**Simulation of Business Systems**
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Lecture - 21
Tecnomatix: Plant Simulation - Part 1 of 3

Good morning welcome back to the course.

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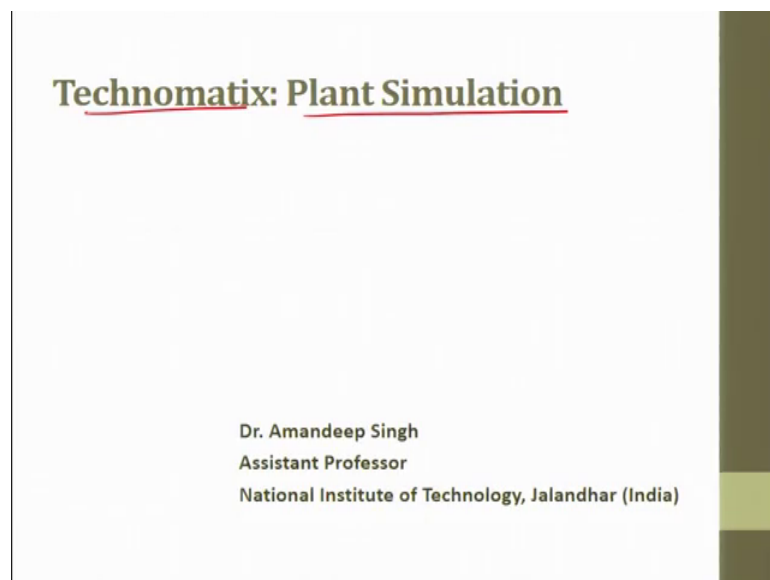
I am Doctor Amandeep Singh and I will take the Plant Simulation Tecnomatix in this lecture. So, we have discussed about the plant we have discussed about simulation, we have discussed about the product design and manufacturing aspects.

So, in this lecture I will just start what is the kind of the simulation that we do in designing a plant, and how do we how material is being carried from one point to another all those thing what kind of stimulation we can do there.
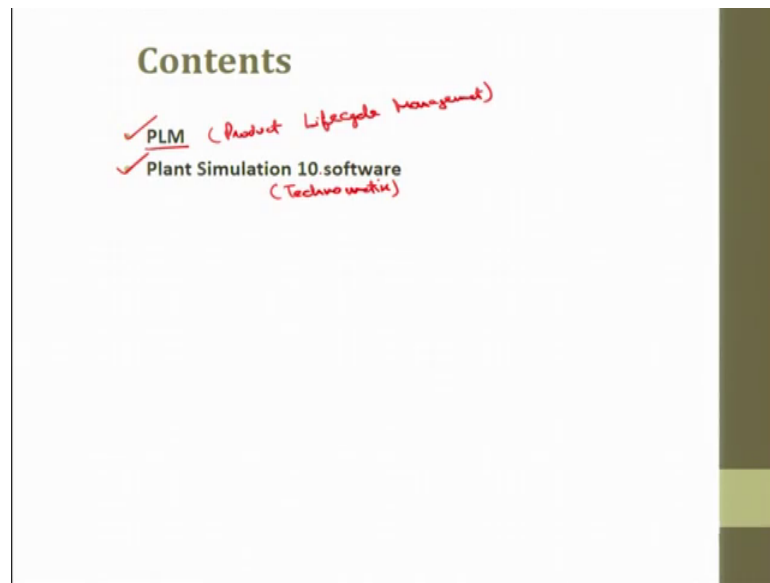
So, before moving ahead I will just like to give the contents here, The contents would follow like this first I will discuss what is PLM? PLM is product life cycle management product life cycle management, then I will just go to my plant simulation software which is plant simulation 10 that is tecnomatix ok.

Then we will just discuss the software another software Arena is similar to this one so, but plant simulation or the PLM software that we have here is in IIT Kanpur that we have is the Siemens PLM version. So, this is the kind of an very advanced version arena has had a an extensive use in research and in few application in industry, but this plant simulation. If we talk about the software get two major functions one thing is specifically simulation software one thing is the functionality the functionality what is the function that software is able to do. So, how intelligent is our software to design the system.

Second things is the Aesthetics or appearance in this case in the plant simulation software I will show you that the three dimensional movements can also be seen the aesthetics are suspended in this case. So, we can see the workers checking the material, we can see the movement of the materials all that animation kind of thing is there. So, that is the kind of an I can (Refer Time: 02:35) add on, but the capability of the software to simulate using different distribution using even we can have energy simulate to minimise the energy used in the plant or also we can we actually calculate the throughput or the total output that is of a day or of a month and in during the day or during the

month what is the total cost that is incurred to cost of operating. The cost of ah processing all those things can be done.

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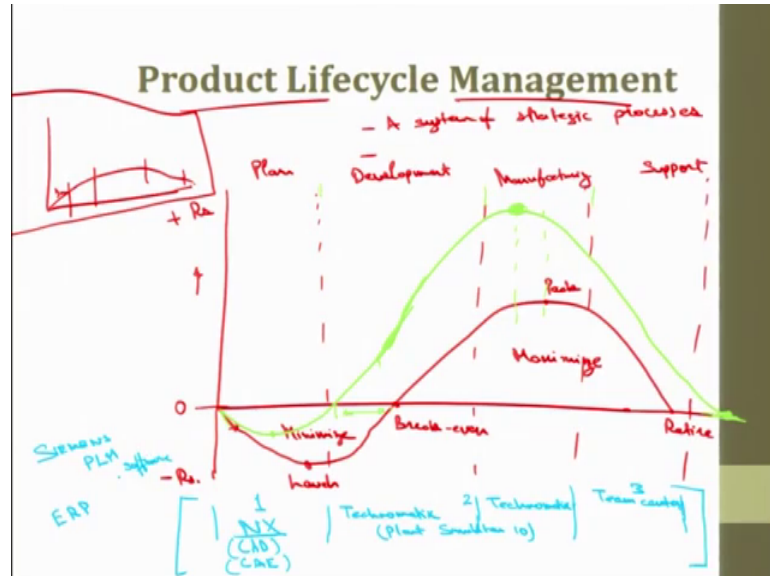
So, let me move forward so, what is product life cycle management? Product life cycle management is the system of strategic process is which have employed to reduce the cost of getting a product to market ok. It is the system of strategic processes I would say. So, you know this is we need to extend the duration of the profitable years of the product because the product if we talk about the product life cycle, product life cycle is something like this not from marketing perspective I will talk from the development perspective product life cycle is if I say this is my profit ok. So, this is I would say rupees and this is plus rupees and this is minus rupees ok.

So, it is if I divided into stages when I am planning and I am manufacturing then I am building the product, then I am trying to provide after sales support. So, this is not the marketing kind of product life cycle that I am doing marketing kind of product life cycle is just like this we have growth then we have sorry first we have introduction, then we have growth then we have maturity then we have decline and also some decay could happen. So, this is marketing perspective. So, I am talking from the product development perspective from the when we design a product, we are talking of the product design and the simulation in the systems. So, when we design the product during design itself the development perspective is taken into account. So, in product life cycle management in

the present day this is known as this kind of curve which I am going to draw this is the curve like this it was something like this ok.

Initially what happens when we are planning this is the planning stage second is the manufacturing stage, then we have the manufacturing can be extract then we have ah before manufacturing ok, I will put manufacturing at third point before manufacturing we have development. Development of the complete plan or development of the maybe prototype of the product. So, after manufacturing the product is sent to the market then we have after sales support ok.

So, what happens? We need to minimize this and maximize this you know this curve that is this is my 0 value that is below the 0 line this is kind of a loss ok. So, this is I can say this is the here I can say the milestone this is the launch of the product I can have breakeven point here because that investment that is made is covered here so, this is breakeven. So, this is the peak profit that we have reached and the product data is here.

So, what is the life cycle of a product? For instance you purchase a new mobile like Samsung note 9 is there in the market where does note 8 go, where does note 7 go I had been using note 2 since last year. So, where does that go that has completely retired the new version of the product has come. So, the life cycle of a product of one specific segment in case of this electronics or maybe mobile is about an year or maybe it as even reduced contracted than in year it is about 6 month 9 month sometime. So, this is finally, the time of the product happens.

So, what PLM if we use PLM or product life cycle management software what happens this is reduced this is reduced and this is maximized. You know this peak is the peek is I would better say peak is pertained earlier than the normal design ok, then product launch could happen even before breakeven is achieved before. So, this is the kind of a profit or rather kind of a contraction of in the time that happens using the software because when we are doing the simulation, you know it is better to fail a simulation than to fail a factory, it is a very common course that is said. So, when we do simulation when we design the product we can do the kind of testing.

So, if I am talking about the product, if we do planning here the product will stands ok.

If I need to design this mouse if I need to design this mouse I will have I need to have this specifications or I can just scan this mouse and get the point cloud and then the triangular mesh and those are the these are the mechanical come to get to do some analysis that whether the strength of the material which kind of material would I use all those things can be done in a software.

So, in that simulation happened. So, that is a kind of a mechanical simulation. So, we can even call at we you if you out of the term computational fluid dynamics that is the kind of a mechanical simulation then certain multiple modules are available for manufacturing the market, but because we are talking more about the product design and manufacturing and we are not to talking about the system design here. So, I will focus more on tecnomatix that is the manufacturing the development or specifically the manufacturing part ok.

So, about this curve this is where we have speed to market that speed to market; that that it has reached the market before then productivity is used you know the slope of this curve is higher this curve the slope is higher over the slope is greater. So, there is a boost in productivity there is an increase in revenue because peak is here right then we have at the standard return the retirement period is now we get retirement at a later stage.

So, this is what product life cycle management, if we actually do the product life cycle management life cycle means not only designing the product managing the overall out of

the complete life of the product from the very idea generation when you have an idea to produce a product to the final retirement of the product retirement means; when the product would just kind of absolute and new product would takes its place.

So, about the software would say we have if PLM Siemen software see we have this four states this part is done by Annex. Annex is a kind of a CAD software ok. It is CAD and CAE, CAD is computer aided design, CAE is computer aided engineering computer aided design is just design like I said I will design this mouse the specific product. I can if I need to have the specification this specific curve I need to draw and I can design that.

That is computer aided design, then I can do certain analyses certain testing on this which are the critical parts and what will be the life of this plastic portion I am not talking about internal body I am just talking about the cover of the mouse here that is computer aided engineering. So, this is Annex software to use.

We would more focus on the development and manufacturing that is done using tecnomatix ok, but this is again tecnomatix ok. This we will use the plant simulation 10 software. So, what does tecnomatix when we have designed the product and we know what are the processes which is this product has to follow for instance this is the product with different components if I dismantle it this cover, this roller, the base, the other certain nuts and this is the cover the bottom the sallies the sallies and external component.

So, I have different components which are to be manufactured. So, for this I need to have plastic manufacturing machines like maybe moulding machines or ah extrusion injection, injection moulding can happen all those things extrusion is not required or the like we need to have the machines.

Now, how to setup those machines in a plant or in a factory, that is known as plant layout, that I love to discuss here. So, this is tecnomatix before moving forward I will just this is tecnomatix and the final support that is done by team center ok. So, this (Refer Time: 12:36) major three versions. Number 1 is annex, number 2 is tecnomatix and number 3 is team centre. This complete version can call it as an ERP an Enterprise Resource Planning ok.

So, it is enterprise resource planning team centre is more focused on ERP, but yes we

will we can say that enterprise complete enterprise resource planning can happen and we can even simulate the simulation happens more in annex and tecnomatix and intense at what happens? Whatever we have manufactured the cost which have incurred for manufacturing and if we need to change something because you know this is planning. And the planning and the actual production there is a difference when that difference happens during actual manufacturing when we actually doing the manufacturing, the data is all stored in our different formats those are used by the team centre version of the software the data is stored in different formats.

So, that can be used though formats which are available in team centre and team centre we can just modify the data according to the actual which is happening do not the schedule the actual manufacturing. So, those are then the simulation can be run again sometimes like to see whether what we have planned or we achieving that or not. So, what is the variations you know you know some variation would always be there and those things it has an extensive application. Arena is a kind of a software which was just confine to the plant simulation only, but this PLM Siemens PLM I am talking about Siemens PLM software ok. So, this can walk in all these domains.

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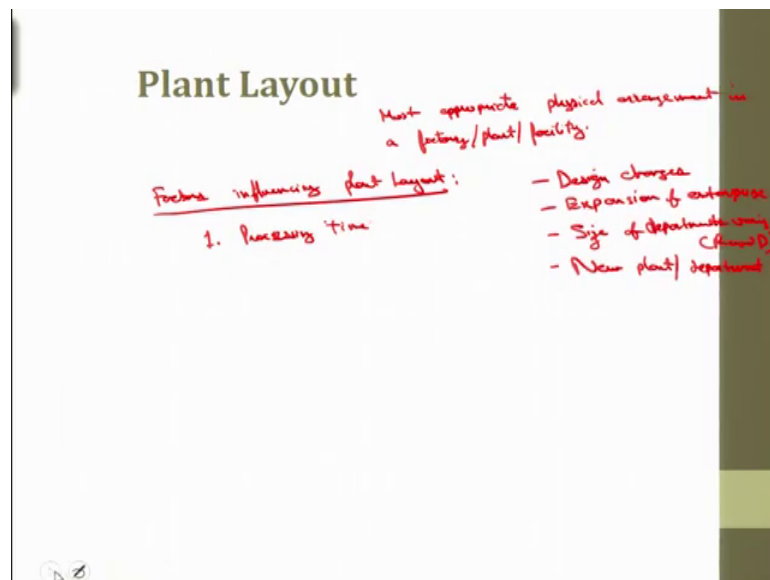
So, next I like to discuss the Plant Layout a brief introduction to this before we actually move to the our software plant layout. What is plant layout? Plant layout planning is the most effective physical arrangement either in the existing or in the plants of an individual

maybe it so it is kind of a study of and it is an engineering study to analyse whether physical configurations of an (Refer Time: 14:57) plants are good or not. So, it is the most appropriate physical arrangement in a factory or a plant or a facility. You know it is important plant layout if even we do not plan it, to minimise the movement to minimise the time that is incurred we have some layout when we stands in a class room the layout is like when a teacher is teaching this the chairs are kept here and in manufacturing you have different kinds of data that I will discuss process, product.

Plant layout I would just put the benefits or the use of the plant layout or we why do we need to plant layout because they are design changes ok. Why do we need to plant? So, because the new tool new processes may be added then expansion is there if expansion of the enterprises has to happen this has to happen ok. Then the variation in size of department for instance the size of department some specifically the R and D department departments vary specifically R and D like company or the factory would like to expand its R and D in the future when new products are coming.

So, when the expansion happens the future plants are to be made beforehand that if expansion happen this wall can be taken down and this room can be converted the room can be expanded and the layout can be just and it change a little to have the proper setup for the future as well.

So, another point I can put here some new department is to be added or new plant is to be setup new plant or department if this needs to be added. So, so the in this cases the plant layout study is required. So, the factors those influence I will just put the factors influencing plant layout. Factors those influence plant layout what are the factors? The kind or the nature of the processes which are working on are we going to do a mass production are we going to do just a batch production or a just a job kind of production.

So, is it a fixed position production so, instance if I am trying to produce a aeroplanes or ships big products, those are the layout is such that the product is kept at the centre and different jobs are done by different work on a different machine at the product or on the product I would say for mass production once specific setup of machine is done then the product have to just flow through this line ok. So, this is known as the product layout because one product is being manufactured for a long period this is product layout then process layout. What factors do influence? Before actually discuss the layout what

factors influence? Number one I can say is processing time before taking this I will just like to just list the kind of the layouts.
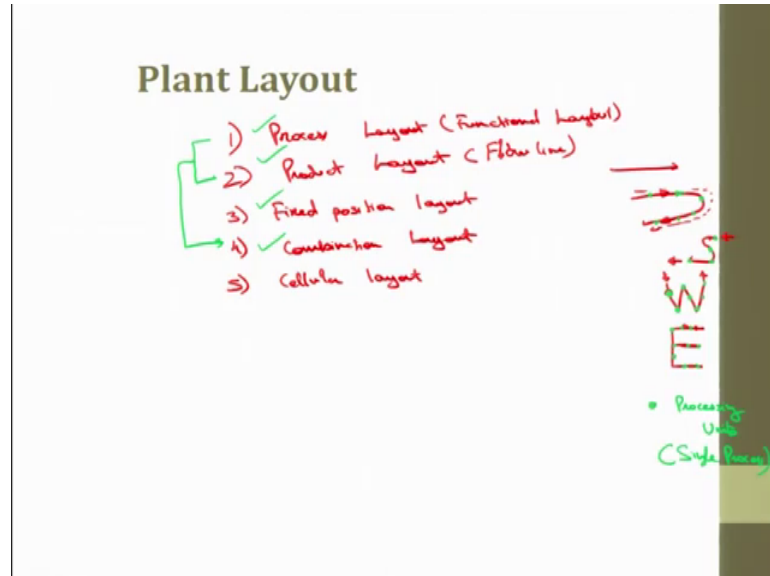
That we have the first kind of layout that I will like to talk (Refer Time: 18:54) is it process layout this is also known as Functional Layout. What happens in process layout? In process layout one kind of process is put in one section in a factory or in a plant for instance the layout in the hospitals all the laboratories are kept in one section and all the OPD thing is kept in one section, then operation theatre or the surgery room is in one section we have all the equipment all the specialists in that the people note this specialist after the specialist helpers who are there who can work there.

So, the process layout is in manufacturing if I say if we talk about, if you know about the machines there are turning machine, drilling machines, grinding machines if all the grinding machines are kept in one section and all the milling machines are kept in one section this is known as process layout. Where is the process layout used? If we need to do mass production you know first process is milling then it has to go to drilling then it has to go to grinding and inspection fine, let me say ok.

So, it has to pass through milling then drilling then grinding; that means, we have to grinding some milling has to happen again it has to again come back, then it will go to the inspection and then go out. If this if a few products have to manufactured that is a kind of a job production or kind of a you know job it is kind of a batch production we

can have think of having process layout because let me say a few pieces are to manufactured the machines are kept on in its place.

But in mass production in actual manufacturing if instance any product that we have it generally manufactured in mass. For instance 10,000 pieces have to be manufactured. So, this kind of movement from one machine to other then I am again coming back and again going to the other machine this is not recommended in that case what we do? We use a product layout. In product layout what happens if flow line is made it is also known as line layout? So, you put it a flow line flow line that is the line through which our product would flow for instance milling drilling grinding milling and inspection another milling is put here milling, drilling, grinding, milling inspection done again milling drilling grinding milling inspection done ok.

If flow line is made and the product would follow this flow line ok so, it can be one line we can have various kind of it is I will discuss about this cellular layout and that can we can say I will just put name of the layout first it is fixed position fixed position layout then we have combination layout, then we can have cellular layout and certain miscellaneous layouts can also be discussed, but these are major layout with that I will try to demonstrate in using my software.

So, what is a cellular layout or product layout? when I am talking about the product layout the line can be just this in one direction this is the line or the line can be something like this if the product flows thorough like we are go here and come back here I will show you the example that I have set that I have made in my tecnomatix software. So, it can be S kind of S is S kind of the direction or the layout is used when the direction that is this is let me say input and this is output when these are in the same direction.

If the input and output has come to (Refer Time: 23:04) has to be in the one side of the layout or of the factory only. If the input and output that or the entry or the exit of a material you know the one side of the factory only we can use W kind of layout. So, this is input this is output ok. So, we can have a sometimes the buildings are constructed like this way sometimes a E kind of layout is also there for instance this is one product line and product is being manufactured here.

So, I have machines here at some points I have machines here we can another colourful machine. So, these are the machines or the processes which are happening ok, these are

the machines green colour is my machine. If an if not machine, I can just call the some processing units processing units I am talking about a factory that is why I am using more mechanical terms like machines, but it these we can just call them processing units these are processing units or I can call a single process ok.

So, fixed position layout I have discussed process and product is discussed fixed position is little introduction is given. Combination layout is the combination of the product and process when the product in factory we have a kind of a process layout, but we know that one of the products is manufactured in a big number. So, we can induce a product layout separately. So, what we have instance this is this is a section in which we have all the milling machine this section we have all the drilling machines, we have all the grinding machine, but we know that after grinding milling operation what is to happen as I discussed one of the processes.

So, we can where just do we can just pick one milling machine from here and put it here 1 or 1 or 2 or 3 millimeter few machine can be put here ok. So, that the product does not have with the material flow is minimised ok. So, that would be then milling, drilling, grinding, milling, inspection this is the kind of a combination of the process and product layout combination can be anything combination can be a product in a process layout or a process in a product layout those things could happen. Then cellular layout is, when we have these kinds of small cells when we small cells like this U as W E small small cells are there and cellular manufacturing is also there also, we have a computer integrated manufacturing when one specific cell is controlled by one computer for instance I may working in hero cycles and there we have a kind of cellular layout for most of the manufacturing.

So, what is there for manufacturing of a ring actually we have the special purpose machines because it is all mass production. So, I will take another example cellular layout is when we have this specific for instance automobile has to be manufactured a big care has to be manufactured ok. So, for car manufacturing engine components are separate then car body is separate car interior are separate then fixing of the component that happens in the conveyer that is the separate thing.

So, engine components where those are manufactured that can be like to pick just one or two engine part let me take think about the (Refer Time: 26:34) system and few walls

those can be manufactured in a one cell it controlled by one computer. So, this is computer integrated manufacturing another cell can manufacture another set can manufacture some other component another set can manufacture another component this is the kind of a cellular layout there ok.

Now, I will move to the software which is the Siemens PLM software which is in the SS OL lab SS L OL is smart systems and operations lab, which is there in IME department industrial and management engineering department at IIT Kanpur. So, the software is installed in the systems in the lab only we have (Refer Time: 27:15) in the lab only we cannot have the software this, but I am using that software using remote access on this computer.

So, I will just open so, remote access connection is already made. So, this is my computer which is there in the lab and I will open my file my software I will go to all programs and I have tecnomatix here and in tecnomatix I have plant simulation and I will open the software ok.

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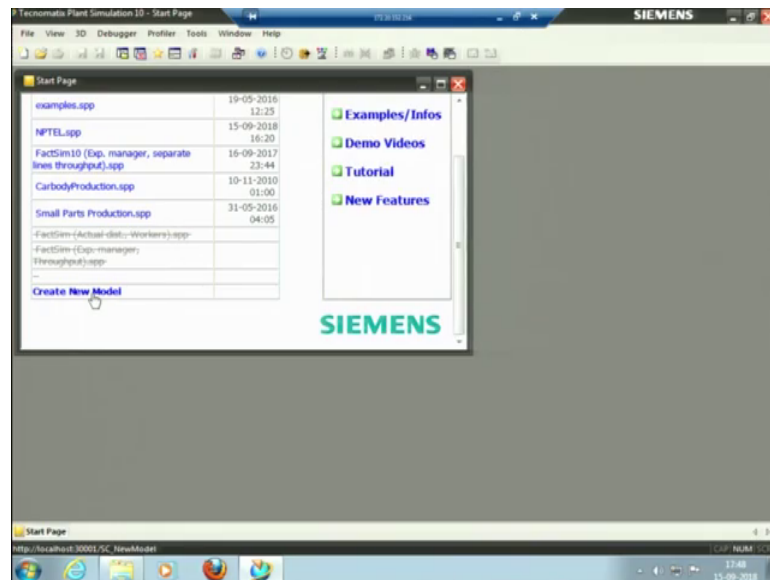
So, this kind of window appears when we just open the software these are certain programs in which I have just walked on. So, the recent programs are there. So, this is the start page ok.

So, I can open or I can create a new model from here. So, I have a menu bar here in

menu bar also I can open the new file I can open the distinct file that we have. So, and also we have another this tab here we have these icons for opening. So, I will just create a new model when I click to new model the new model is trying to open yes ok.

Now, it has basic objects here. The basic objects which are there these would be enough to discuss in this lecture we have limited scope and time here. So, basic objects whatever it is selected I will just say yes to new wherever there multiple models that we can select here we can select certain because this big library and I can select the 3D or this you know this is A G V automatic guided vehicles and 3 dimensional conveyer, 3 dimensional robots conveyers all those things, but I will stick to the basic selection whatever it is the wall selection apply so, the model is open. So, this is the model screen. So, this is my work space where I will work ok.

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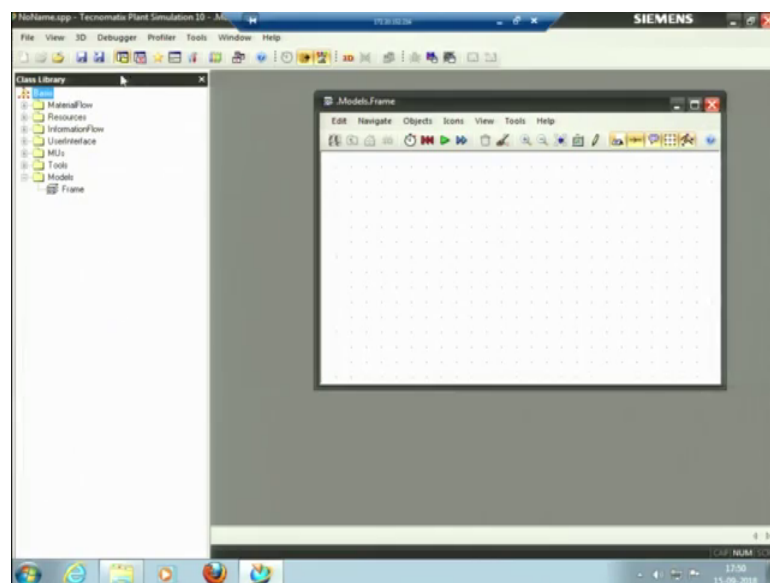
This is the work space I would say this is work space where I will work and this is the grid you can say the distance between the any and there is a grid the distance between any two points here the horizontal or vertical distance is 1 meter I can just switch off and on the grid from this icon this pattern here, it hides or shows the grid. So, these very this is I show later.

So, this is my class library I am just clicking it to bring my icons here ok. So, these are the components before actually starting the model I will have to show you what is the, I would say the potential of the software. So, I have one example here this is the car body

manufacturing in three dimension car body manufacturing ok.

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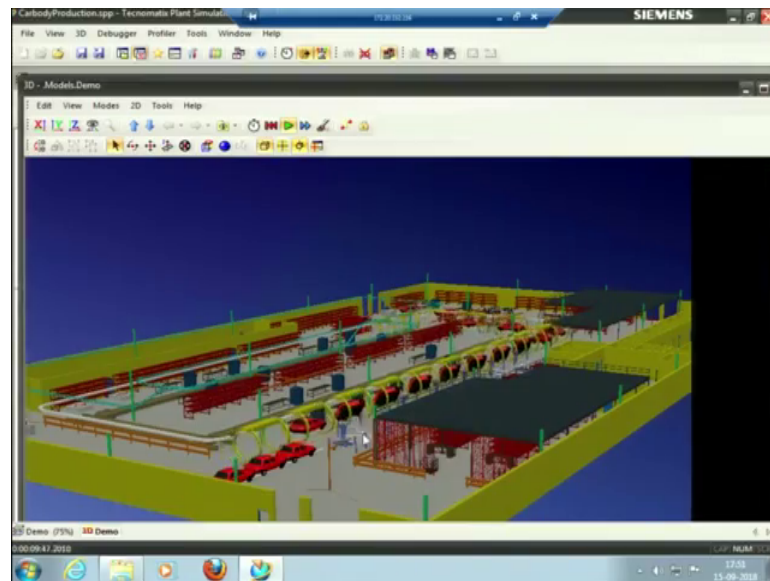
So, this is an example in which whole factory is build in this software and also with general motors had built one of is its new plants, using the software and they have put it that 50 percent of the series were there in the development part because they developed they try to simulate the say movement of the objects and the time and all those things and what actually they were trying to do in manufacturing, they are able to see that in the software like the animation ok.

So, this is my event simulator or even controller. So, I like to show you other manufacturing happens you know this is you can see this is actually moving very fast like control this speed you know workers are moving in very fast this should fastest speed. So, I can control this speed using event controller let me stop it and let me say the speed is real time into maybe 5 times or may be real time into 10 times apply then play. Now the car is coming here, it is then taken by the over hump conveyor ok. So, the workers are standing here you can see workers are doing they are trying to fix may be tires or you know tires the wheels here or the side mirror.

So, the car is completing manufacture the accessories are just put on the cars and those are then sent. So, these different workers do the working in different stations this is the workplace, I will just show the objects when I will come to the actual practice on the software.

This is the work place work tool, where the workers could stand when they are not working and this is the workplace for the worker and worker just picking it is from some point these purple pillars that you see watching this purple pillars that you can see these are this purple pillar and this purple pillar. So, these are the workstations where worker actually this space at the bottom, this is the work place where the workers working and some other processing is also happening. So, cars are just this is my entry point this is my entry point this is my entry point and here it is checking return and this is my exit point. So, this is the factory ok.

I can show you some other examples.

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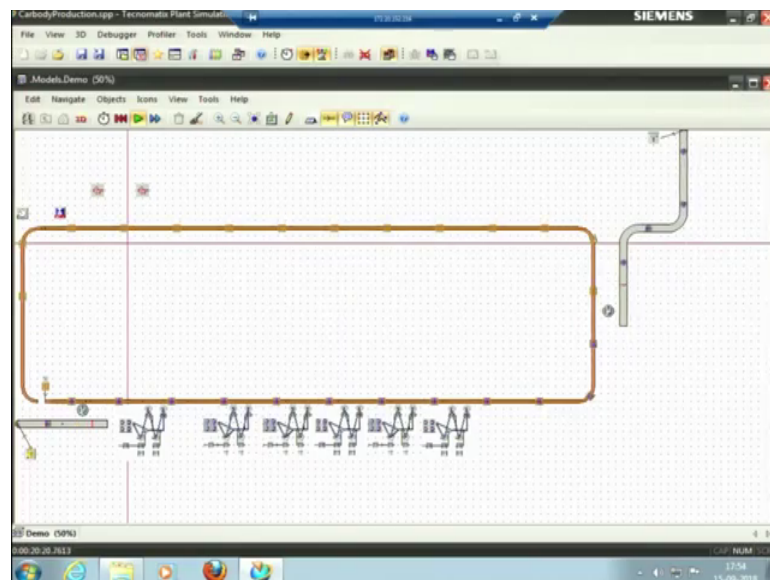
So, this is the two dimensional version of that two dimensional versions the workers are working here you can see ok. So, the car is going out and for some other part for may be inspection it is going. So, I will just close this model and I will come to my start page again view from view come to start page there is another model small parts production you know also it is model carbonic model the small parts production it has open in the document for that ok. The model is not there no worries we will make other model and we can see show you the other example.

So, this is how we can see or I can just pick let me open this model, this is one of the model which we have used the experiment controller ok.

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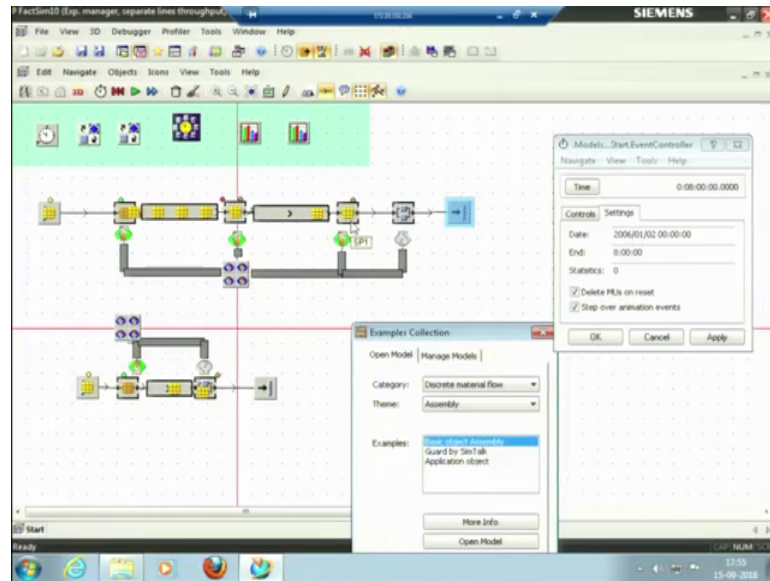
So, you can see if I run the model it has run for 8 hours in the fastest position, it has runs because I had put the n time for 8 hours model has to run and I can see that throughput here open it is the drain the final drain of here, I can see the throughput here what is the throughput what is the total number of components you have to those manufacture in this is throughput per day if you see here this is throughput per day 534 pcs and throughput per hour just 22.25 pcs.

Based from the input that we have given to the specific process is what are the input in the process? Is that I will discuss it is the setup time, processing time then the availability is it available for the complete time or is it available for 95 percent or 90 percent time then we have a distribution, we have a specific process instance it is a manual process and we do not have much data, we have only 2-3 data points which are previously available. So, we can pick may be triangular distribution, if it is an automated process I can pick normal distribution with a very less variation because the process is automated based upon the inputs that we gave the software we try to simulate and give us a throughput ok.

So, any software when we say the software is here there is a very common codes at study it is GIGO Garbage In Garbage Out. Software's can just help us to bring our overall ideas into one place and we can simulate the competition that we sometimes try to do one page those can be done here. And this is the software's are able to so, the animations

in a very elegant way. But if the input is not proper input has to come from the systems manager from the person who is trying to work on it. So, if the input is not proper output would; obviously, be affected the more arrays would come ok.

So, this is I just showed you how to see the throughput. So, let me close this one as well and try to make a model for you two people and I will let you know all the model is meet. So, I will have to stop here and thank you for being in the course. So, we meet next time.

Thank you.