Simulation of Business Systems
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Lecture – 19
Simulation with Arena: Use of Batch Node

Hello everyone, welcome back to the next lecture of Simulation of Business Systems an Applied Approach. I am Dr. Suman Samanta.

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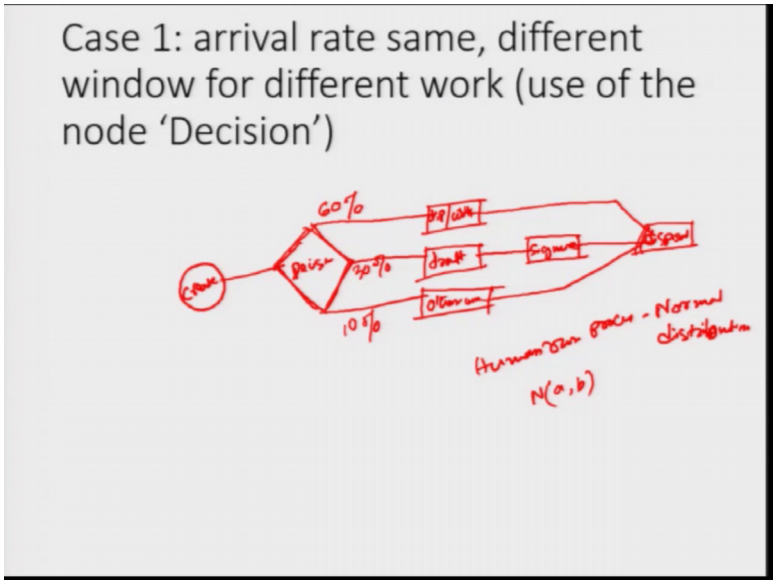

So far we have discussed about how decision node can be used to divert the various customers depending upon the probabilistic number (Refer Time: 00:3) by chance.

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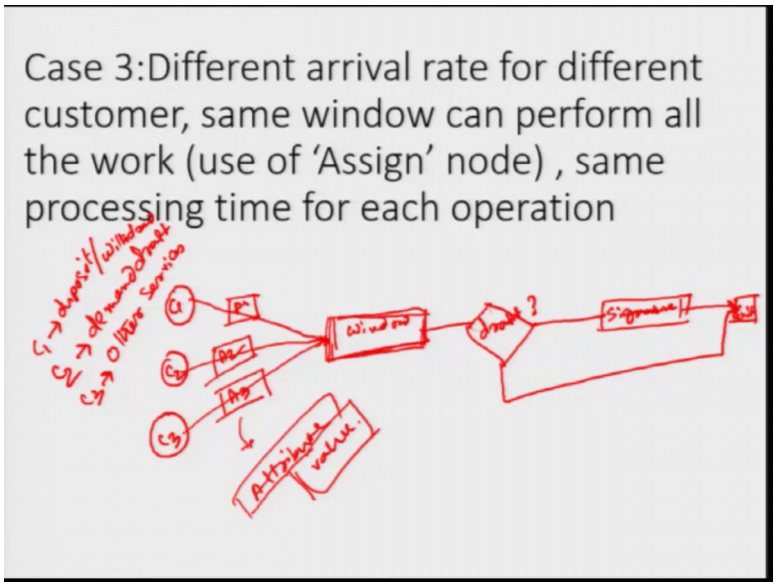

Second is that we have also discussed about how the assign node can be used for particular process and particular it can use for making a decision whether the entity requires a particular process or not. Now, and in the previous case also we have discuss assign node, but the problem with the previous case is that it is not that much practical, because we have in the process window, we have assumed that all the processes require same kind of time wherever in practicality it is not really the case. What happens is that you go to the bank, and you try to do your work done. Say for example, money deposit and money withdrawal or you are making you are going for demand draft or other options, but the time cannot be the same for all these processes. You have different time that we have to bear for other different kind of processes.

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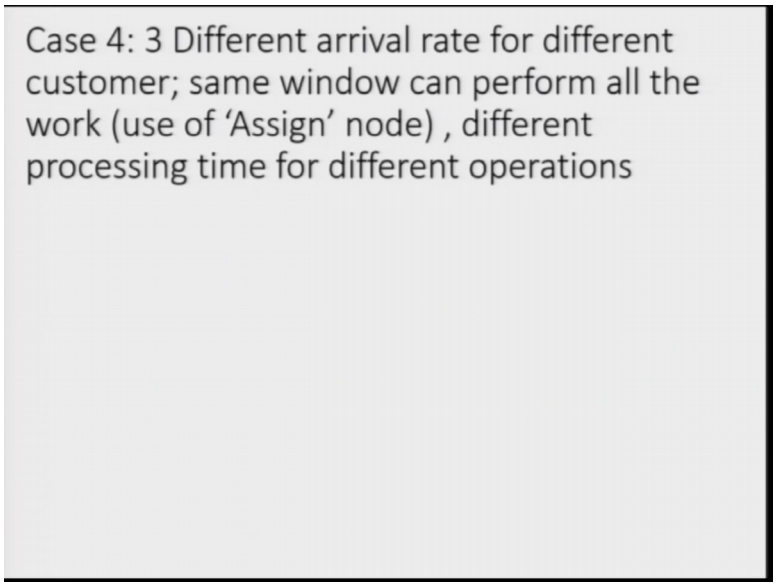

So, now, in this case what will discuss is that how will make the processing time different for the different customers, whereas making the process done in the same window. So, again we will draw this thus diagram of this in a similar model will be very much similar as the case 3. They are also we will do the similar kind of things, because we have only single say single window to serve all the processes.

But, what will be added is here is that in the assign node, we will put another extra attribute that will specifically identify the process. And there that will assign the processing time on the particular entity, and when in the server I mean in the process window, when they reach to the process window, what they will do is that, the window will take the processing time as assigned to the particular customer. So, we will directly go to the arena simulation model.

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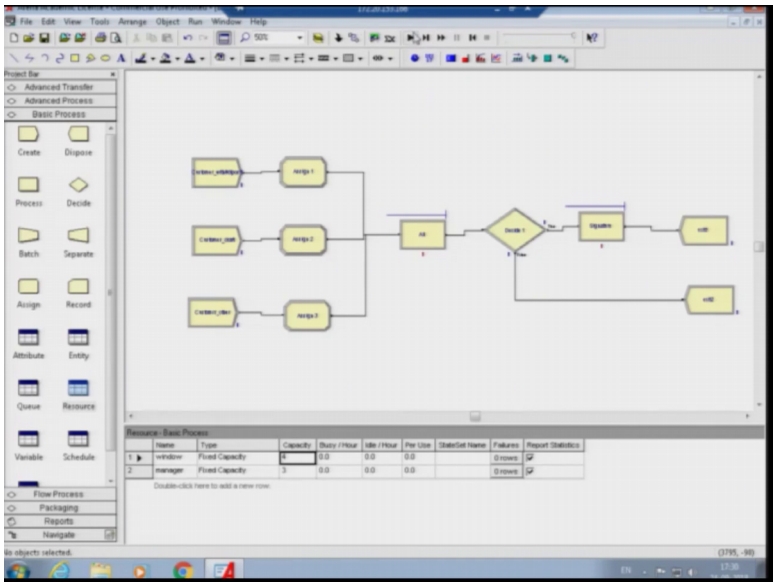

Load the previous file and that will do the required checks required changes in the previous simulation file previous arena model file. And then we will show you that how it can be done and how the module can be done. So, we will load the demo 3 that has been developed previously. You can see that the previous model is here.

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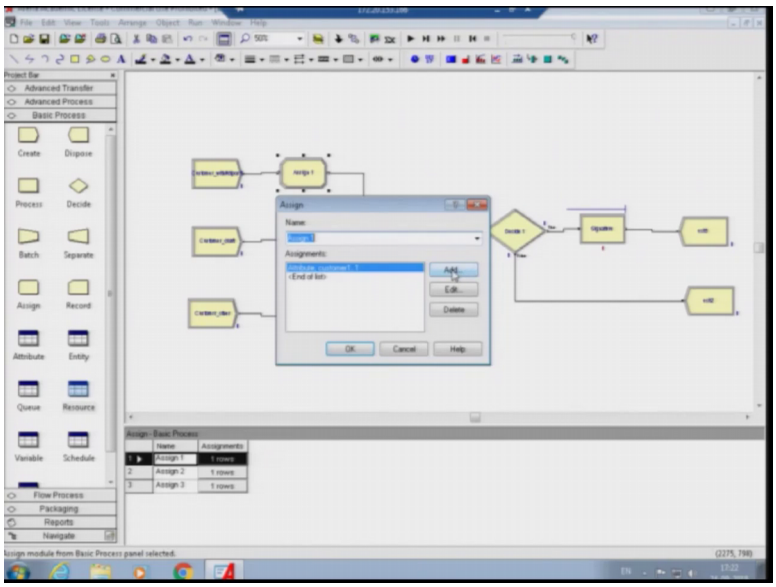

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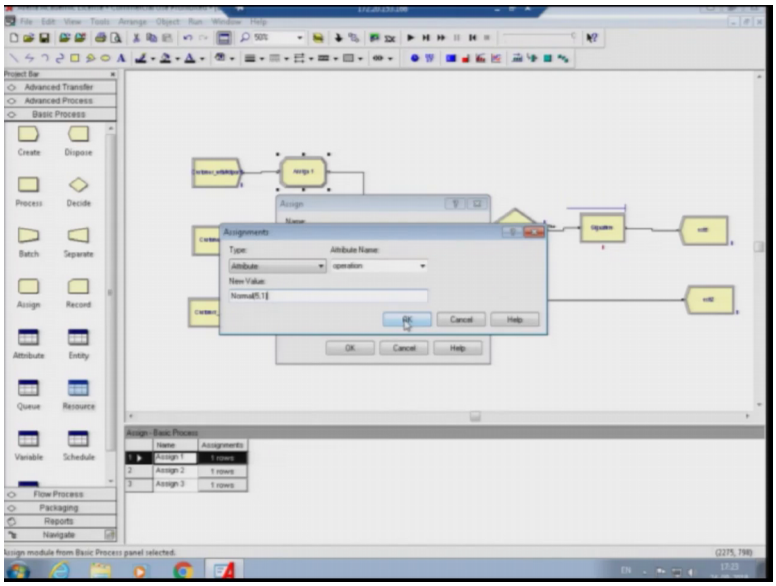

Now, what will you do is that in the assigned node, we will put another attribute in each of the customer with the same attribute name say for example, operation. And we put the value as normal 5 comma 1. This basically signifies that we are ah defining one attribute named as operation. And the value of this attribute operation is normally distributed with 5 as a mean and 1 a standard deviation.

So, what this signifies is that when it this ah particular entity reaches to this particular process all. The all will take the value of this attribute only that will have to change this process characteristics that will that I will come to come later on. Similarly, for the assignment assign two node, we need to add the attribute whose name is operation is value is different from the first case, but this again distributes use normal distribution with say for example, 4 is a mean and 1 is standard deviation. And very similarly for the third case as well we will add an attribute whose name is operation and this value is normal with say for example, 7 comma 1; 7 is the mean 1 is the standard deviation.

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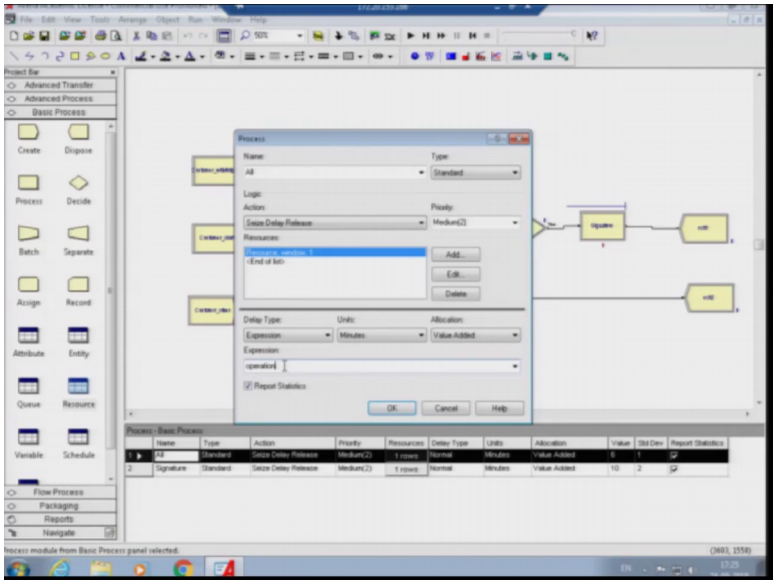

Now, when we assign these processing times in these three kind of customers, we have to make a change here. So, what will do is that in the delay type we will use expression instead of using this distribution in the previous case. And what we will do here again is that we will put the name of the attribute that we have given to all these customers, Then we would have attribute was operation. So, we will put operation as the point at this particular tab expression. So, what this process now will do is that it will search for this expression operation. And we will take the value of operation as whatever defined in this assigned node. Say when this customer reaches to I mean when this entity reaches to this particular process, and it is finds that operation equals to normal distribution 5.1.

Very similar to this case as well when this particular entity reaches to this process, value of the operation will be change to normally distributed 4.1. Rest of the things will remain very much same, because signature will be requiring similar kind of time as I assume. And other things are decision also will be required to be decided by using that previously we have defined as customer 2 equals to 1. And then after this services the exit things will be also remain the same, so because we are not changing the resources.

As we have a defined in the previous case as we have identified in the previous case, because this will previously we have seen that we require 5 capacity resources in the window and 3 capacity resources of manager. So, we are not basically changing it, because we have only used separate values. And we will we will try to find out whether these are basically working or not whether we need to reduce resources that also can be

checked now. So, let us see how it again as I told you before that we need to find out the setup is or not.

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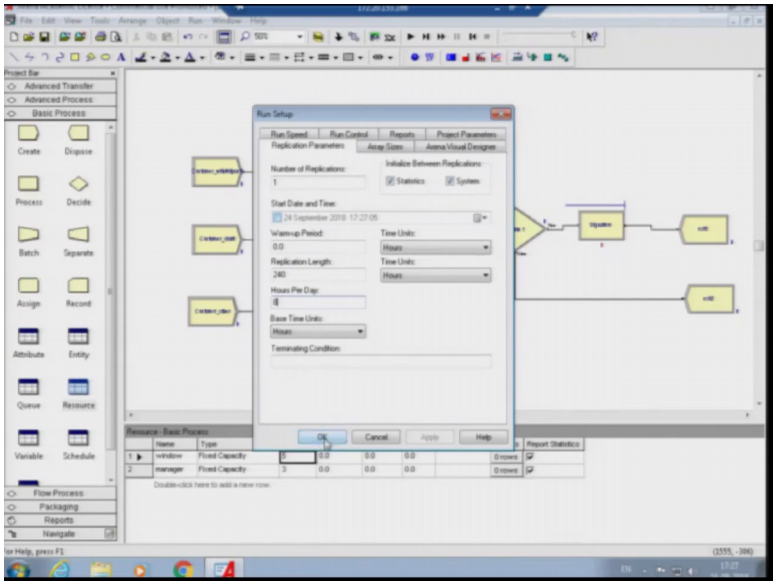

So, setup is fine, because we have already loaded the previous case. So, the setup looks fine by saying this replication length is 240 and watts per days is 8 hours. So, we will run it again and we will check how the system works.

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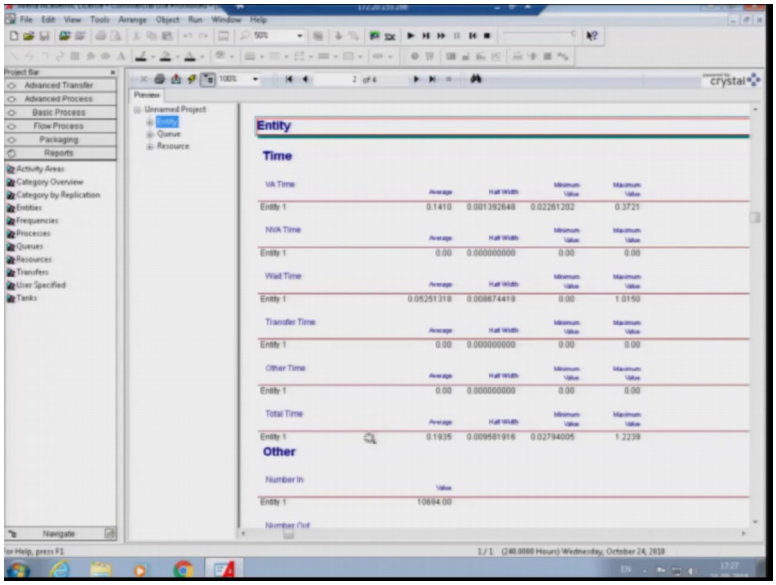

So, we can see that number of total a input is 10649, a number of total entity out is 10677 that is pretty much same and pretty much close.

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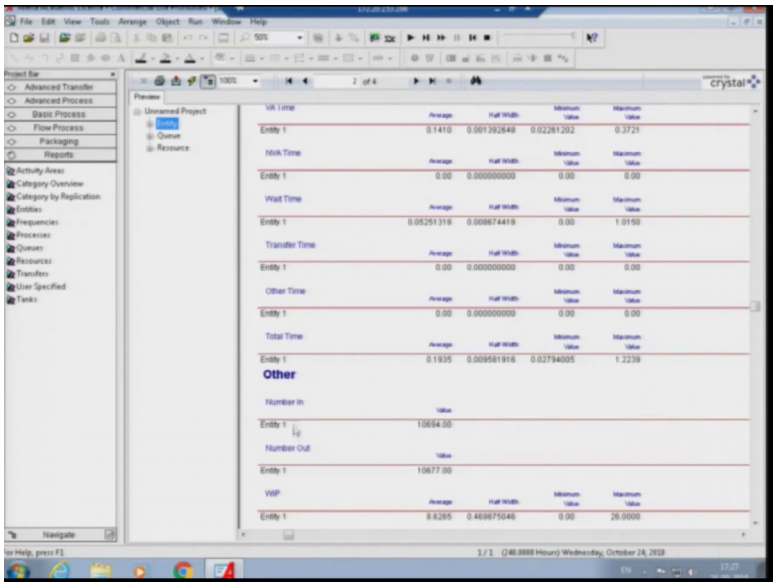

So, there has I mean with this tribute you can have a initial interpretation that whether you require a major change in the system or not. If the there has a very huge difference in this value, then you can have a initial interpretation that there must have some issue on the on this particular process. And you need to find out very you need to go very close look into this queue and resource cases. And then you have to find out whether where the problem lies and you need to make the corrective action. But, since you can see that these two values are very close, then you can have when you will see interpretation that you do may not require that much close view, and there may not have some that much issue with the system.

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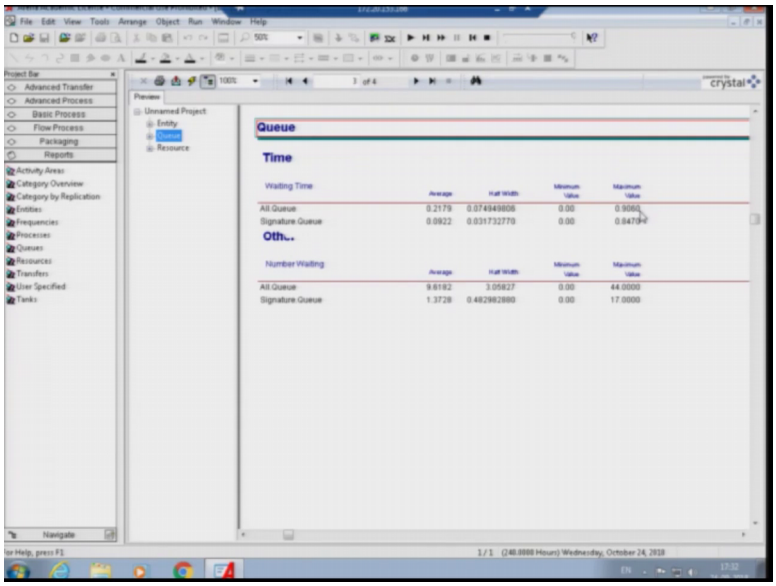

So, as I said in the when you see the waiting time the average waiting time is 0.019 0. With a maximum value of 0.2 minutes it is pretty much acceptable time waiting time. Similarly, for the process sign also the also the average time waiting time is 0.0199 and maximum waiting time is 0.98 that is also pretty much acceptable. And similarly when you see the number of people number of people waiting in the queue for the all window case, the average waiting time waiting number of people waiting is 0.86, where is maximum value is 15. Signature case also the signature I mean process also they are the average number of people that are waiting is 1.45,1.48 and similarly the maximum value is 18 ah.

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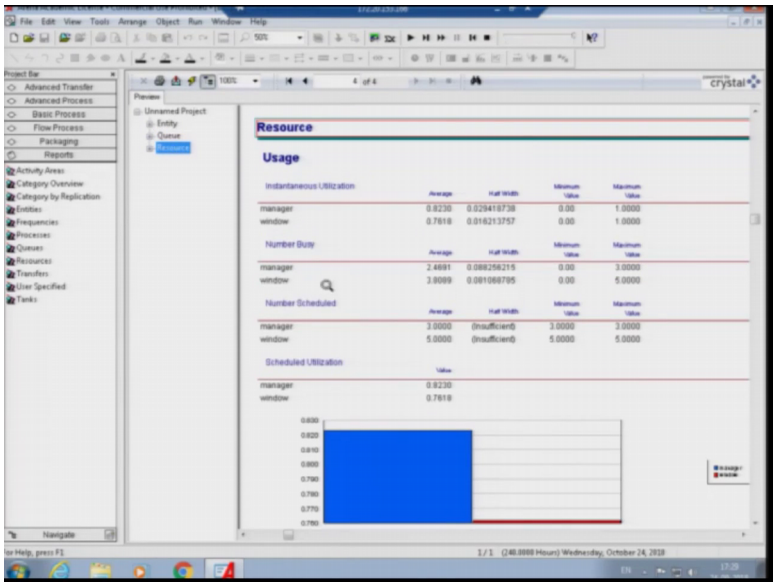

When you see the resource utilisation that also you can see the manager have an utilisation value of 0.8230 and windows of the value 0.763 on it. These are pretty much acceptable I mean values that you can go with, so that issue is that if we found that this value is very less, then we can think that there has some resource which is underutilized. So, even in this case also we can check it whether this was underutilized or not. Let us see by reducing one resource for the all processes. And we let us find out whether the process was previously underutilized or not.

So, we have the total capacity of 5 windows for this all processes ah. So, now, let us reduce it to 4. And we will let us try to find out whether the process is basically underutilized when we use it, as a 4. So, again did the same thing we just added reduce the resource number. Resource and then we run it again with the previously defined characteristics. So, when we study the report as I have said the first impression is basically can be given whether the process is working fine or not. By this number of entities that has been produced that has been produced and number of people that has been that is into the system and the number of entities that got out from the system.

So, you can see the number of entities that went into the system is 10597, and number of entity that is been out from the system is 10582. So, you can see these are very close. Again we can see that again we can interpret that the process does not get affected. If we reduce the number of resources, so this also can be a case where the process is working

fine. People are not understanding whether they want to reduce a resource or increase a resource. And once you get analysis and then find out that there is one extra resource that can be reduced and the process still can work fine work pretty much fine.

So, as you seen the queue also even after the reduction of the resource in the all windows, you can see that average queue waiting time average persons waiting time is 0.0.21, which is pretty much acceptable with the maximum value of 0.990160 that is also very much acceptable waiting time considering the banking system that we avail in our daily life. Similarly, when you see the queue length, the all queue length has an average value of 9.61 with the maximum value of 44 that maybe once or twice in the entire run period ah. Similarly, for the signature queue is pretty much acceptable.

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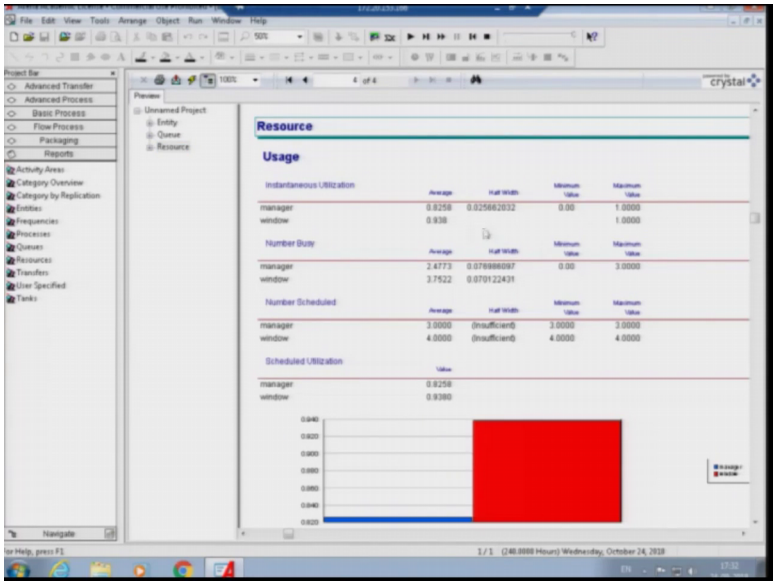

When you see the resource utilisation, then also you can see that though with the 4 windows we have around 9.93 percent 0.93 utilization and 0.82 as the manager as which is very much similar previous, but as the windows resource utilization has been increased from 0.73 to 0.93, but still you can say that this is pretty much with the system, because there has some ideal time for the window resources. So that is how you can do a manager interpretation of the results, and you can find out whether we want to add a resource or we want to remove a resource or this kind of stuff.

So, when you see this stuff, then you can these I mean GUI after the run then you can see that. Here also we can find the there are only 12 customers that has been not solved after

the end of the run that is also this essence we have used various probability probabilistic distributions. This kind of numbers may vary when the real life real life situation ah, so 12 is pretty much acceptable number of people that can be I mean that can be we go with without making any change. So that is how you do we use this assign nodes to assign various processing times, and that is the how you can change the process to get accompanied with these assigned nodes and find out the different how different customers can be processed at different time table.

So, this is the case 4 and we will discuss another case after that which will be discussing about this two more batches two more nodes. It is one batch and separate. We will discuss after saving this file we will discuss that. And then we will develop the simulation model for that we will run that in the in the arena.

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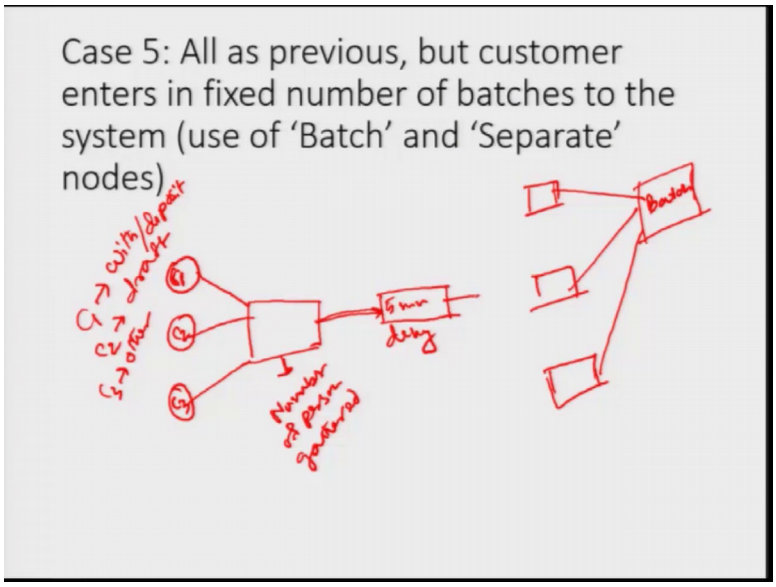

Let us come to the final case in which we assume that the customers entered to the bank as a batches. Though it is not a very much normal situation in the bank, in the bank people use to come and they enter into the bank directly, but for the in order to show you how batch and separate node operates. So, node can be operated in the arena. We have made this assumption that people one people cannot enter into the bank directly. There has some ah number of people once a once a number of people gets gathered. Then they will enter to the enter to the system I mean enter to the bank say.

So, similar to the previous case we will have three create nodes here. We will discuss it by pictorial, then I mean we will discuss it in the process flow then it may be much clearer to you. So, again C 1 is stands for money withdrawal or money deposit C 2 stands for demand draft making, and C 3 stands for other operations. So, a previously what happens is that this C 1 C 2 and C 3 directly enters the bank and go to the process. But, in this case they do not directly enter to the bank. They first need to sit in a say for example, in a waiting room and until and unless a number of person gathered, they cannot enter the bank ok.

So, basically this batch particular node is used in process industries, where you need to make some say for example, when you need to make assemblies and other things, say for example there are there are three separate parts that are processed from different they there are similar parts there are they that are processed from front a process flows and then they a need to be joined. So, under this can scenario we use this batch node. There are other industrial implementation of this batch node is that, say for example you need to transfer material from one particular position to the another particular position.

So, under this case maybe may not be transferring the materials I mean materials or parts individually. So, on under that scenario also you need to wait until a number of parts came to a particular point. And then you collect those number of parts say for example, 20 part say for example one person can take a I mean bag and that can transfer 20 parts together to the next particular location. So, until and unless 20 parts comes that person cannot transfer the material to the next person next person. So, this kind of scenarios are, scenarios ah will be requiring this batching ah node in the arena simulation to be utilised.

So, coming back to our particular case; so, again we will try to draw this figure first, then we they will draw this process flow first and then go to the arena. So, we have made a placed a batch here which will collect number of people I mean the number gathered here we will put it reaches to the bank say for example, reaching to the bank requires another 5 minutes of time.

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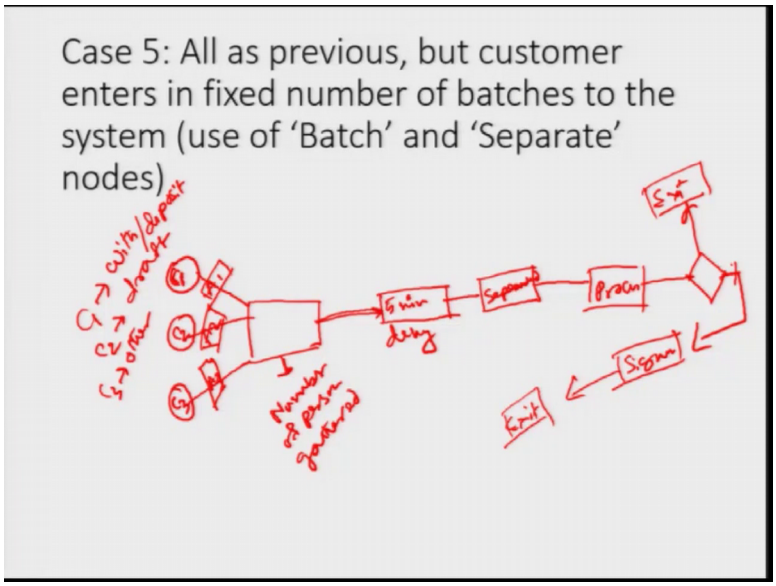

So, we will put it as a delay and then once they return to the bank the customers basically moves to the once customer reaches to the bank the customer basically needs to be separated. Because otherwise if it is not separated then I mean once you have made a batching of the customer, then the arena what arena thing is that there is only one customer.

So, before entering the batch entering the bank you need to separate these batching ah. Otherwise all this, whatever number you have decided as to go as a batch that number will be joined together and make only one entity. So, before entering to the before reaching to the process you need to separate them ah, so that the arena can realise that the, they are basically separate entities. So, after that you put the process and then whatever the process is then again that decision node that whether the customer is from ah customer to or I mean whether the customer wants to make a draft or not. If these making the draft, then he maybe adding this signature process; if not making the draft, and you maybe put them into the exit here also you can put them exit.

Before reaching the batch we need to assign put the assign node as well just like the similar case just like the previous case. So, this is how you will batch, now batch and separate nodes, now we will use arena simulation software to demonstrate this thing and that will be much clearer to you, when you use the arena simulation software.

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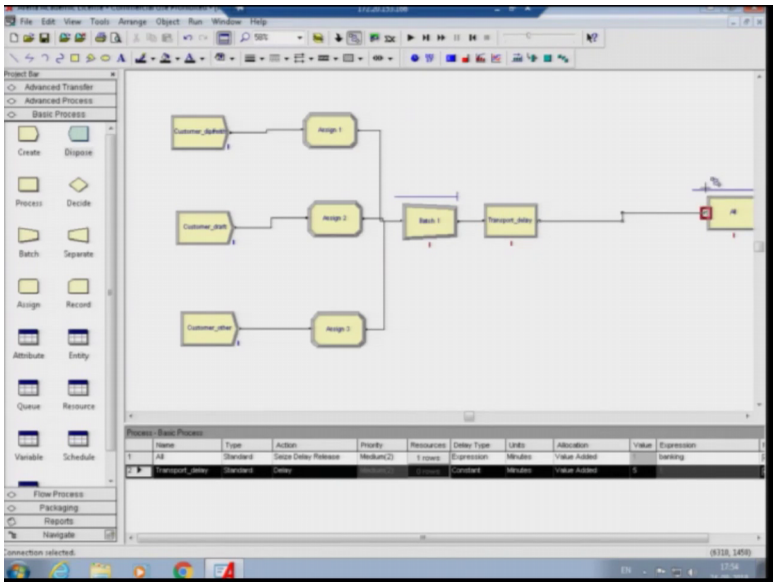

So, we will put another new file we will develop another new file very similar to previous one. We will make three separate create nodes.

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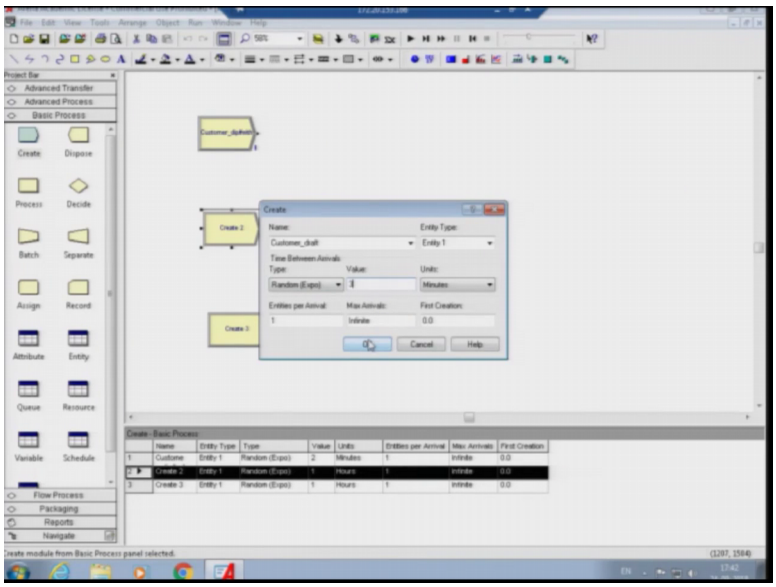

Give name to the separate create nodes as differently say for example, the name of this create node was customer deposition and withdraw and now exponential with 1 percent per 2 minutes. Similarly, here also customer draft. So, I can put into the minutes 3 minutes 3 minutes per they 1 customer arise after in each 3 minutes. Similarly, for the 3 rd create node you can keep the name as customer. Other here you can say in every 5

minute 1 customer arrives. So, similar to the previous case we will put assign node in front of each create node.

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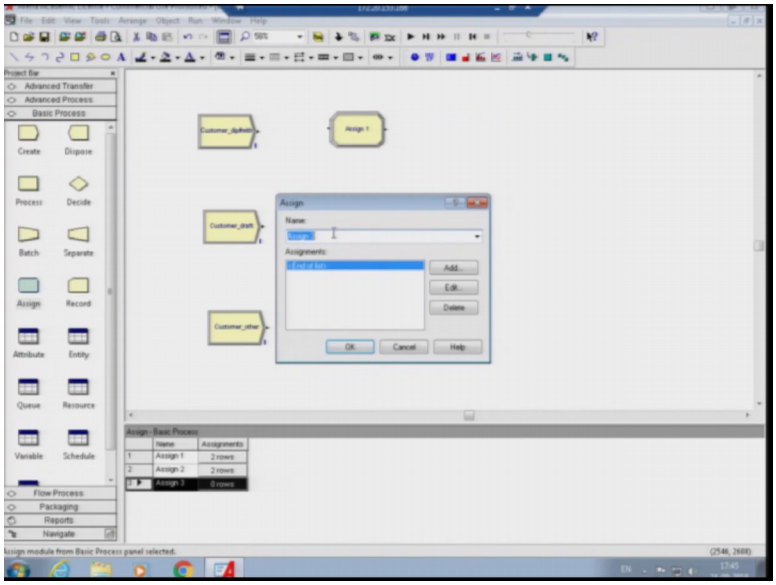

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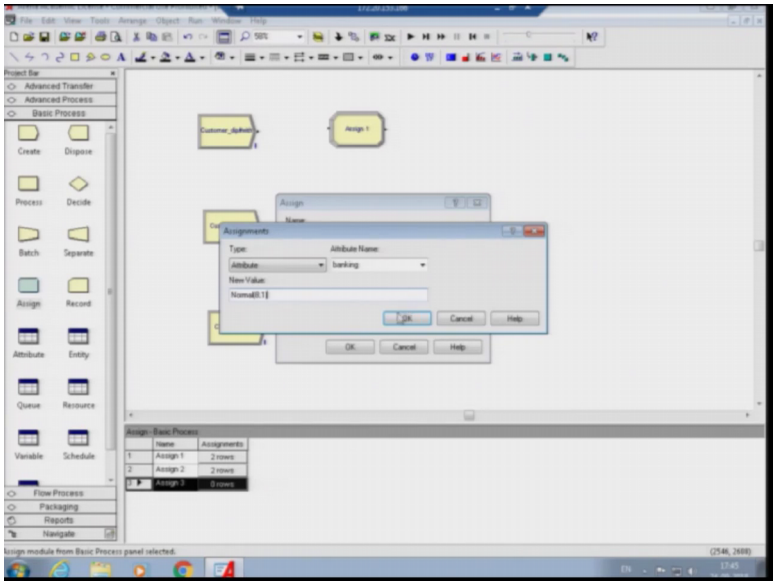

Just like the last case we will put two attributes; one is one is for specifically detecting it, whether it belongs to customer 2 and add 1 process to it. And the second is the second attribute will specifically define its processing time. There is normal 5 comma 1 is again a normal the processing time for this particular customer normal distributed with the mean 5 minute, and standard deviation 1 minute to repeat the thing again. So, again for

the second customer we will need to add 2 attributes. Attribute 1 which is basically customer 2 whose value will be 1. And second is attribute 2, which is basically the processing time. The 3 rd class will do the same thing. Customer 3 value is 1 do not know to add attribute it is banking put the value is. So, as I said previously we will add a batch here. And we will say that in this case until and unless a number of people does not reach to a particular place, they cannot enter into the system.

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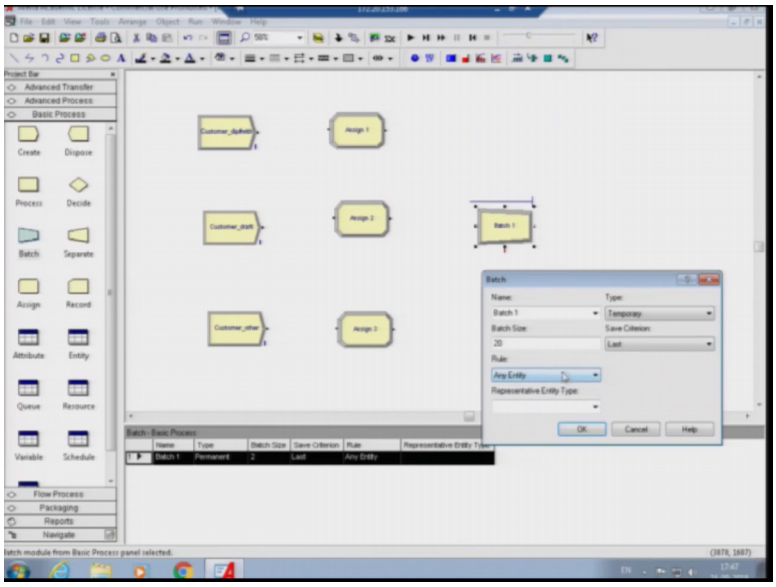

So, if you see the batch, there has particular (Refer Time: 23:50) there has particular place for it says that type of the batch. There are two kinds of types one is permanent, one is temporary. Now, the permanent batching is used normally where assembly operation is done, because once assembly operation has been made then you do not required to break the batch, because it became one particular three-two parts join together and make one particular product, but for the case where you need to transfer the parts to another places. So, when you need to transfer the parts to the to another place, if you make the batches permanent then what will happen is that, you cannot separate the parts again.

So, when you need to only this transfer kind of operations, then you need to put this as it under the category temporary batch. So, and below this there has another particular place, which says batch size. So, we need to define the number batch size, batch size is that the number of entity. If the number of entity is lesser than this batch size, the batch

does not allow the entity to pass through this. So, say for example, for this particular case we will take the batch size as 20. And the rule is any there is a there is a set of rule that you need to define whether want to see for particular entity or you want to see for any entity.

So, if you click there click there, you can find that there is two things. One is any entity and by attribute. If you put the by attribute case, then you need to specifically define what kind of attribute you want to know ah, but here we do not want to put that we want to you only want to keep it as a any entity . So, once we do that then again as we said k, said we need the delay I mean that is basically say for example, the people will require there to move from one I mean from a particular place where they join together. When 20 people come together, and they walk together to the bank gate, and they enter into the bank gate.

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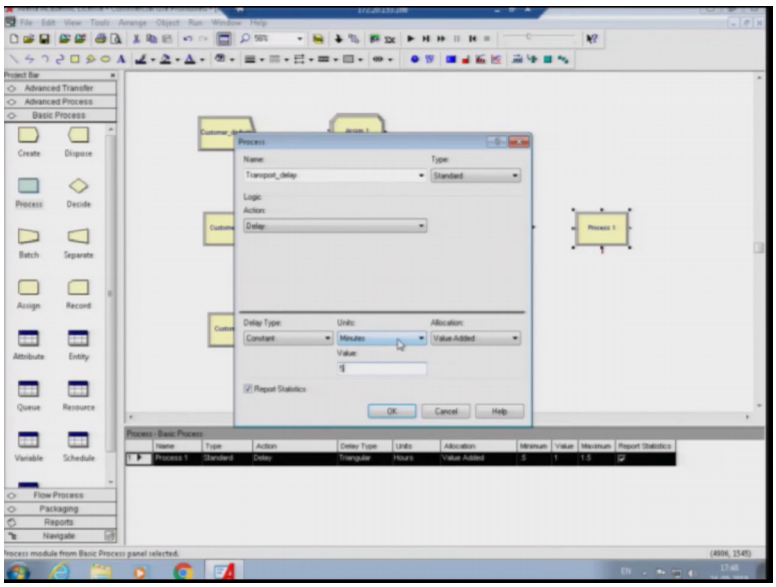

So, we consider this as a transfer delay or transport delay transport underscore delay. So, this is basically a delay not a process. So, if you keep it as a delay, then we will keep it as a constant value of say 5 minutes. Now, if you say that 20 people after reaching to be after a gathering together, they need to walk for 5 minutes to reach to a to the bank, so that is what it basically significance. So, once they reach to the bank we need to again separate them. Otherwise the arena simulation will ah take it these 20 entities together. And they treat them as a LDT. So, we will ah put this separate node here.

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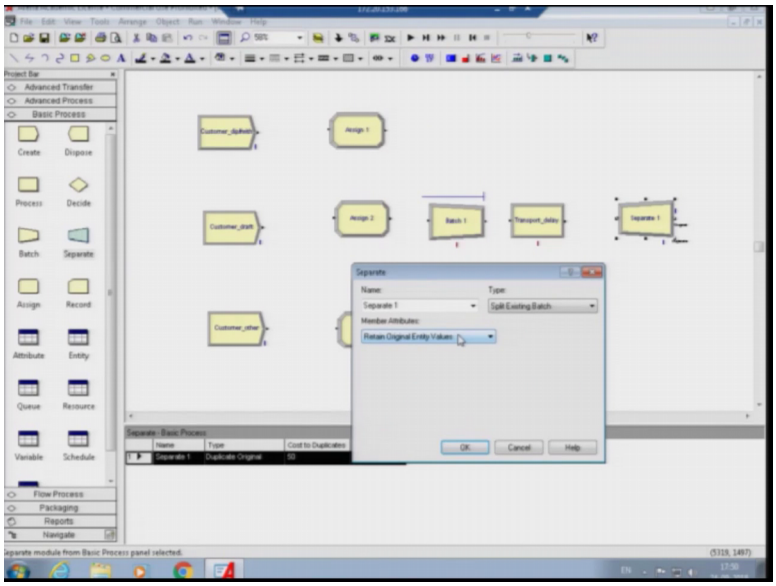

Now, when you click the separate node, you can find that there is in the type there is 2 kinds of properties. One is duplicate original, speed existing batch. Since, we have not used the permanent batch we will do they we will use this type is split existing batch. Now, the members attributes column you can see that. There is three options whether retain original value entity value or take all representative value or take specific representative value.

So, what the thing is that if you click any of these, then you need to change the attribute values and other things. But we want to retain the attribute values, ah because the entity values that we have been that we have been already defined in the assignment node, because once I we go to the ah processive process case I mean, once you go to the processing window we need these values to get them processed. So, we will keep this particular attribute as retain original entity values. Now, similar to the previous case again we will add the process of banking.

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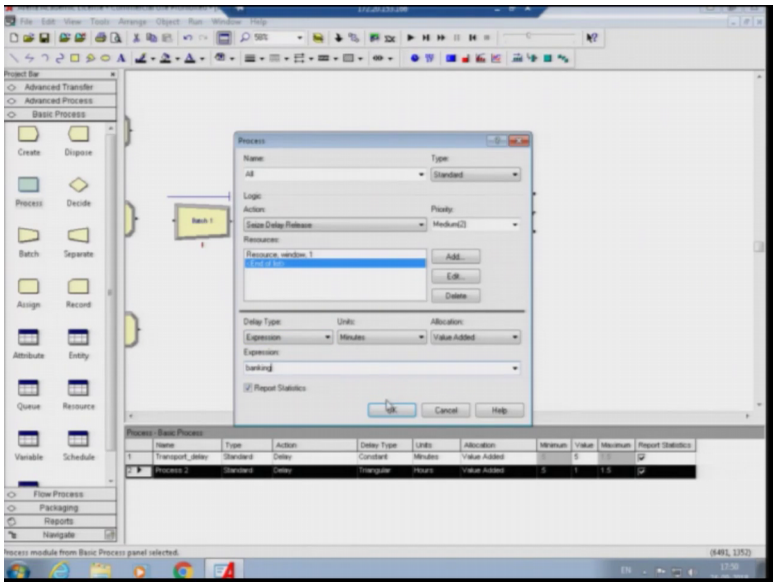

And say for example, as we given the name is all. So, we will put the name as keep the name is all.

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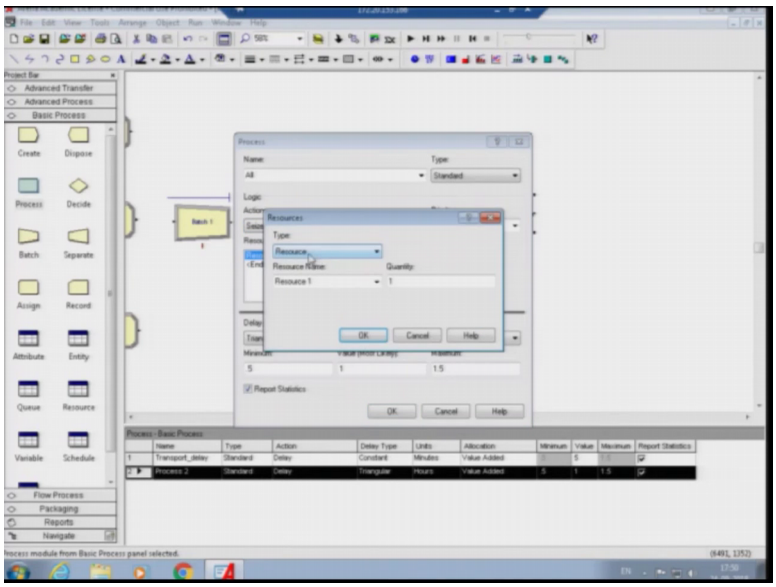

And we will make the name of the process as window and similar to the previous case we will add expression here its minute and the expression name is banking. So, before giving the name you can also check that what name you have given. Otherwise it can create any row error. So, as you can see we have the given the attribute name as banking which basically defines the processing time of these customers.

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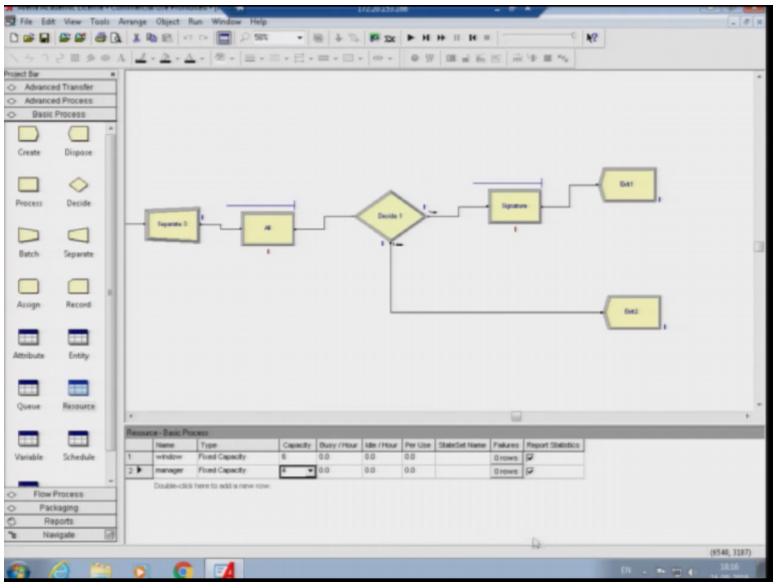

So, we will put expression name as banking. Then we will put the decision node in order to identify, which of the customers belong to the group, which one to make a draft.

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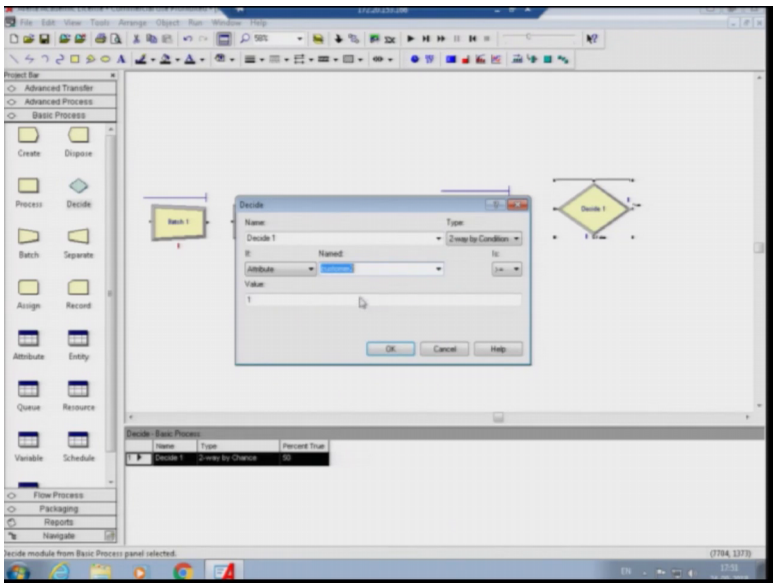

So, we will again use two way by condition with the attribute name as customer 2 equals to 1. Then we would use two different disposal nodes. We will give the name as a exit 1, and exit 2. Now, we will join these nodes again you need to put in more process that is basically signature. And this name is resource name is manager that time is normally distributed as 10, 2.

So, again to brief the system you can see there are basically three create different create nodes separate create nodes that create separate kind of that create separate kind of customers that is we defined that customer arrival time for different customers are different. Now, each customer for each customer we have assigned two different kinds of attributes one attribute will separately select the, which kind of customer it is. And the second attribute value will define his processing time in the in the banking window. So, then what we do is that we define that until and unless 20 percent reaches to a particular place, they cannot enter to the they cannot go to the bank, because there is a transportation system, which allows 20 people to reach to the particular bank.

So, similarly the transportation system takes 5 constant minutes time to for the batch of 20 people to reach to the customer window to the banking window. So, once the banking once the customers reache to the banking window, the banking window starts making the operation. Banking window seeks for this expression banking and takes the value, whatever the banking particular activity banking careers or assigned in the assignment block.

So, once these operation has been banking operation is done. Then the arena tries to decide whether the customer belongs to the customer 2 attribute that is whether the customer want to develop make a draft or not. If the customer want to make a draft, then the decide block directs it to the signature process. And the signature is done by the manager and the particular customer exits. And if it is if the customer is not ah seeking for a draft, so the customer directly leaves the system.

So, again like previous one ah here also we add the attribute for the particular I mean windows here only we have at the, I mean resource. At the resource in what will window, this there is only one there is only one capacity in the resource windows. So, we will increase it to three at least, because we at least have 3 process three different kinds of processes. So, we add the capacity at 2 at least 3. Now, we will run this again and we will try to find out. So, now, we will run this model and I will check out what are the problems in the system. So, we can see the run is started we will go till 240 hours, and then it will automatically stop and go for see again as you can see.

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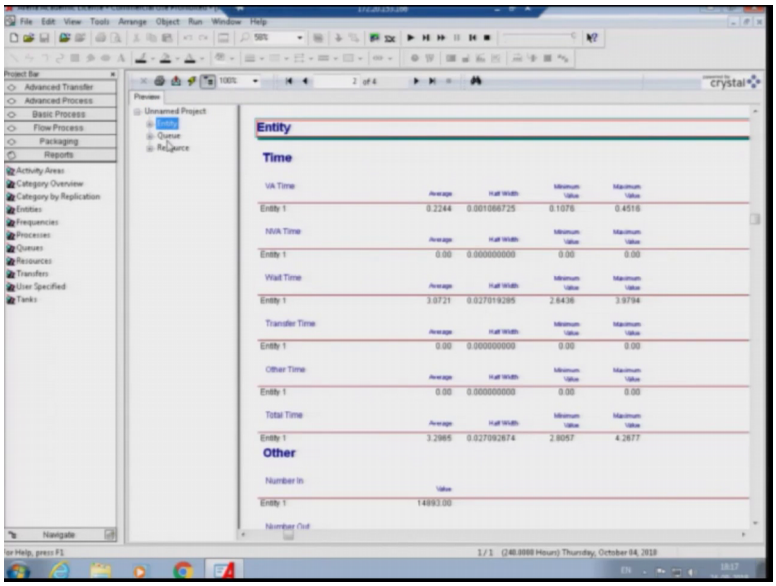

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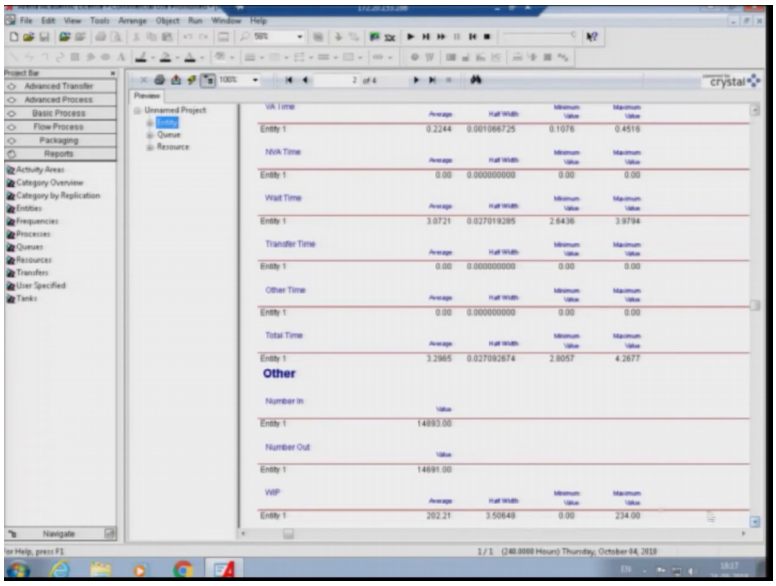

As I have discussed previously when you see there is a discrepancy in number of entity that enter into the system, and number of entity that got out from the system, then you are going to find that the they definitely have some issue in the system. So, as you can see that there has 15430 number of entities that has been entered into the system, and there is 6666 number of entities that has been got out from the system.

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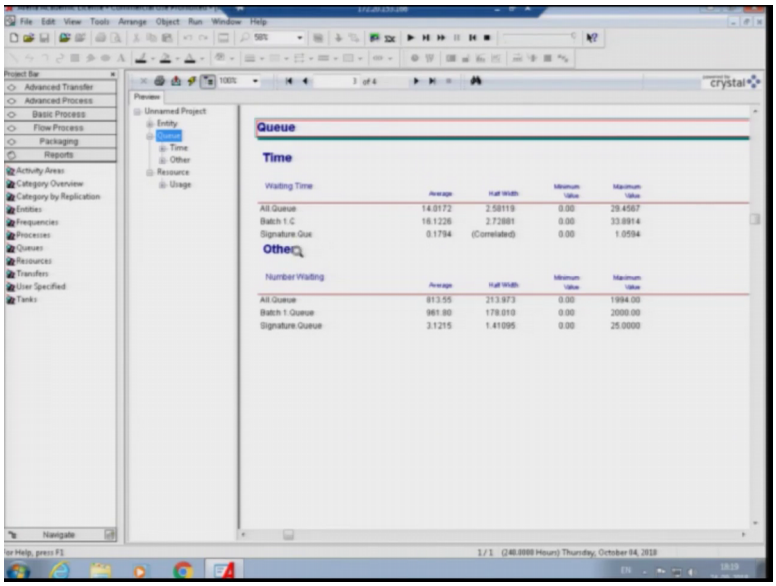

So, you need to check the queue and resource that whichever resource whichever process is basically over utilised and they required to be (Refer Time: 34:50) valid. Like the previous cases as you can see that that all queue have an average waiting time as 53 and with maximum waiting time is 104. Very similarly the signature queue is also an average entity average waiting time as 55.47 minutes. And maximum waiting time is 110 minutes. Similarly, number of persons waiting in the queue for the average for the all queue there is around 30214 number of people that are waiting in the queue with the maximum value of 6505 number of people. Similarly, for the signature queue also we have 613 number of people waiting in the queue an average with a maximum value of 1243 number we will be waiting in the average. As we have used the batch node we can see that there is another queue that is being added that is batch one queue. So, the batch one queue also have some average waiting time and the maximum value. We are not concerned about this thing, because we have to bear with it, because we have made the assumption that until and unless the batch side is 20 we cannot get into the system, but it is not like this cannot be analysed.

We have to analyse this part also to find identify whether the batch size is optimal or not, because in some cases what happens is that you increase the batch size in insignificantly and that causing a problem in the system, because say for example, instead of making the batch size as 20. If we end up developing a batch size of 100 and then what happens is

that there are a more number people who are waiting to get batched and ultimately the process is affecting.

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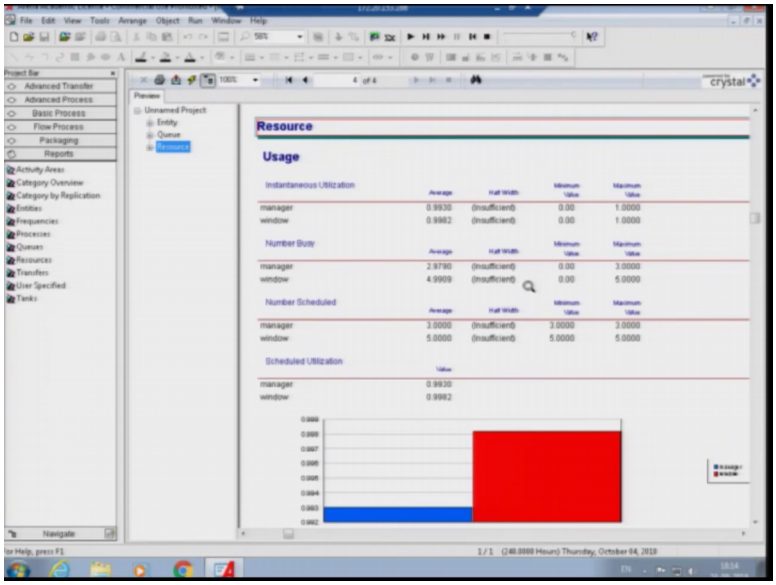

So, these also have to be taken care of. So, first of all you need to take care these two particular processes. Then we will discuss how the batch size change of batch size can impact on the process. So, as we can see the manager and window or windows utilization is almost one. So, we definitely and there are two issues one is three issues basically.

There is there are number of input and number of output is significantly different. Second is queue length for these two processes are very high and queue length of this two process is very high, waiting time is also very high. Similarly, the resources are also I mean the resource iteration is also nearer to one. So, we are pretty much definite that we need to add extra resources to this particular two processes, so very similar to previous cases.

What we will do is that we add capacity in the resource block. We will go to the resource block; we increase the capacity from 3 to 4. Here also we increase the capacity from 3 to 2 for the manager. So, by adding these capacities, we will again run the model, and we will find out how this is basically working.

So, when we check the entity, we can find that again we have large number of discrepancy in a number of input and number of output that is number input is around

1500 and 500 and number of output is around 11031. So, we will check to the queue again we see that all system, all window queue and the signature manager queue are queue having a larger waiting times.

And similarly number of waiting is very high for the all window queue and for the signature queue also have been see it is significantly high for the resource case as well. You can see both are still having nearer to the I mean nearer to both the I mean process still have a utilization value nearer to one. So, we will add one more resource to each of this block I mean each of this process so that we can reach the optimal value. And then we can change batch length, and will show you how this batch length affects the process.

Now, you can see that number of entity the entity input is five 15394, number of entity output is 14308. So, similarly the queue length has been significantly reduced, but the all queue is still very high. All queue minimum waiting time is around 7.5 minutes, maximum waiting time is 15 minutes. However, still the all queue looks very high as you can see the all queue have an average utilization is 0.99, so this is still pretty high.

So, we will add another resource here then we will check it again how it is behaving. So, now you can see again it has been improved the input and output ratio has been improved from the previous case. Now, we will check the queue size and queue length. So, now the queue size and queue length has been improved for the all queue, but for the signature queue it has been again increased.

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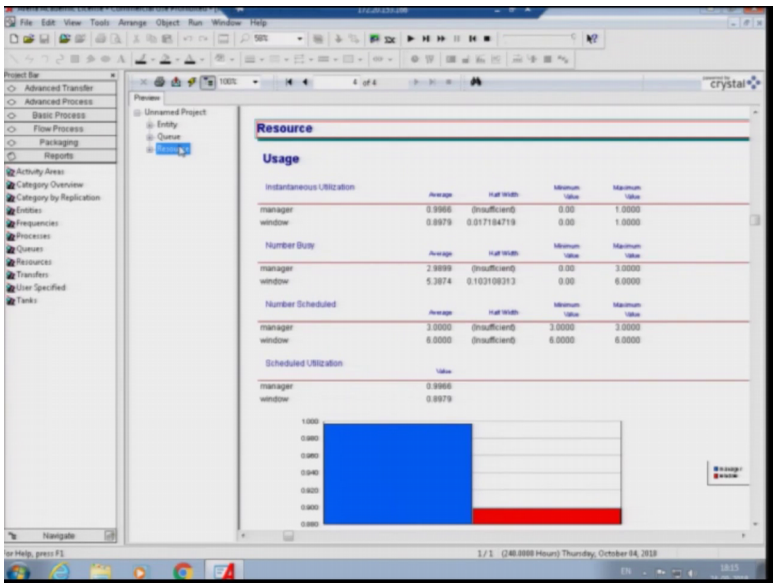

Because we so for the window for the process resource window, you can see that the average utilisation has been reduced ah, but for the manager it is still 0.1 I mean near about 0.1 ah. So, again we will add this resource I mean increase the resource to 4, and then we will run it again. Now, you can see that number of about 11 out is pretty much.

So, now, you can see that the there is very less difference between the number of entities input and number of entities output. So, we can see the queue length. This is the queue length has been I mean queue characteristics, you can see the queue waiting time has been significantly reduced for all the cases. Similarly, ah the queue length has also been reduced for the significantly for the all the two processes.

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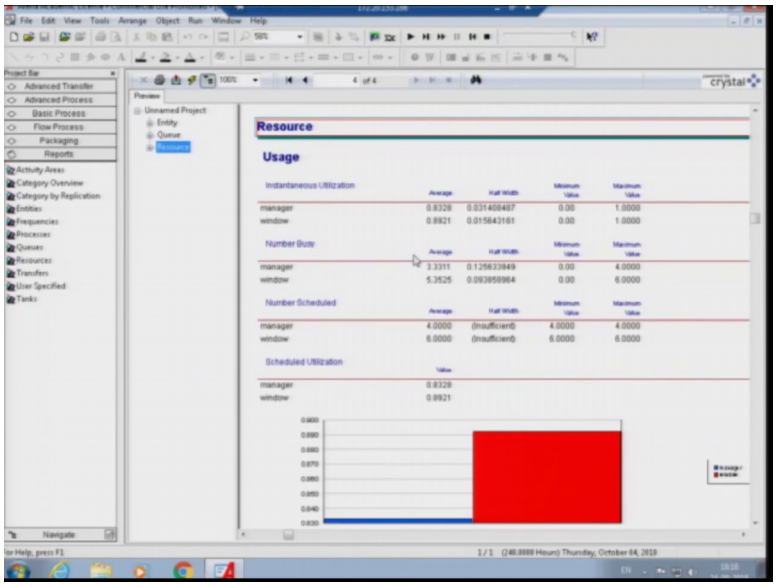

So, now if you see the utilization factor, then also you can see that the utilization factor is also been reduced. So, we can say that now the system is in steady state condition with the resource window having 6 capacity and manager having 4 capacity. Now, we will do little bit of change in the batch size and I will show you how this batch size can affect on the process.

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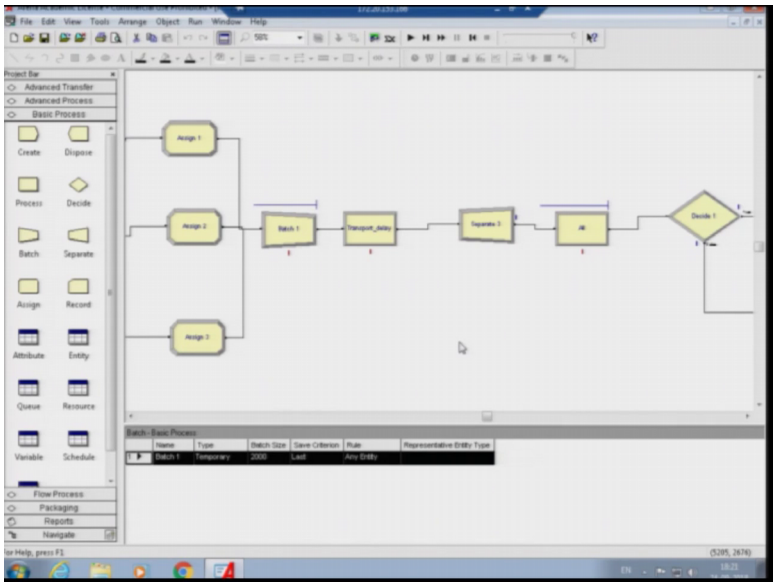

So, previously we have used 20 as a batch size, now increase say for example, 200 as the batch size. Now, you can see that how this a will impact on the output. So, previously we were getting around near about same kind of entities enter into the system near about same number of entities were going out of the system. Now, we have increased the batch size to 200. Now, let us see how the system effects by this [vocalised-noise]. You see when you will increase it to 200 still it is not affected, so not much affected I mean you can say 200 number of will number less entity got output from the system. So, you can say it is not that much affected.

So, what we do is that we increase it at the abruptly it with some very large value say for example, say until and it reaches 20,000, 2000 it cannot go out. Now, you can see that now you can see number in and number out has been significantly changed, because of the abruptly increase in the batch size. We have increased the maximum 2 to 20 to 2000, so this problem has happened.

So, what happened is that in the queue characteristics I mean in the queue characteristics what happen is that the waiting time for the signature queue. And all queue has been remains almost the similar, but the batch queue has been the waiting time in the batch queue has been increased. Similarly, waiting number of people waiting in the I mean number of customers waiting in the batch queue also has been increased from the previous one.

Previously, it was very much negligible with around 7 8 people were waiting in the queue. Now, it is increased to 961to and 2000, because this is a basically we are allowing 2000 people together going out. So, in this way we can see that we have to find out a I mean we can select a batch size which is basically optimises this particular process or we can ah find out how this batch size can impact on the process as well, so that is how we can we can use various nodes in the simulation software to describe various different, different kinds of situations.

And ah we have used here a very simple models, so that you can work them out in your system itself by ah installing the student version of the arena simulation software, because with the licence versions cannot be available everywhere. And thus you cannot get in hands on with the license version. So, we made this model very simple and I also recommend you that when you do study these videos, you please install then a student version of the arena on your system. And you ah develop those models along with the videos and run them on your ah system, so that you can get a good idea about how these nodes can be used, so that is all from my side. And I will wish you all the best for you for the course.