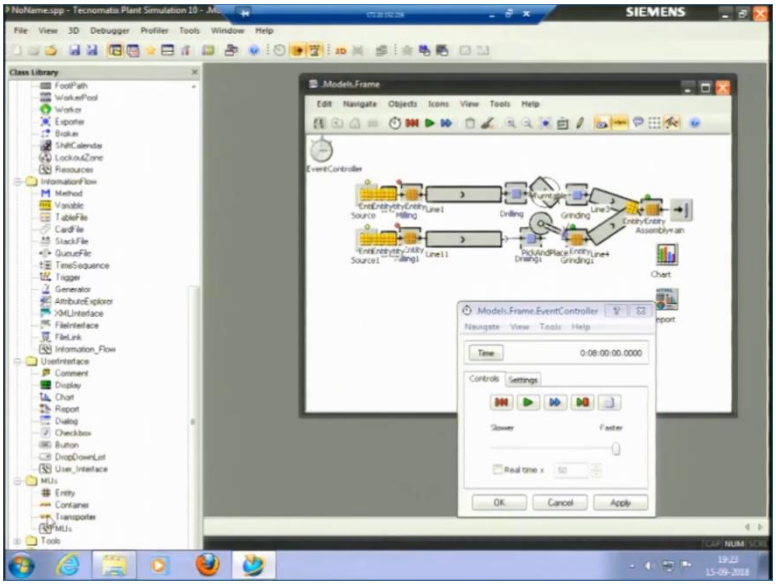

If I just show you my comments here, the machines milling, milling one all the charts that I have just seen, those can be put in there for the time for which the machines were working those can be seen in the report, all these things can be produced. So, next this mobile units are there mobile units, the units which we are being used are entity. If I this thing, these yellow pieces these are entity.

So, similar to entity we have a container, container has a capacity, for instance from the conveyor we know taking 1 mobile unit, the conveyor is taking a container which is containing a few mobile unit or few entities actually so, this entity had it is just a block, just a box this is kind of a box showing here the entity 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, sometimes the conveyor is fixed, but the transporter is a 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 like bottleneck analyzer, some bottleneck analyzer like we have just visualized the bottleneck in the charts the in the example, that we have just seen here but, bottleneck analyzer is also here, that will show this is the primary bottleneck, this is another bottleneck. So, first work on this those things, all 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.

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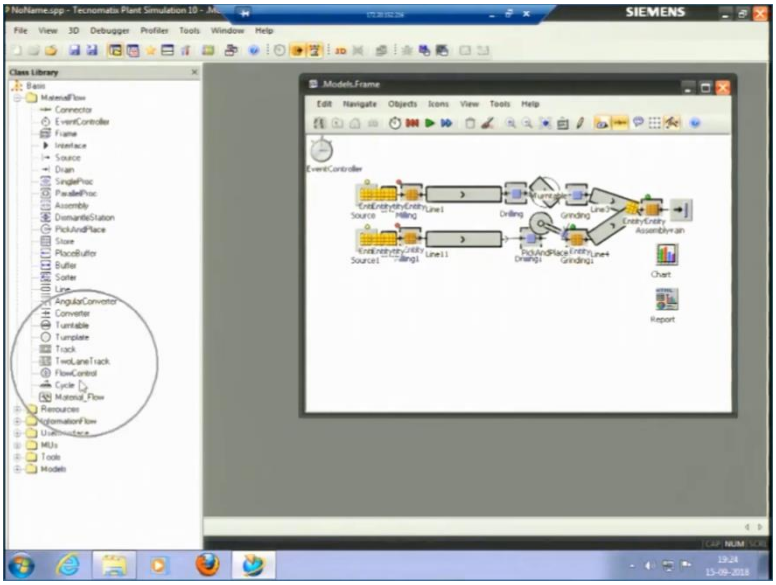

So, these are some of the tools which are used in this software some of the object, so now, I will try to pick some examples and try to explain you how do we use certain tools. Now, these tools are just to design the process, the material flow tools just adjust to design the layout. Then important tool resources, I have just tell you resources just the workers or exporter broker, which are used.

The information flow, how do we use the information? Then the tools which are said how 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 of could be done. So, I like to stop here and thank you for being in the course so, we will meet next time. Thank you.