Object-Oriented System Development Using UML, Java and Patterns
Professor Rajib Mall
Department of Computer Science and Engineering
Indian Institute of Technology, Kharagpur
Lecture 28
Activity Diagram

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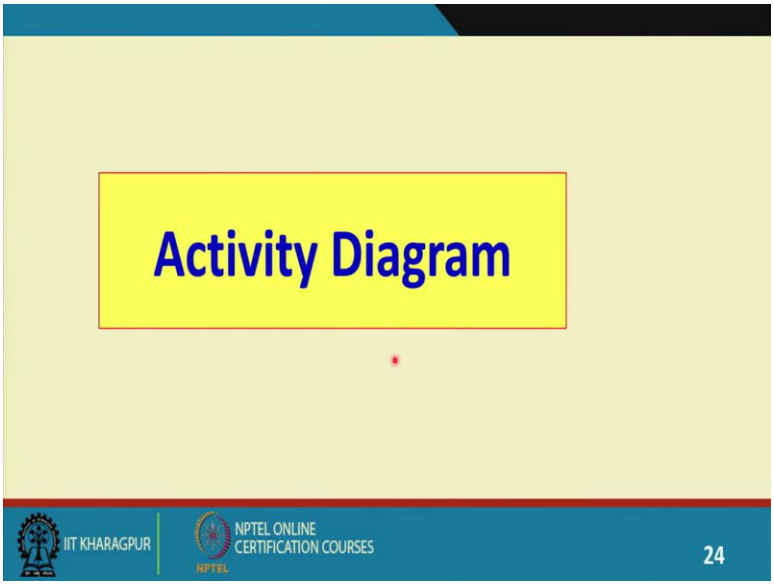

Welcome to this session.

In the last session, we were looking at the sequence diagram, collaboration diagram, which is now called as a communication diagram, and so on, and we were just starting to discuss about the activity diagram.

These are important diagram used in almost all design activities we will first get familiarized with these diagrams, draw simple diagrams and then we will see how these diagrams are used in a design process to arrive at a suitable design. Let's proceed with our discussion on activity diagrams.

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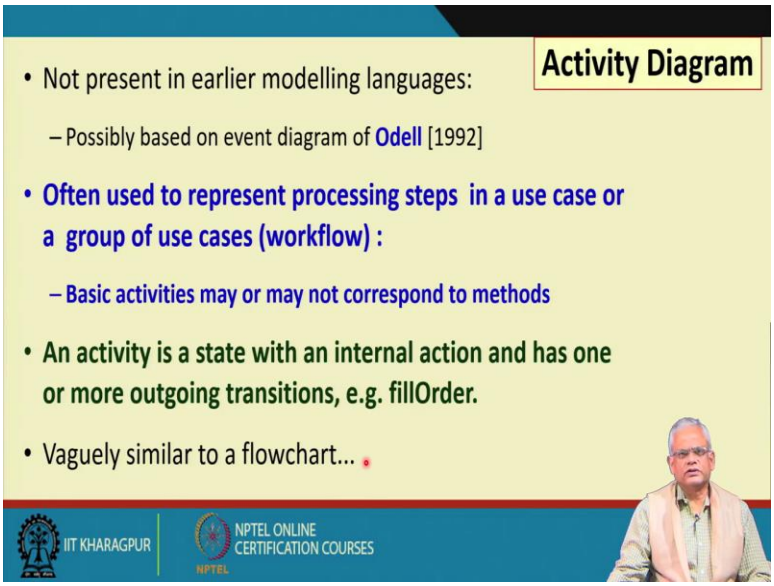

Last session just mentioning that in UML that activity diagrams were introduced and these do not correspond to any diagram in the earlier modelling, languages like OMT, Booch, language, Rumbaugh, OMT and so on. But possibly the activity diagram has been derived from the event diagram of Odell has vague similarity, but not really the same thing. We can say that the activity diagram is a new and powerful modelling technique that has been introduced in UML.

The activity diagram is used to represent the processing steps during a use case execution, especially for complex use cases where many steps occur. We use the activity diagram to represent the steps. It is also used to represent the activities that occur in a group of use cases, which is a workflow. Let say you have been asked to undertake the design of an automation, of the clerical activities that occur in steel plant. The activities are many, for example, input procurement, sells etc. The input procurement is not very simple because there is a tendering process, there is a quality selection process. Then after the quality check, the payment process happened and so on. If you read the document of the input to a steel plant let say, the processes for input procurement in a steel plant it may run into 50 or 100 pages becomes very difficult to understand because there are many terminologies and so on.

But then we can represent it using an activity diagram and will see that it becomes very understandable and helps in the design process also we will see that the activity diagram is used

in the design process to get the final design. We will see that the activity diagrams are a very powerful modelling technique. And if we use it properly, we can contain the complexity in a problem.

The basic elements of an activity diagram are not the methods, this can be of higher coarser granularity than methods. A group of methods may become just one element of an activity diagram. Or maybe the processing that are indicated in the activity may be just part of a method. Typically, the activity diagram is used to contain complexity and therefore it is at the higher level and multiple methods typically represented as a single activity in the activity diagram.

The activity diagram, as the name shows consists of many activities and each activity is represented and an activity typically has a state. And there is some action occurs just to give an example of the fill order, the filling of the order activity takes place and the system is in a fill order state. And as soon as the fill order is completed, it transits to the next activity. If we look at the diagram, you get a very vague sense of similarity with flow chart.

The flow chart is a basic modelling technique if you remember that a flow chart can model execution of a program, where each node of a flowchart is a statement in the program or a group of statements, and then we represent decisions in the flowchart, iteration and so on. Basically, a flow chart shows how the control flows during program execution. But will see that the activity diagram, even though has something similar to the flowchart where the control flow is represented but then it is much more powerful than a flowchart. For example, in activity diagram there are notions of parallel activities swim lens, states of the activities, events and so on. So, even though there is a very small similarity with a flow chart, but then it is much more powerful modelling tool than a flow chart.

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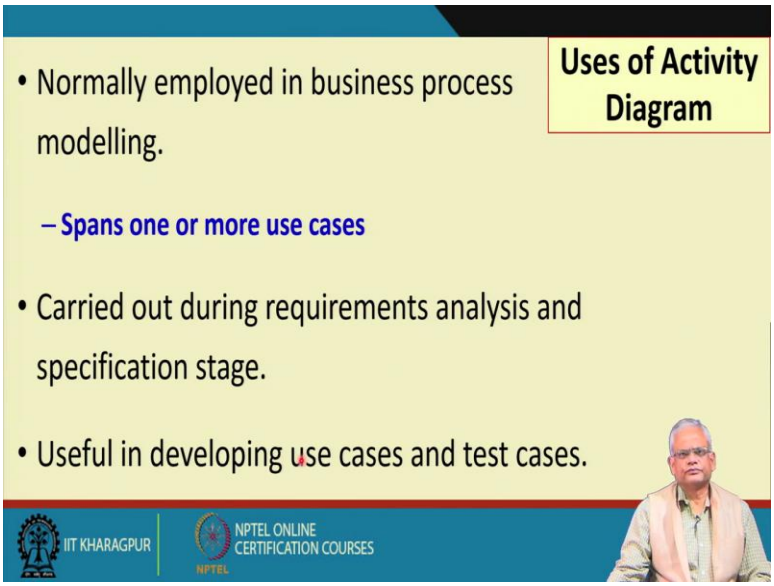

The use of activity diagram starts with the initial development where we understand the problem and we understand the business process that we are modelling. Just like as mentioning about a steel plant where to automate the clerical activities we need to first understand the different clerical activities that take place and two important clerical activities are input procurement and output dispersal.

And of course, there are other activities like employee management and so on. Using an activity diagram, we can represent a business process, such as input procurement is part of the business process, output dispersal, employee management and so on. If we look at the description it appears very complicated, but then if we draw the activity diagram, it becomes easily understandable and usable in the design process.

The initial activity model is developed during the requirements analysis where the developers try to understand the business process that they are going to automate. And not only that, it helps to arrive at a proper design, but then it is also useful to arrive at the test cases. We will see that the activity model can be used in a straight forward manner to develop the test cases and the activity model of course can be used in the use case development.

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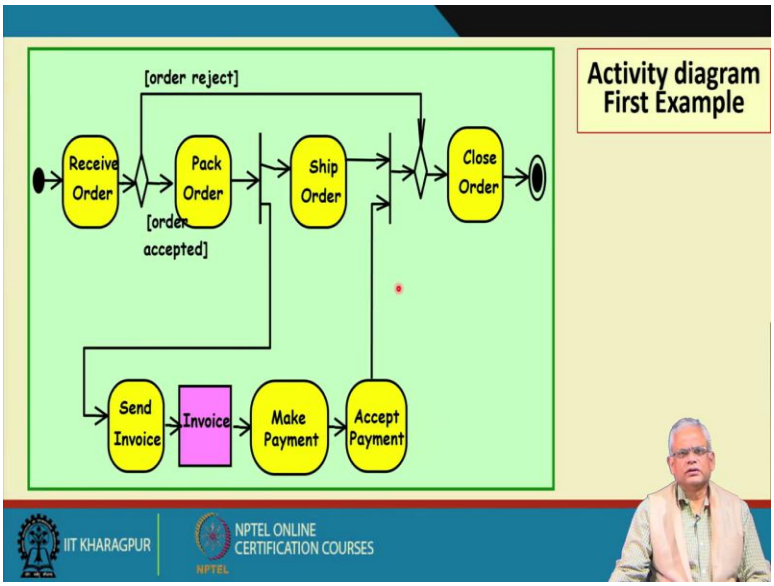

This is our first example of the activity diagram (in the above slide), very simple diagram it does not show many of the features of the activity diagram but then it gives an impression how the activity diagram looks like. If we try to understand this diagram there is an initial state, which is a pseudo state, and then there is a pseudo transition to the first state (Receive Order) and this activity diagram is about a trade house which receives orders from customers and processes the order.

The trade house receives orders and then there is a decision here (shown by diamond symbol). During a receive it also takes the validity of the order that whether the trade house deals with such items that have been ordered and if it does not deal with the item that are requested, then the order is rejected and the order is closed. But if the order is like that the trade house deals with, then it packs the order, this is the activity of packing (Pac Order). And then there are parallel activities here (shown parallelly). This is a synchronization bar (straight bar in the above slide) where these two activities (Ship Order and Send Invoice) start parallelly. One is that after the packing is done, it ships the order because these are known customers who already have placed many orders and therefore, as soon as the order is received, these are shipped and at the same time an invoice is mailed to the customer.

And this is the invoice object (Invoice in the above slide) possibly sent electronically and then the customer receives it and makes payment. But just see here this Make Payment is the activity done by the customer, not by the accounts department or the e-commerce. The trade house itself, this activity belongs to the customer in this primitive form of the diagram, we are not showing who is carrying out this activity.

Later we will see that the activity diagram has features using which we can show that who really carries out each of these activities. After Make Payment they accept payment which done by the accounts department. Once the payment is made by the customer, payment is accepted and then this parallel activity similarly joined through the synchronization bar and then the order is closed. This is a simple diagram, intuitive, we easily understood.

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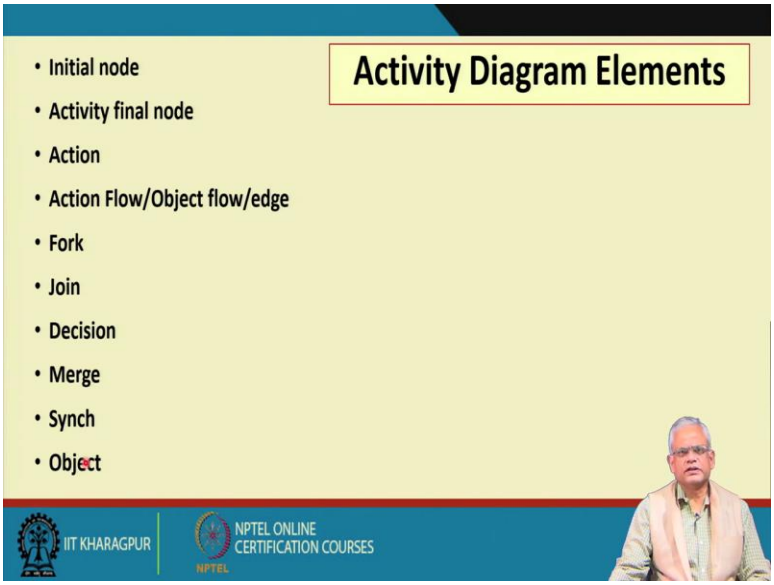

Now, let see the various features of this diagram as I was mentioning, this is a much more powerful modelling tool as compared to a flow chart. It has many features; we just saw few of the features, but appeared very intuitive. We just saw the initial node, final node, actions, the action flow, the object flow, fork, join, decision, merge, synchronization, object representation and so on. We will just see these aspects so that we can develop simple activity models for business processes.

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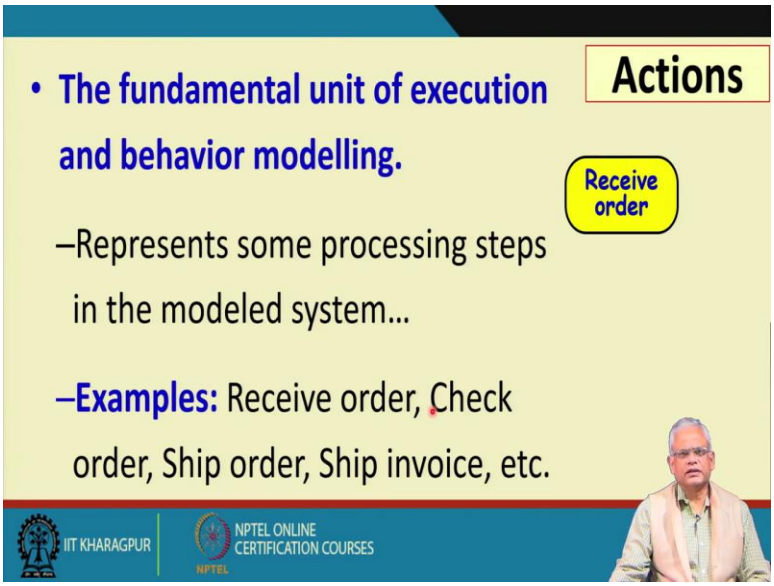

The most fundamental thing is the actions in an activity diagram. This is the fundamental unit of execution and behaviour modelling. Typically, an action is represented using a rounded rectangle.

For example, Receive order it represents some processing steps of the model system. There are many examples of actions like Receive order, Check order, Ship order, Ship invoice etc. Each action takes some time. There is an entity which performs this action and also at the completion of the action some other action gets triggered or it enters the final pseudo state.

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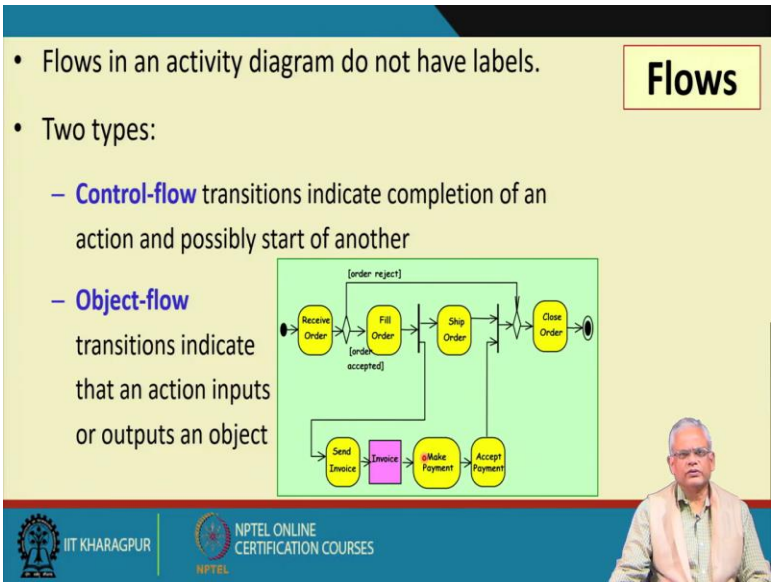

In an activity diagram, there are two types of flows that occur. In a flow chart only we had seen, the control flows in a simple flow chart. We know that in a Flow chart a transition represent that some processing step is complete and some other processing step is going to start and here in activity diagram we have the similar control flows between one activity to other. Of course, we can have decisions and guards during the activity. For example, that this diamond is a decision here. There are guards also present, guards are conditions when it satisfied, the transition take place.

After Accept payment it does not even have a guard, and therefore as soon as the accept payment is complete, it transits to join. The transitions in an activity diagram appear without any labels and the only label that may get associated here is a guard or a conditional. Other than the control flow like this between the activities, there can be an object flow between activities.

The invoice object here represented as a rectangle can flow between two activities and the two activities may be carried out by different entities. For example, the accounting department and the customer. The object may correspond to a physical object because we are modelling a business process where possibly actual invoice is sent through the post or maybe it is an object invoices sent electronically. And the object flow occurs between two activities. Just to summarize the flows, there are two types of flows:

One is control flow between activities and another one is Object flow. An object is modelled as a rectangle, an object may also flow between two activities.

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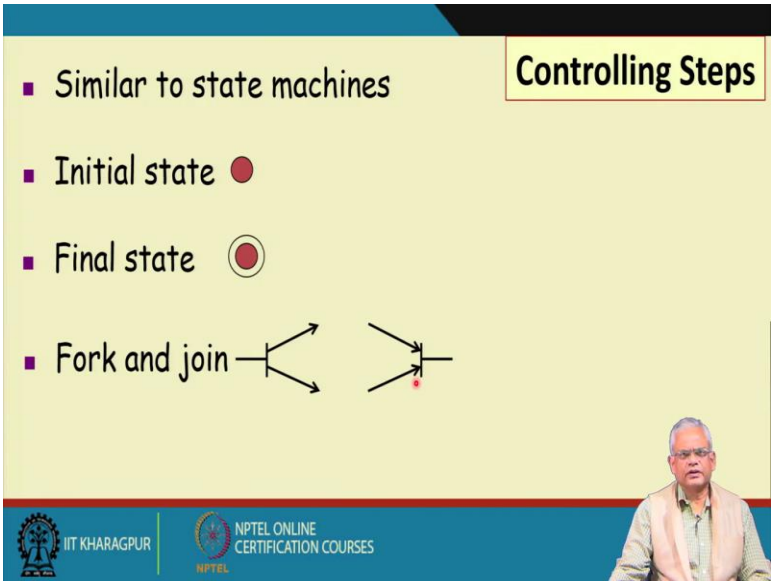

Now, let see the controlling steps here. An activity starts with an initial state activity model the initial state is a represented just like a state diagram by a field circle (as shown in the above slide). The final state also like a state diagram, a field circle with another outer circle (as shown in the above slide). Here we have parallel activities at some point, parallel activities start and this is represented by this symbol in the activity diagram terminology called as a fork (as shown in the above slide), and once the parallel activity is complete, the join (as shown in the above slide) and this is a synchronization bar here where it indicates that all the parallel activities have completed.

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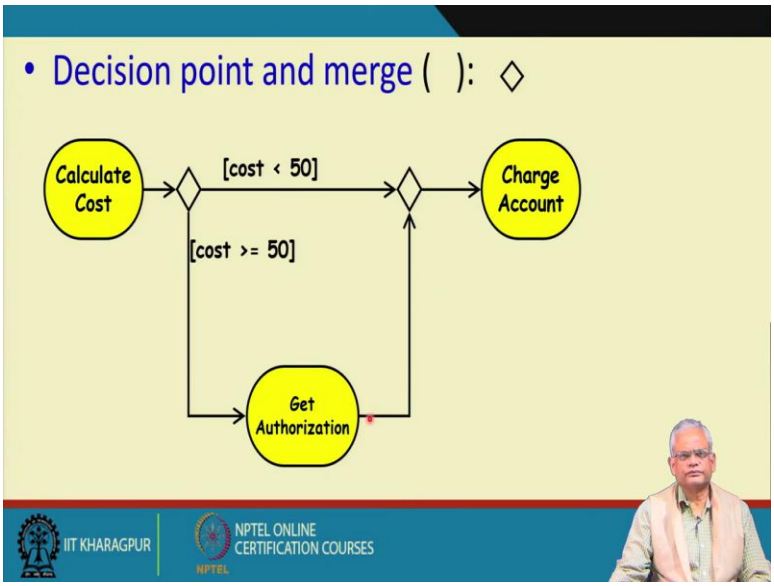

The other control statements are decision points where based on the decision outcome two alternate activities may start and also that is a merge (diamond symbol in the above slide). The diamond symbol that these two different activities merge at some point.

So, first Calculate Cost action calculate the cost and if the cost < 50 (as shown as guard in the above slide), then it is directly charge to the account. But if the cost > 50, then an authorization of the manager is required. And once this process is complete then again, it is charged to the account.

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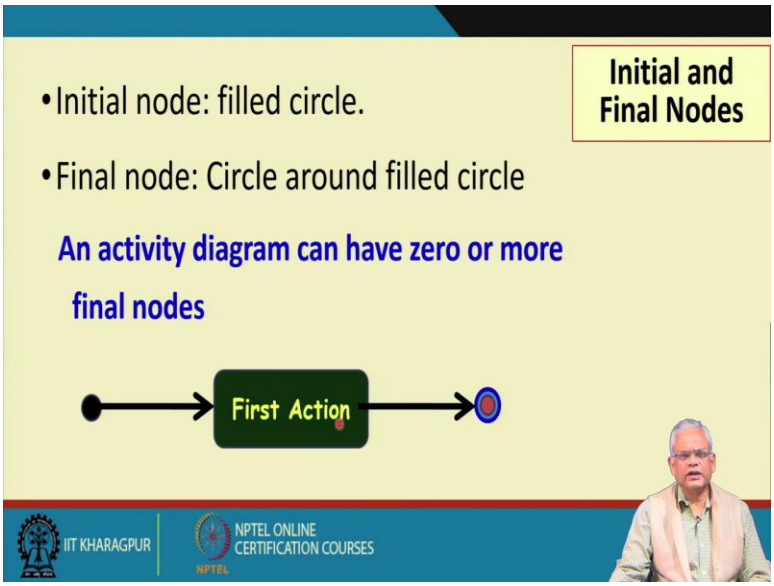

This is an example of the initial and final nodes (as shown in the above slide) by default, starts with initial node. And this is the action (First Action) and then ends in the final state or the final node (similar to a state model, shown as a field circle inside another circle) and an activity diagram can have more than one final node.

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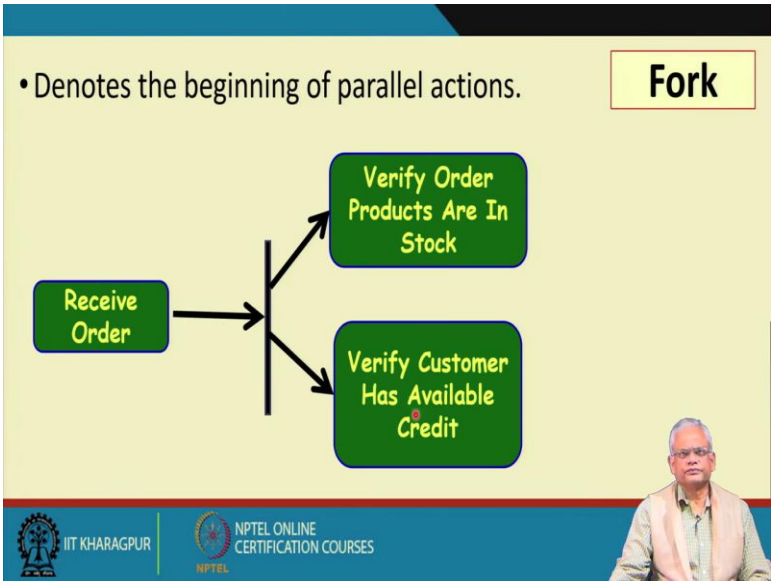

This is a fork (as shown in the above slide) parallel activities start once the order is received, the verify order products are in stock may be done by some person manually or may be automatically and verify the customer has enough credit that is done parallelly. Both these occur parallelly in a manual situation maybe different persons do it, but this can also correspond to processing steps in different threads or maybe in different computers and so on.

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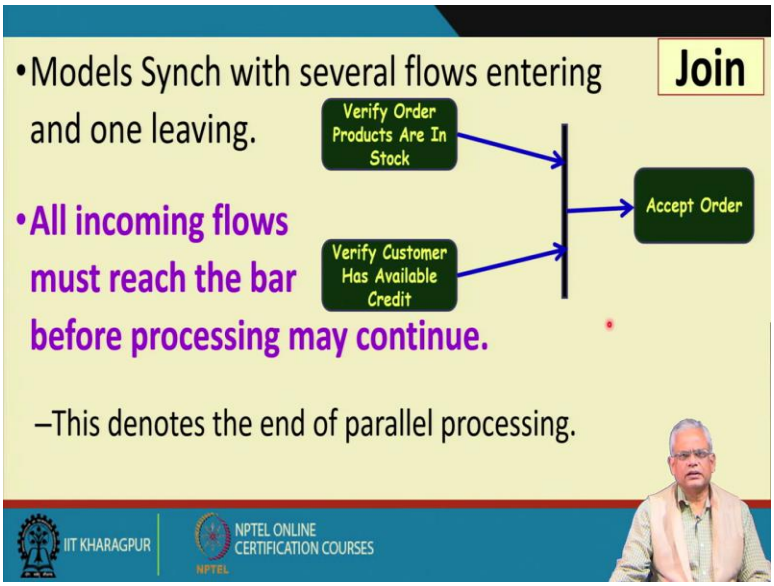

And once all the parallel activities complete, then there is a synchronization, which is called as the join (as shown in the above slide). It even though one completes earlier, waits before the other activity can get started. Only after both the parallel activity complete, then the next activity starts.

So, this is a synchronization point between all the parallel activities that occur. And the terminology used is join and all the incoming flows to a synchronization bar. This is called as a synchronization bar all the incoming activities must complete before the next activity can start.

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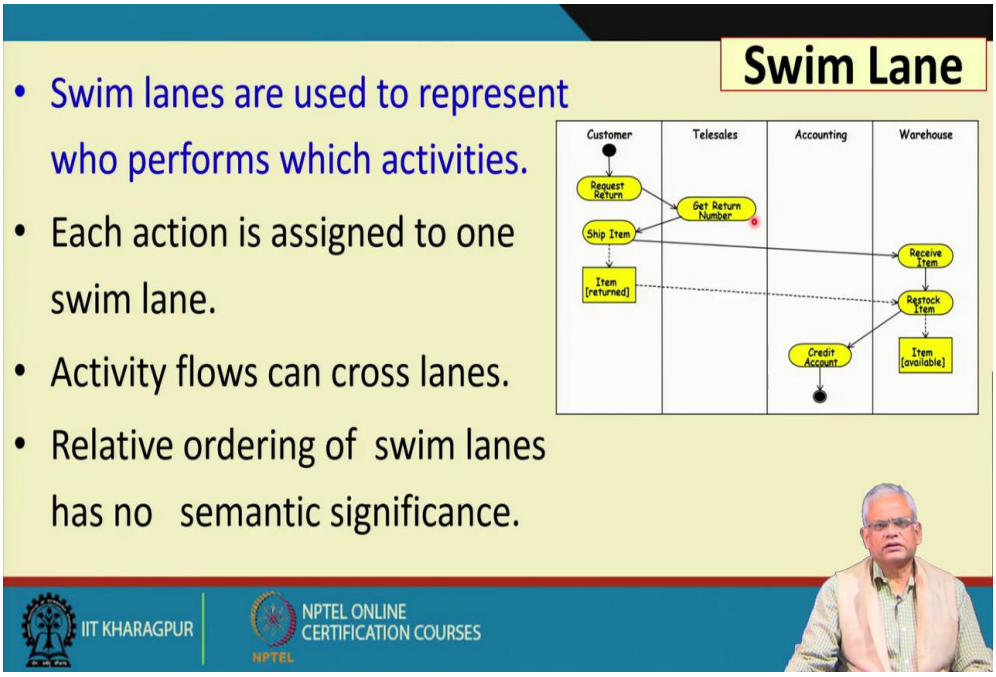

Another important construct in an activity diagram is are the swim lanes. The swim lanes represent who performs which activity. For example, the customer performs Request Return, Skip Item etc. (as shown in the above slide) activities and the accounting department performs Credit account activity and so on. In the first simple example that we had seen, we are wondering that who performs the make payment activity. Is it done by the accounts department or customer? And we said that it is a customer who makes a payment and we could have used a swim lane there and written the make payment to the customer. Here, each activity is assigned to one of these lanes and the entity or the component responsible for these activities are represented in the lane. For example, the customer lane here Request Return, Skip Item etc. are the activities that are the responsibility of the customer.

The telesales lane has Get Return Number activity which is the responsibility of the telesales and so on. And activity obviously is the responsibility of one component, it cannot be written in between swim lane that it is denoting that it is part of two entities. Each activity must be assigned to exactly one swim lane. Of course, the flows here (the direction arrows), they may cross different swim lanes. The flows between activities can occur between different swim lanes but the activities themselves belong to only one swim lane.

But you might be wondering whether it is all right to write the telesales first and then the customer or is there an implicit meaning to the ordering of the different entities? Just see here at the top of the swim lanes were writing, who is performing the activity. And then the activities in the swim lane is performed by this component. But the relative ordering of these components are the swim lanes is immaterial in the activity diagram semantics.

You are free to represent the different swim lanes as you like the only constraint may be to simplify the diagram. For example, if we represent one swim lane, the next swim lane possibly that might have a little bit simplified the diagram and so on, the number of lines crossing swim lane and so on, just to increase the understandability, we might reorder the swim lane.

But then the ordering of the different swim lanes has no semantic significance. We have seen some very important features of the activity modelling, very powerful mechanism. We can use it to accurately represent business processes which are difficult to represent using any flowchart or other formalisms, and that is the reason why the activity model has become very important. Activity model popularly used not only in the design, but you might come across activity models used to explain certain business processes and so on.

We have only been seeing at the control flows and the swim lanes and so on other important features are the object flows, the event and so on. We will discuss those in the next session and look at some simple examples and we will be ready with a design process. We will discuss design process next after completing the activity diagram.

A design process where given a problem, how do you go about the design using all those UML notations that we have learned so far.

We are almost at the end of this session; we will stop here and continue in the next session. Thank you.