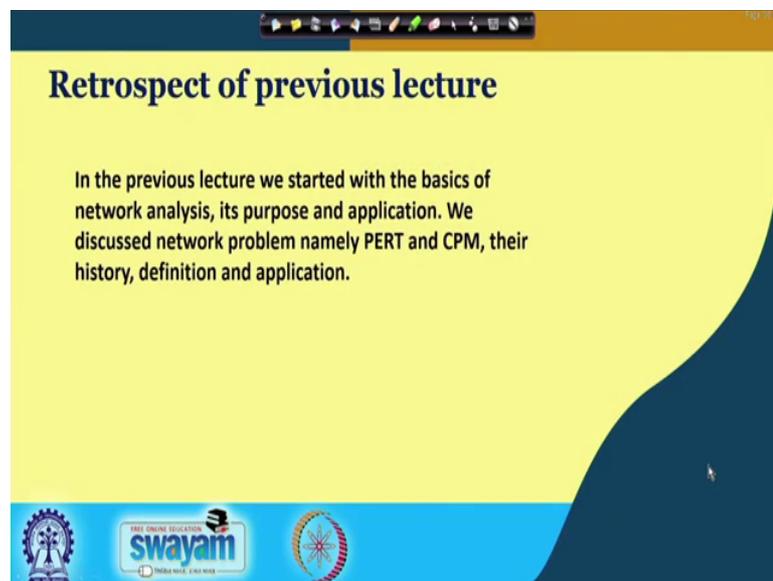**Network Analysis for Mines and Mineral Engineering**
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Lecture – 02
Introduction to network and some terminology

Let me welcome you to the second lecture of NPTEL online certification course Network Analysis for Mines and Mineral Engineering.

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So, in the previous lecture we introduce our subject to you, now you know that basically network analysis is nothing, but analysis of the different unit activities carried out for achieving some manufacturing or for completion of a total process. So there are, there is a total process which comprises in number of unit activities network analysis is nothing, but presenting them in a network form.

And that is required the analysis for its optimization either in terms of time or in terms of cost or in terms of the conservation of the material. You are also known that this approach may be divided in two part, one is the probabilistic approach another is the deterministic approach the probabilistic approach is called PERT P E R T Program Evaluation Review Technique and deterministic approach is called Critical Path Method or CPM. Their history of development definitions and applications are also discussed in the last class.

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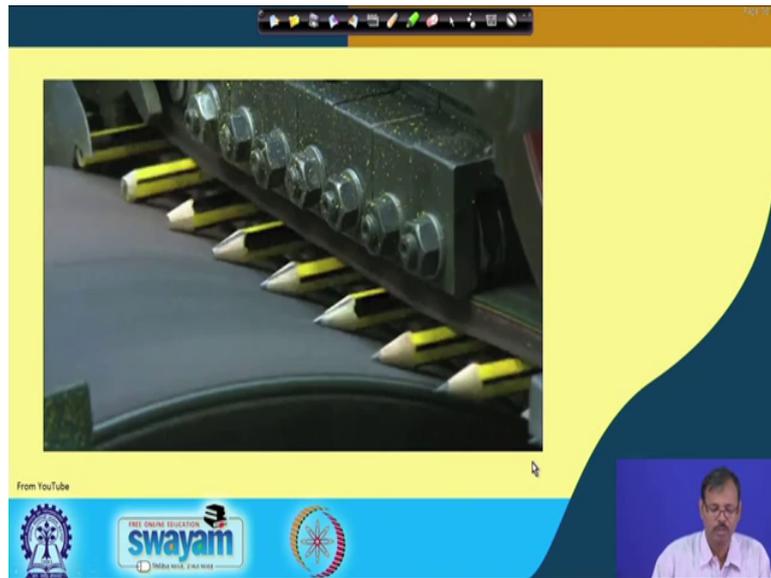
So, as last class also you have absorbed some videos, but I want you must see another video 18 basically gives you some good idea about the different manufacturing process. This is also taken from the YouTube which is nothing, but the pen nothing, but a pencil manufacturing process. So, in this what is happened, first the lead of the pencil is made which is nothing, but the mixture of the graphite of the black soil.
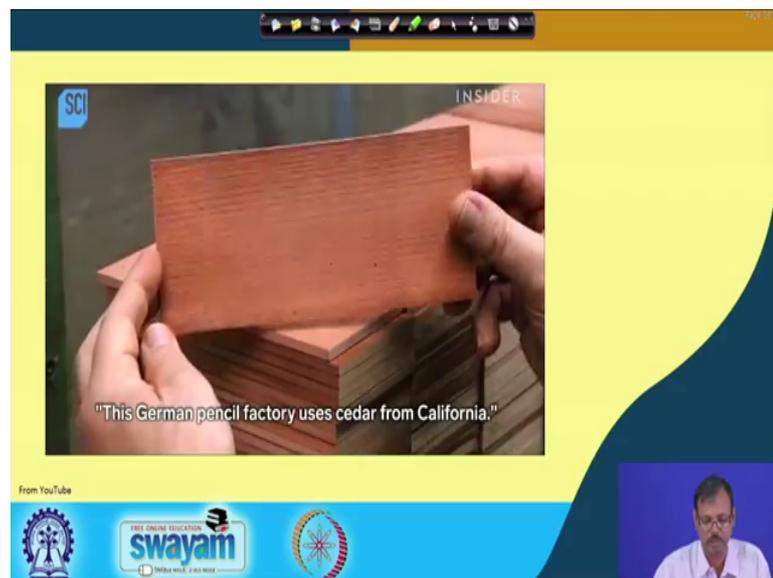
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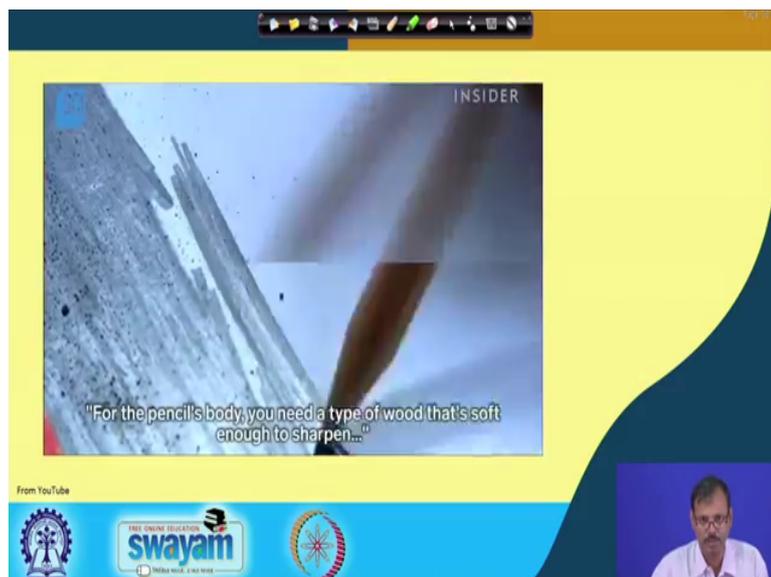
And then that pencil is fixed between two wooden pieces, you can see.
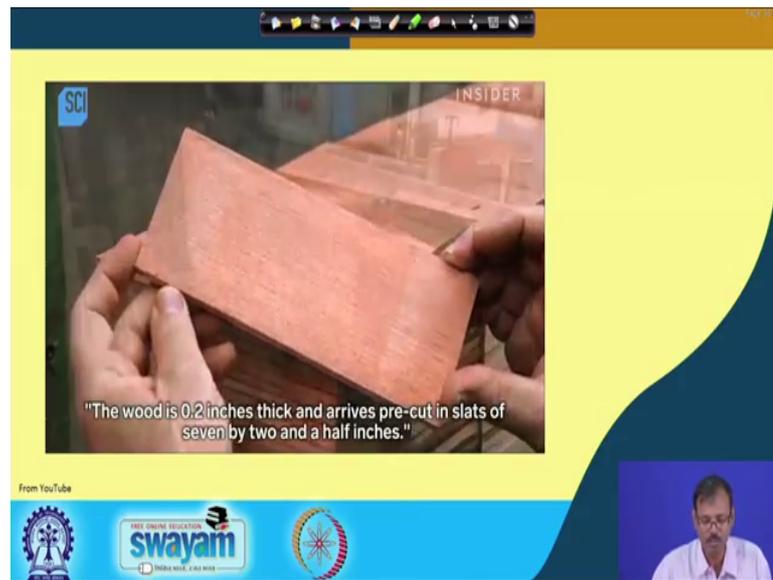
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These are placed in this type of place.

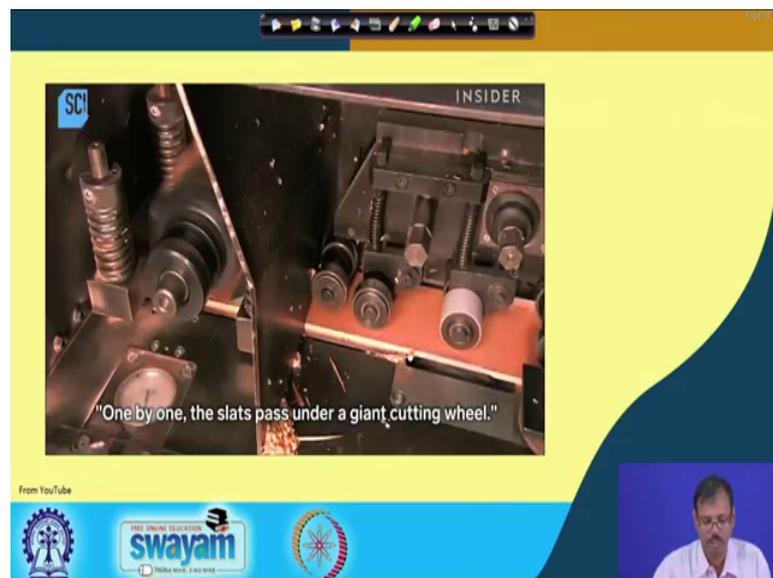(Refer Slide Time: 02:23)

And you can see how these are made.

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You see 0.2 inch thick wood pieces are cut here.

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These are they are polished.

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Then the groups are made into that wood piece.

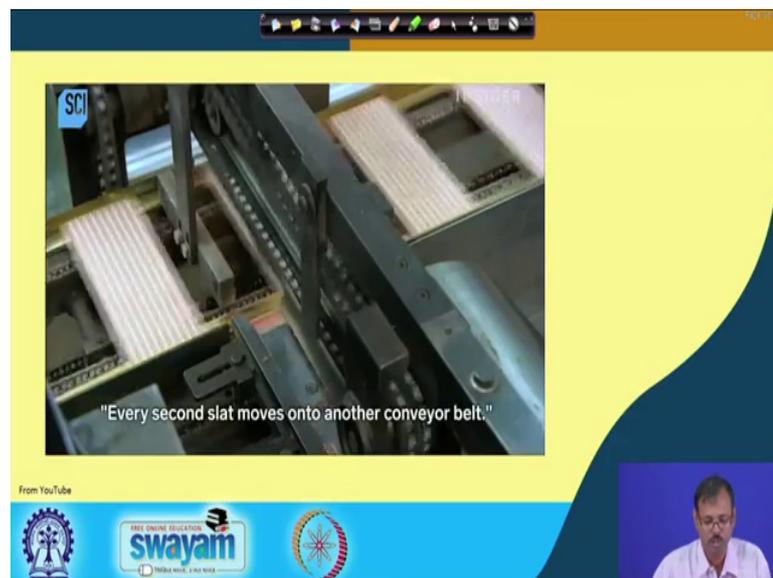(Refer Slide Time: 02:44)
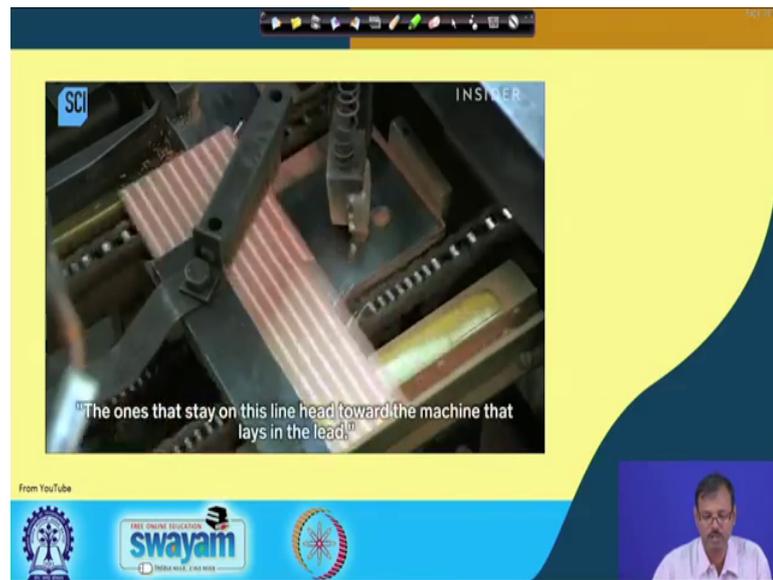
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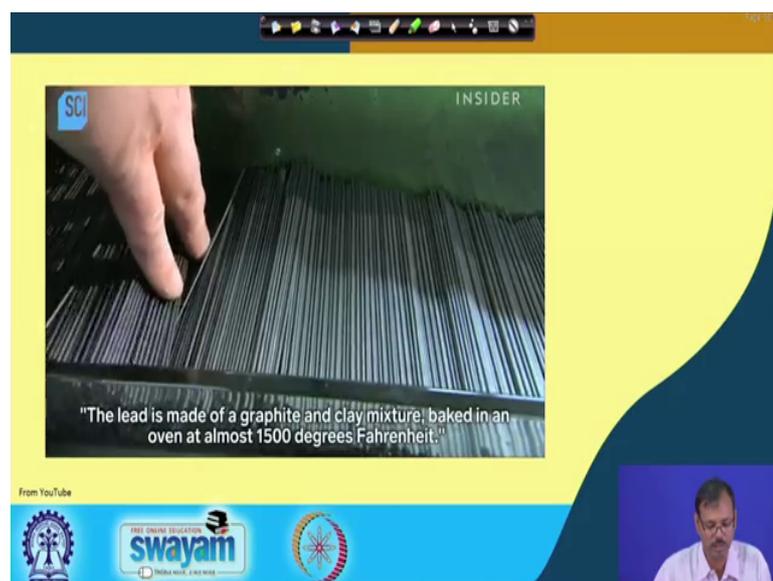Then the glue is filled in those on those groups.

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After pressing the glue, the lead which is already manufactured will be placed on that.

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You see these are already manufactured graphite and clay mixture.

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See these are placed automatically on those glue groups.

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And then there is another a flip of wood will be placed on that.

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That and so these are lead covered with the another wooden piece.

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And finally, these are set like this.

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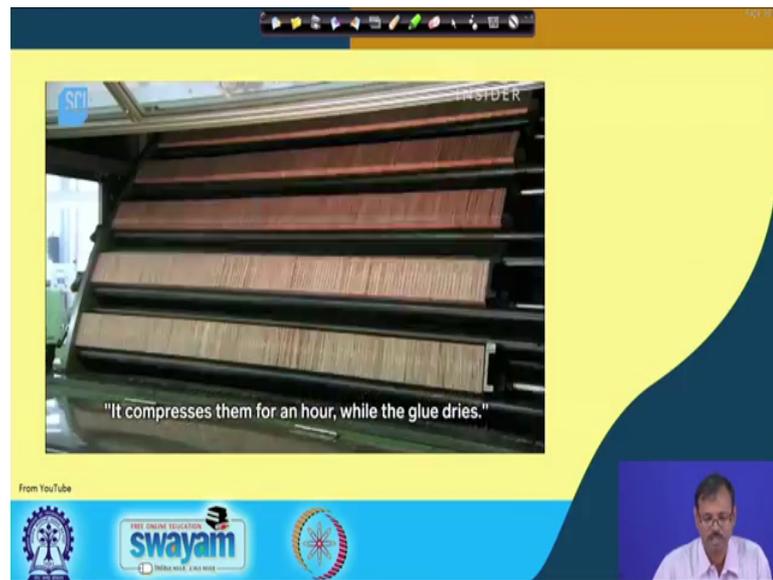
So, that a pencil can be formed.

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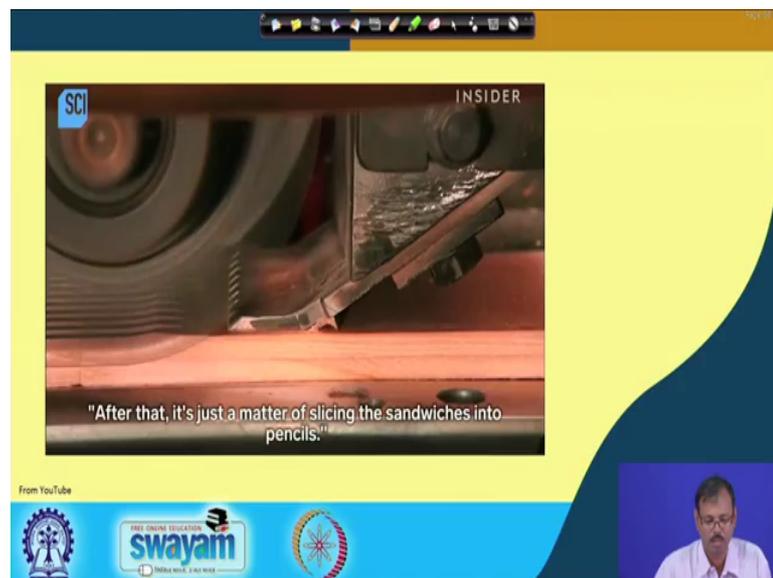
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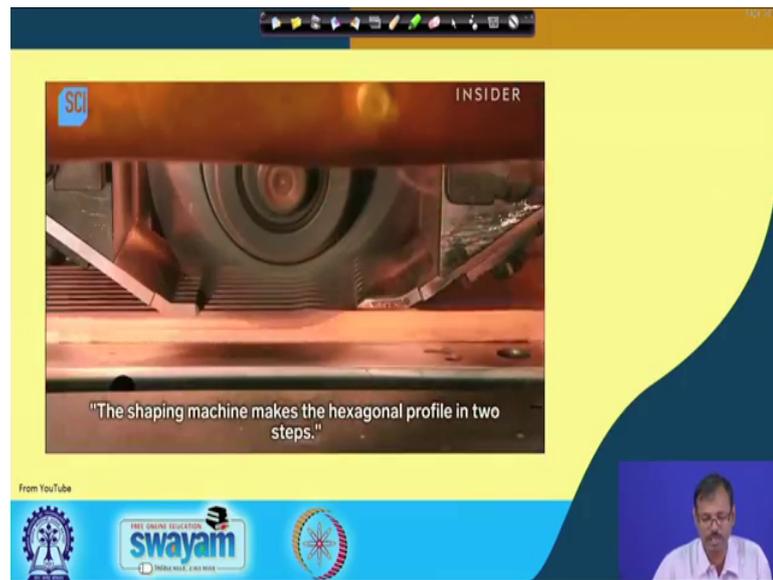
Then they will cut each pencil separately from that.

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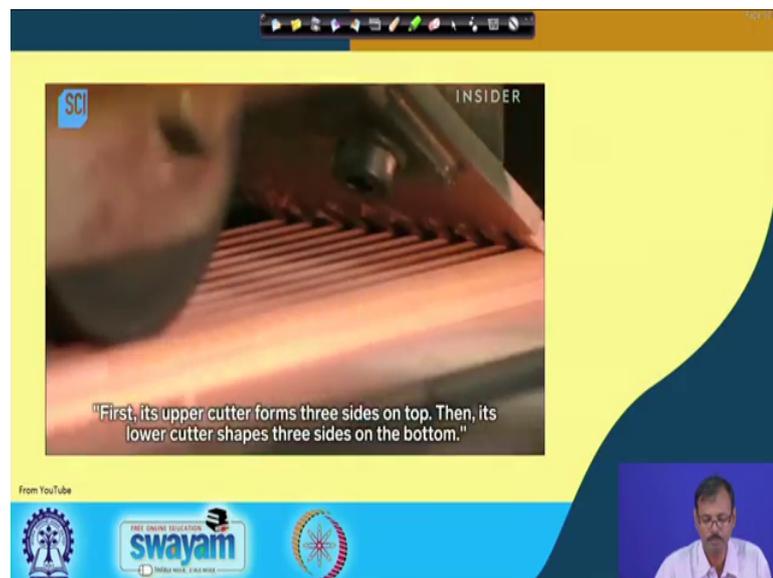
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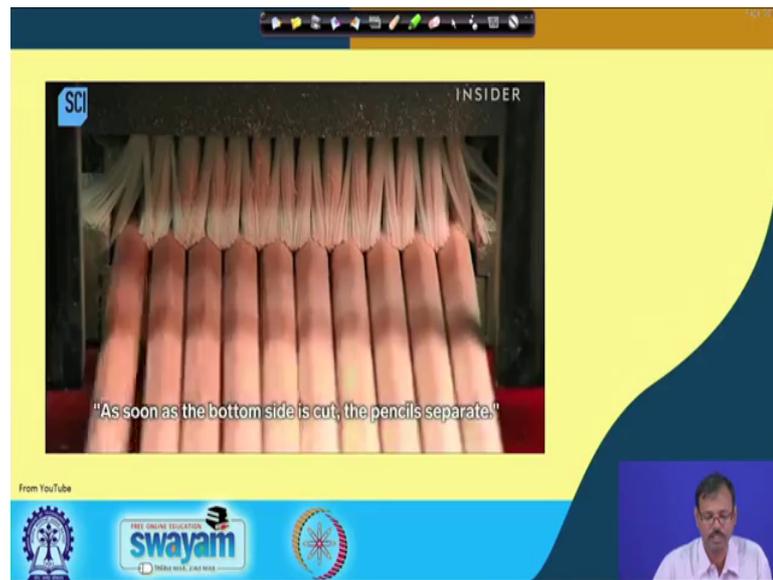
And then sharp it from the different sized sides.

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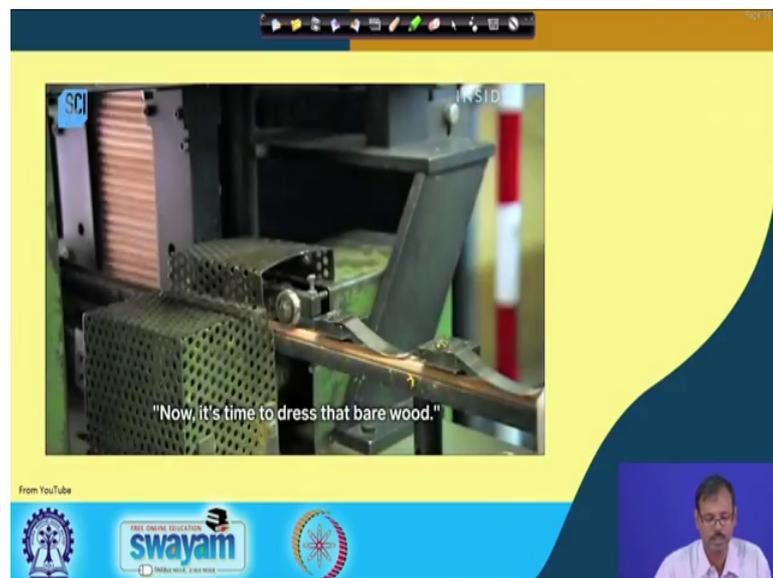
Then the decorations are made on the pencils.

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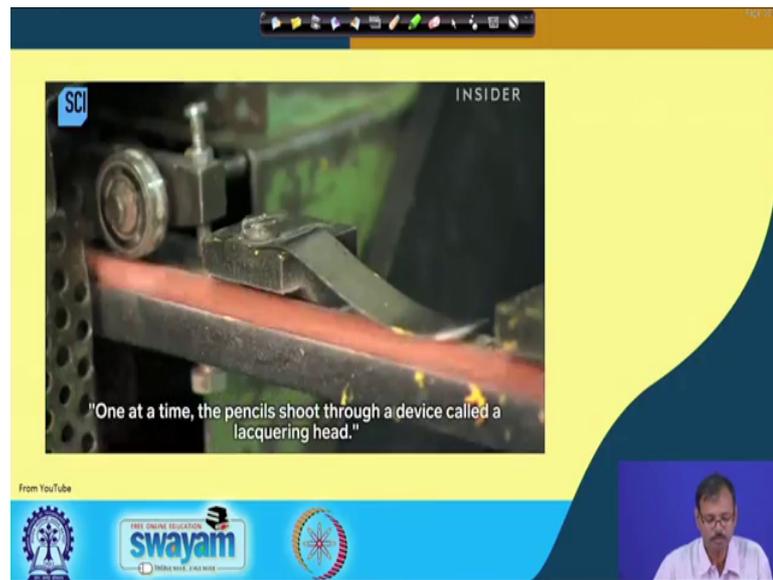
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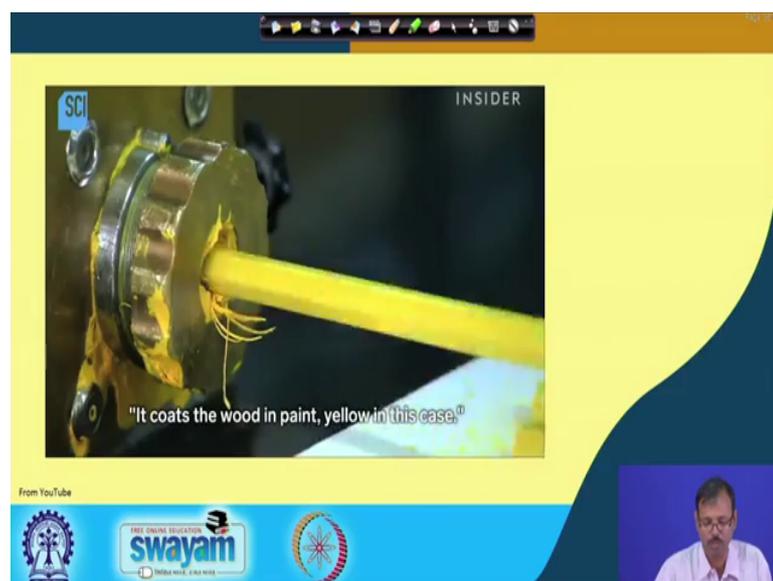
Colouring also made so fine, this is the final finishing colors etcetera are being provided.

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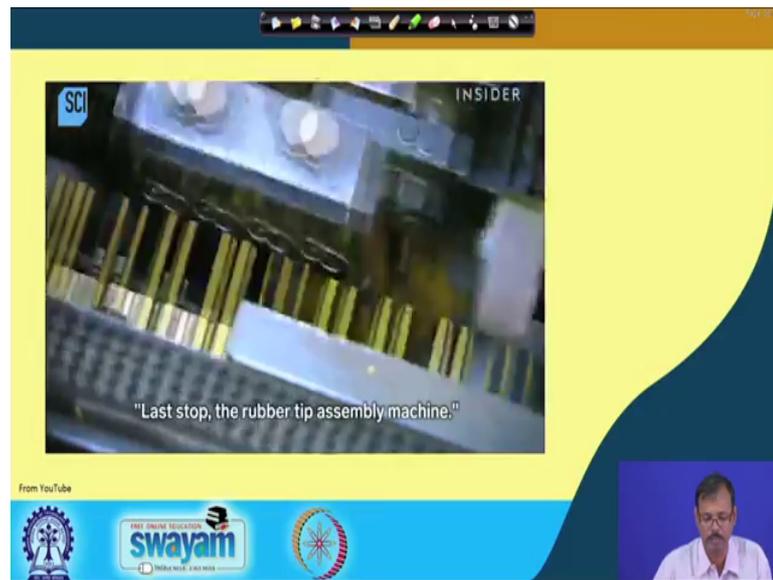
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Then if it is required the eraser will be placed in the back side of the pencil, one side of the pencil.

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And finally, they are placed in a box for the further shipping.

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So, in this lecture we will learn the different terminologies used in the network analysis. So, how this term, terms are little bit different.

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So, that is why we use different terminology. So, basically you know network is nothing, but the comprising n number of activities. So, any unit operation is basically called activity or job. So, say as you are mining people if you are considering that drilling is basically one activity, blasting is another activity. So, the excavation of material from the mine required drilling, blasting, (Refer Time: 05:37) marking, transportation etcetera. So,

all these are unit operations and this each unit operation operations are called activity or jobs. So, basically activity is nothing, but a job or nothing, but an unit operations, a unit operation.

And that operation is expressed with a arrow ok, but there must be some starting point of the arrow and some endpoint of the arrow. So, this starting point of the arrow and endpoint of the arrow if you consider the drilling; that means, the starting point of the arrow is the bench top, and end point of the arrow is the bottom of the hole. So, that is the drilling requirement. So, that is why this is arrow must there must be a starting point and that is must be a ending point.

So, these activities are expressed in those terms that this will be the drilling work carried out here and this is expressing as the drilling which is being started at this point to this point, but not physically this points. You can consider this may be starting time x, this maybe starting time x plus t ok. Suppose if you are considering a person as we have given the example in the last class, a person is moving from Ghaziabad to Delhi.

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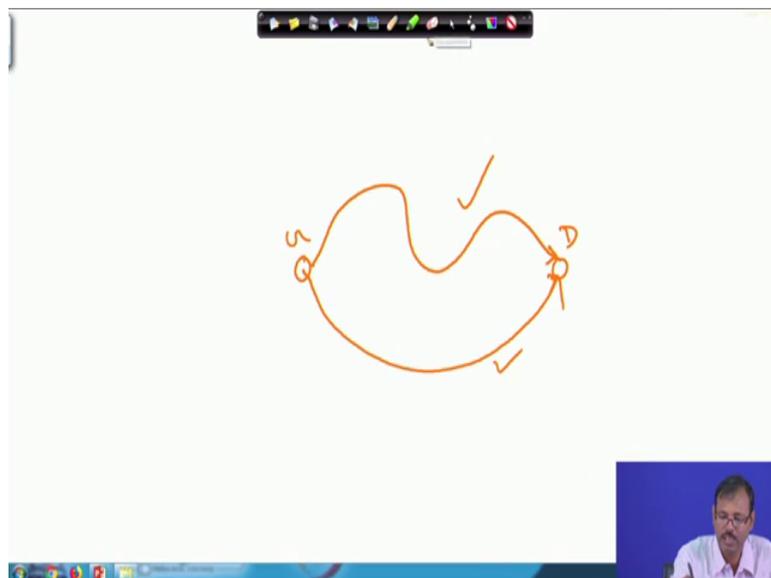
So, this consider this is Ghaziabad, this is Delhi the person has taken a car route and moving Ghaziabad to Delhi like this, the person has taken a rail route and moving from Ghaziabad to Delhi like this.

So, that means, the job is basically from going to Ghaziabad activity is from going to Ghaziabad to Delhi, but paths are different. So, this is one path this is another path and this paths, this activities are also paths which are shown in the arrow.

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So, basically arrow is nothing but an activity; arrow is nothing, but an activity named or job named as A in the bracket the duration of the activities is expressed in the network. The activity has a starting point, activity has an ending point.

That means the Ghaziabad to Delhi journey activity has the starting point at Ghaziabad is 0 starting point at the Delhi is x. So, this Ghaziabad to x this journey is carried out is the journey activity A is carried out in a time T if it is through car. The same activity may be carried out in some different, using some different machineries that is also A activity, but the duration is T 1. So, that means, the activity or job or unit operations are expressed in terms of an arrow which must have a starting point and must have a an ending point and the arrow is showing the activity.

That means activity is represented by an arrow and the name of the activity is placed, whichever it is the symbol you are using and in the bracket you mentioned, in the bracket you mention the important thing which you wish to analysis that is the in this case it is time. If you would like to analyze, analysis it based on the money you may keep the money at this point because that is the variable which you would like to analyze. So, the variable is expressed under the bracket when you are expressing an activity, this starting

point and ending point of the activities must be fixed otherwise open ended activities cannot be there.

So; that means, you cannot start from Ghaziabad and you do not know you have to you may arrive at Delhi you may arrive at Calcutta, you may arrive at Chennai that is not a possible process and that is not allowed in network analysis. That means, activity must have a starting and ending process and that is essential requirement, open activities are not allowed. It may be finished activities; that means, if you see the pencil manufacturing in the previous one the last activity where the pencils are placed in the box which are being sent to the market.

So, that is the last process placing the pencils on the box and that ends in the finish place. So, that is why there may be starting point, there may be ending point, but those are fixed for the individual jobs, this points are also called node. These points are also called node in the network analysis. So, that must be remember that the point starting point ending points are also called node, starting node ending node ok. So, here nodes are given as the number one is the starting node and two is the ending node.

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Activities may have some predecessors activities; that means, this predecessor activities are essentially required for carrying out this activities, say in our last video what you have seen that pencil manufacturing, say for placing the lead inside that wooden pieces the lead manufacturing is previously required.

So; that means, lead is manufactured, lead must this is say lead manufacturing which takes t time and this is gluing lead inside the wooden piece. So, this is lead manufacturing must be complete before the placing the leads into the glue is essential requirement. So, essentially required requirement lead manufacturing must be there otherwise gluing of the same inside the wooden peace is not possible. So, that is why this activity is the essential activity required before this activity or before this unit operation.

That is why it is called predecessor activity, predecessors job. So, in a schedule a predecessor's job must be logically comes immediately before the another activity on which the activity depends. So, without this activity cannot start. So, that is why the completion of this is essentially required that is called the predecessors activity. Similarly if you are considering this is this is the success of activity of this activity because only after the completion of the lead the next activity which will be started. So, this lead will basically go into that unit operation to start that operation so this is the successor activity, it may be possible there are more than one predecessors activity if you are considering the gluing of the pencil.

If you are considering the gluing of the pencil we will find out the lead must be manufactured before hand, second one that the wood piece the glued wood piece must be placed at this position. And then only you can glue the lead into the wood piece so; that means, there may be more than one predecessors are possible, similarly there may be more than 1 successors are also possible ok. So, but the nodes are; that means, you can use this for some other thing also that is also possible. So, that is why these are essentially required there may be more than one predecessors, there may be more than one successors and finally, analyze we will understood this you will understand this much much in a better way.

So, this number of predecessors, number of successors may be more than one and that makes the more complex more the complex situation for this network analysis.

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So, an event is a point in time or a milestone in the total work to be accomplished and it marks the beginning and end of an activity, event do not conserve resources or type so; that means, this events basically nodes are not basically consuming anytime or material. So, the condition is not in network analysis is that the different activities are unit operations are combined with the nodes and it is assumed that the nodes are not consuming any cost, nodes are not consuming any time.

So, whatever is the time requirement those are basically the activities is laid in the activities those are the cost requirements those are also laid in the activities, there is no cost no time requirement for the nodes. So, this is the essential assumption made in the arrow diagram of the activity on the network analysis.

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So, network diagram which are made basically classified into 2 types, one is the activity on arrow are called arrow diagram or activity on node diagram or AON diagram basically the presentation is different in the arrow diagram and AON diagram. Let us look into a deeper way into this.

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Say in activity on arrow diagram we are having activities combining together, say suppose we are having drilling then blasting then excavation then transportation ok. So, this is the starting point, this is the ending point.

And these are the nodes of 1, 2, 3. So, starting points 0 to 1 this starting point is basically describing us drilling activity and this drilling activity may have the characteristics it takes x hours and it may take y cost or say x 1 hour x 1 hour y 1 cost 1 to two is the blasting activity that takes x 2 and time and y 2 hour. 2 to 3 replace represents excavation activities, x 3 y 3 and 3 to 4; 4 is the end point which is basically gives us transportation of the same that takes x 4 y 4 time expect 4 time y 4 cost.

So, these are the representation of each activities on the network form so; that means, here arrow, this arrow point is basically showing the activity cost time that expenses in the node is basically 0. So, these activities are called activity on arrow or arrow diagram is the way where we are presenting this activities. Activity on node is a different types of activities where the arrows are basically connect the different activity.

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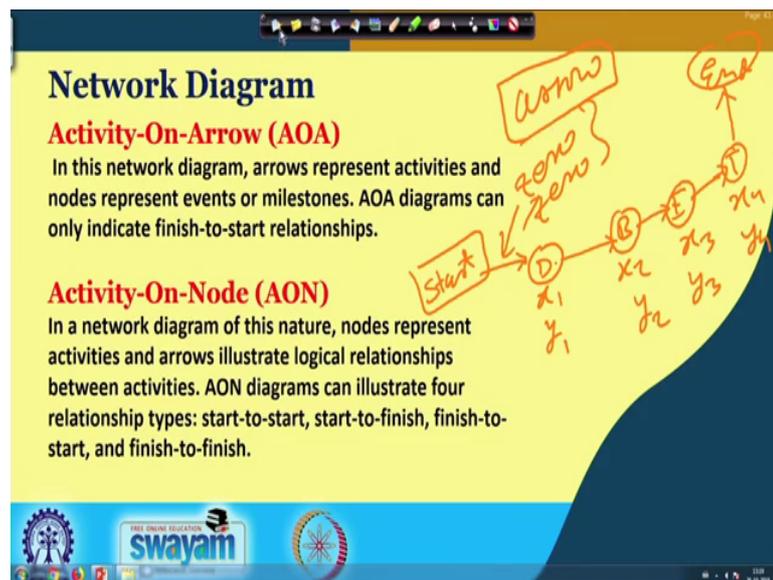
Say first activity is the drilling which are expressed in on the node and before that there must be a starting point; that means, we start our analysis process. Then the first activity which is expressed in the node is drilling, next activity expressed in the node is blasting, next activity expressed in the excavation is in the node, next activity expressed in the node is transportation and finally, it ends. So, here we represent the drilling time requirement is x 1, cost requirement is y 1 x 2, y 3 time and cost requirement, x 3 y 3 time and cost requirement, x 4 y 4 time and cost requirement for transportation and the essential assumption is that there is 0 cost is 0 time is 0 on the arrow.

So, arrow are basically connecting the activities, but the time and cost expenses on that is 0. So, basically it is the reverse way of presenting the different unit of operations in the different type of network formalism.

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So, let us now see the and a network diagram represents a network of any process that uses arrows to represent activities and nodes to represent the events or milestones. That means, if you are considering in this activity 2 by 2 the activity c is complete, but here that facility is not available in activity on node diagram.

An arrow represent the starts and end of a job or activity where initial point was the start and terminating point so that is the end activity that is A 1, A 1 activity and an arrow can represent an activity or a path to connect two activities depending on the network diagram is either AOA or AON types of presenting of the network. So, this is the two basic types, arrow diagram activity on node diagram are commonly used for presenting a network and their analysis are also similar type. Both are having some positive and negative features, we will discuss those things when we will discuss in detail how the networks are being analyze analyzed in the arrow diagram and activity on node diagram.

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So, these are the nodes, already described to you at the point where the arrows are meeting and in AON diagram the jobs are assigned on the nodes not on the arrow.

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Alternative is basically some people they used to represent the activities in a different form, in this form say they represent activity A where first one is representing the starting node number, and second one is representing the ending node number. So, basically this gives the benefit, this gives the benefit to analyze the network in a computerized form. So, basically it is an array in the computer programming in that array it is showing the

starting node and ending node so that either graphically or in during the analysis this can be easily represented and is easily analyzed.

So, basically alternative is the type of representing different activities by giving its starting node number and ending node number under the bracket ok. So, this is another type of representation of the activities in a different form.

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So, this precedence relationship establishment, successor relationship establishment is the essential requirement of the construction of the network. So, this is very very important and the user must be very very careful about this assigning; say suppose as we are observing into the drilling, blasting, this predecessor drilling is always the predecessors of the blasting. You cannot carry out blasting without drilling and drilling is not the predecessors the successors of the blasting because we do not go for drilling after blasting. So, that is why drilling is essential predecessors of the blasting and blasting must be carried out before the excavation, these are the predecessors. So, the establishment of the relationship is very very important in these cases.

As in the first last class we have seen the example of construction of road. In the road there are layers, say first layer is the embankment second layer is the sub base, third layer is the base fourth layer is the wearing surface ok. So, the embankment which is the soil one or sub grade one has to be placed first and that must be rolled properly, then only the sub base which is basically granular sub base those aggregates must be placed on this

where it is the soil layer. So, the layering that is the precedence of the construction of the embankment is the essential for the construction of the sub base layer.

So, this precedence must be followed properly and that is why they must be identified, they must be identified. So, precedence activities are essential unless and until the completion of the precedence activity is there successors activity cannot be started. So, that is why these are the essential requirement and that must be properly followed while the network analysis is being carried out.

So, what I would like to emphasize there this terminology; this terminology you must adopt in you so that in next class onward when we will discuss and that time we will only discuss this terminology. Say we will not tell it a unit operations any more we will tell it activity or job, we will tell from node 1 to node 2 we will not tell that node is the basically connector of the arrows and that.

So, these terminologies you must in still you knew. So, that next class onwards when we will discuss about the arrow diagram we are we will discuss about the activity on node diagram that time it is easier for you to understand.

Thank you.