Risk and Reliability of Offshore Structures
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Module – 3
Risk assessment and Reliability applications
Lecture – 13
Event Tree analysis

Friends, welcome to the 13th lecture in Module-3.

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In this lecture we are going to talk about Event Tree Analysis. This is 13th lecture in module-3, where we are focusing on Risk assessment and Reliability applications.

In the last lecture we discussed about the fault tree analysis, the advantages methodology, and how one can easily find out the fault tree algorithm or logical tree algorithm by dividing the system into system and series in parallel and one can find basically the failure probability of the whole system provided. You known the complete details of occurrence of failure, rate of occurrence of failure, consequences and effects of each event like basic event, triggering event, initiating event etcetera, in a given logical tree algorithm and try find out the whole analysis using this.

In the current lecture we will talk about another method of risk analysis using this event tree. We already compared if you remember both the analysis and said one is reducive and one is on the forward direction.

So, event tree analysis is inducive algorithm goes on the forward direction. So, event tree is actually representation of logical order of events, leading to some condition of interest for a considered system, generally looking forward for failure conditions. There are different states of the considered system because the state can have a multiple failure. So, a system can have a multiple failure we should say multiple modes of failure and hence there can be many conditions which we will be interested in. So, one can easily see that for different states considered of the in the system one should associate consequence of each state.

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So, it is important that each failure condition or let us say adverse condition should be also associated with its relative consequence that is very important. Now event tree analysis slightly deviates from the fault tree in the following manner. Let us say event tree actually starts, event tree starts from a basic initiating event and then develops from that point onwards until all possible states with the adverse consequences are reached; develops until all possible states of adverse condition provoking adverse consequences

are reached.

The initiating event which actually is the starting point of event tree may typically arise as top event from fault tree analysis; the initiating event can start from the top events from the fault tree analysis. Before constructing an event tree, event definitions and logical value should be known.

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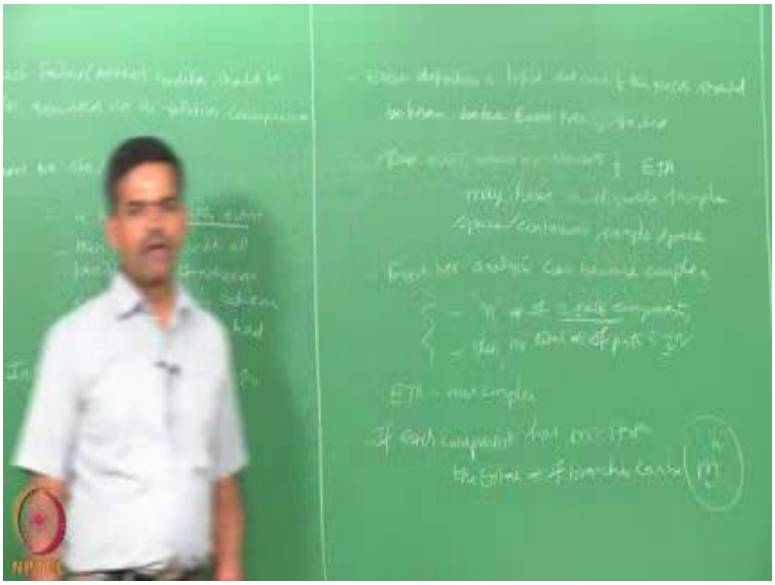

Even definitions and logical outcomes of the event should be known. Before event tree is started which are elements of event tree analysis, which are event elements of event tree analysis may have a discrete samples space or the continuous sample space.

Therefore, it is very interesting that event tree analysis can become complex which can be easily realized that for a given system if there are n number of let us say 2 states components then, the total number of path is 2 power n which makes the event tree analysis more complex. Let us say each component have m states now we are talking about only 2 states; if each component has m states then total number of branches can be m power n because if there are 2 states is 2 power n, because n is the number of components each component has 2 state therefore, 2 power n is the number of paths. If there m states it can be m power n, which will make the analysis further more

complicated. Please pay attention to the figure shown on the screen now.

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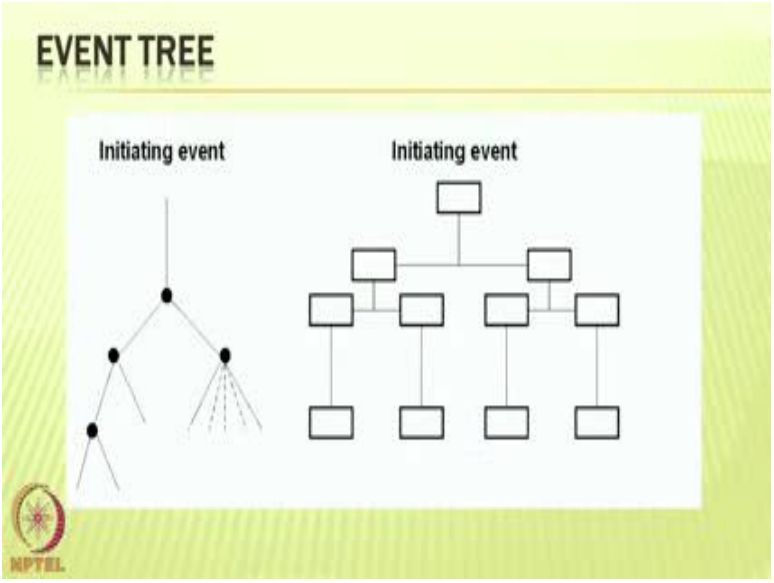

Let us say the initiating event can be represented in two forms, either the one set of event shown in the left hand side or the one shown right hand side. From the initiating even one can keep on branching out and every information of all elements participating in the event tree or what we call components of event tree. The total information should be available to us it can be derived from a discrete sample space or from a continuous sample space. To understand the consequences or effects of every event on the overall failure of the system which could be certainly a font of logical tree may be FT or ET analysis let us talk more information on cause and consequence analysis.

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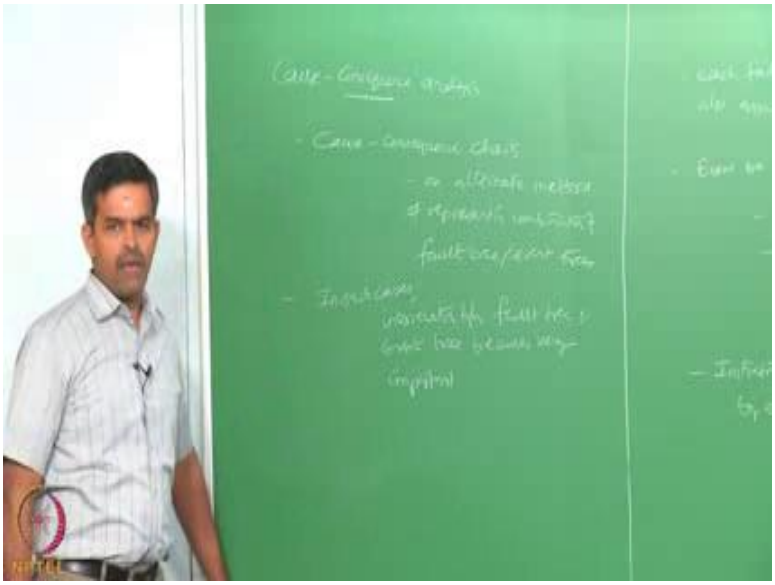

Cause consequence charts or another method of representing a combination of fault tree event trees. So, cause consequence chart is an alternate method of representing the combination of fault tree and event trees. The inter relation between the fault tree and event tree become very important in such cases, the inter relation between fault tree and event tree becomes very important.

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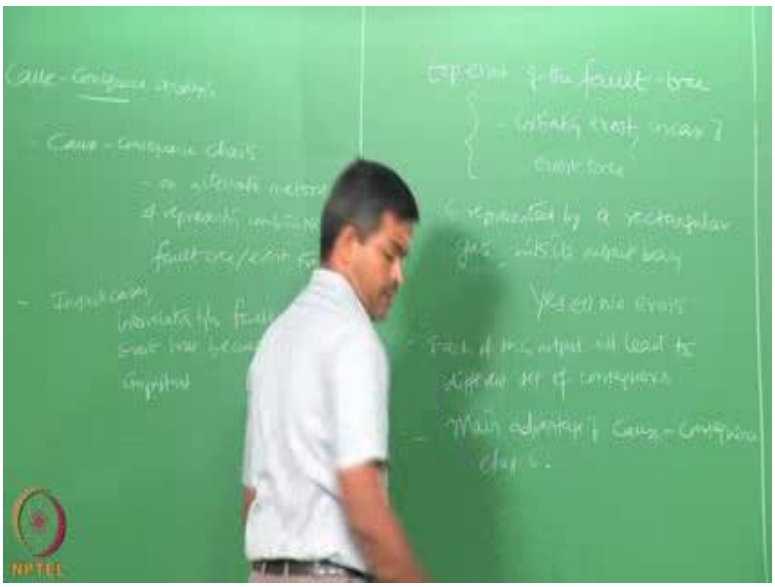

Namely, the top event of the fault tree which is called initiating event in case of event tree is represented by a rectangular gate with output being event of yes or no values. Each of these output will lead different set of consequences therefore, benefits of cause consequence chart is the main advantage, of a cause consequence chart is fault tree need not be expanded in the representation.

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Therefore the overview of risk analysis is improved great. So, that is the advantage what you have in case of a cause consequence chart. A typical cause consequence chart is now shown on the screen now, one can see here the consequences which has the series and parallel events that is p i and 1 minus p i depending upon what kind of element you are looking at.

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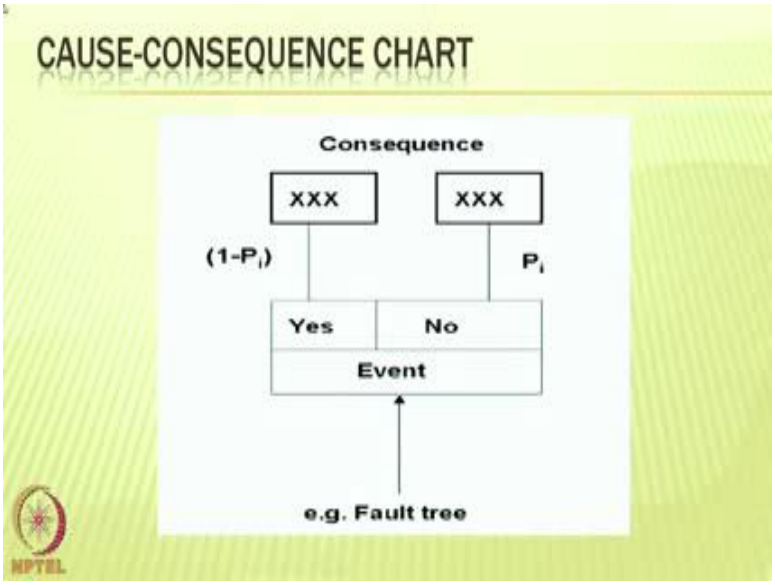

The output will lead to yes or no variables ultimately it will come to an event which can be now an example event of a fault tree.

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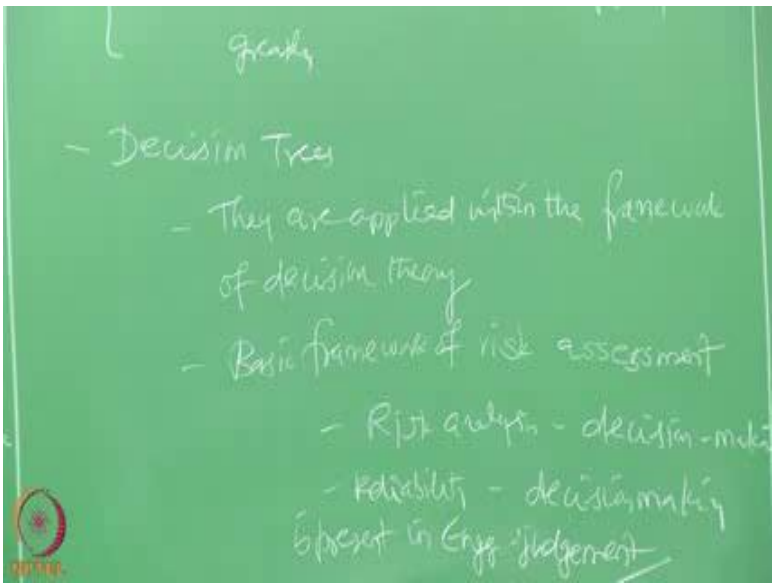

Alternatively, people also look for decision trees. They are applied within a framework of decision theory is one of the basic framework of risk assessment. Because risk

analysis serves the purpose of decision making we all known that, as a risk analysis is actually originates from a decision making theory and in fact, we look at the reliability question making is inherently present towards engineering judgment. Therefore, interestingly friends it is important to know that risk level not for industry should be predefined as per international practice.

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Why we say should be predefined because we estimate the risk present in the system, it is compared with what we call acceptable risk and then you decide what action to be taken. So, the decision theory is applied when the risk present is compared with acceptable level. So, one need to actually define or predefine the acceptable level of risk in the offshore industry of course, this is truly acceptable and truly standardized as per international practice. We already said that people defined risk in offshore industry using a concept called ALARP, which is risk is as low as reasonably practical.

So, offshore industry can be identified as one of the industries were zero risk is not possible, but of course, you can always predefine the acceptable level of risk and then estimate the presence of risk in the given system compare that with a acceptable level what you are predefined. Please understand you cannot define a risk subsequently later after you do the risk analysis. We got a predefined their acceptable level of risk then do a

risk analysis compare that and think about either improvement or action taken recommendations etcetera either to bring down this level or bring down the consequences or both.

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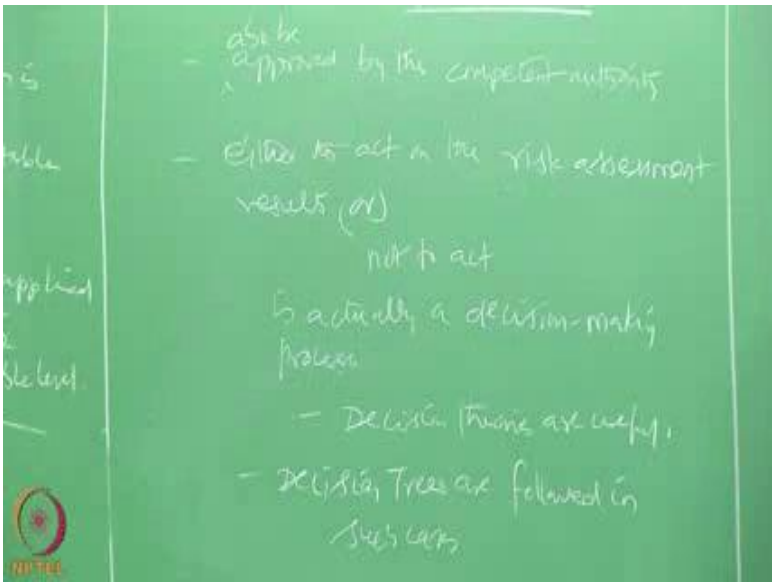

More interestingly the predefined risk level should be also declared in the public domain. It should also be approved by the competent authority. So, the predefined risk level is not a proprietary item or a royalty or the liberty of the offshore industry, it has to follow certain guidelines implemented by various international regulatory agencies. The company or the owner or the group of company should declare the pre-acceptable of risk in advance, in the public domain which should also seek an approval from the local government or local agency that the declared predefined risk level is acceptable as per the local government standards. Therefore, it is important to either to act on the risk assessment results or not to act is actually a decision making process where decision theories are useful. So, one has got really do decision trees in such cases.

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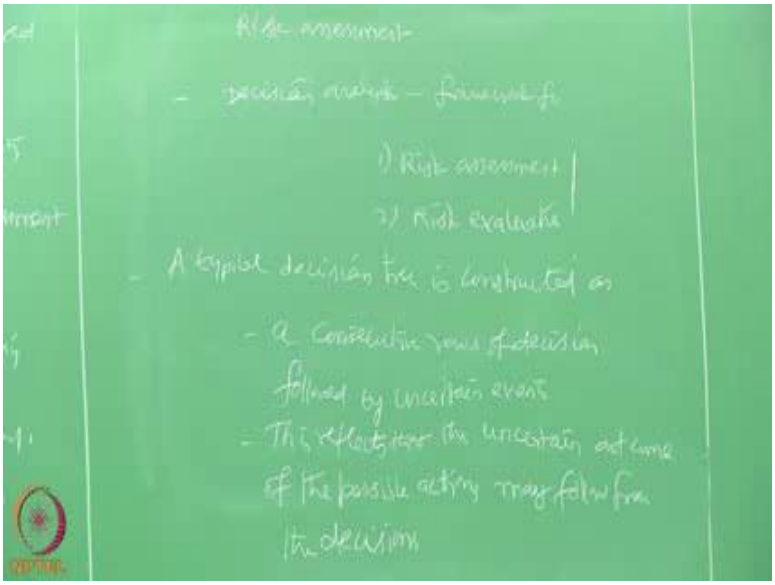

Therefore you can say that decision trees are important part of risk assessment. Decision analysis of framework for risk assessment and risk evaluation as well both, so decision analysis is a framework for risk assessment and risk evaluation. So, please pay attention to a typical decision tree which is used in this assessment.

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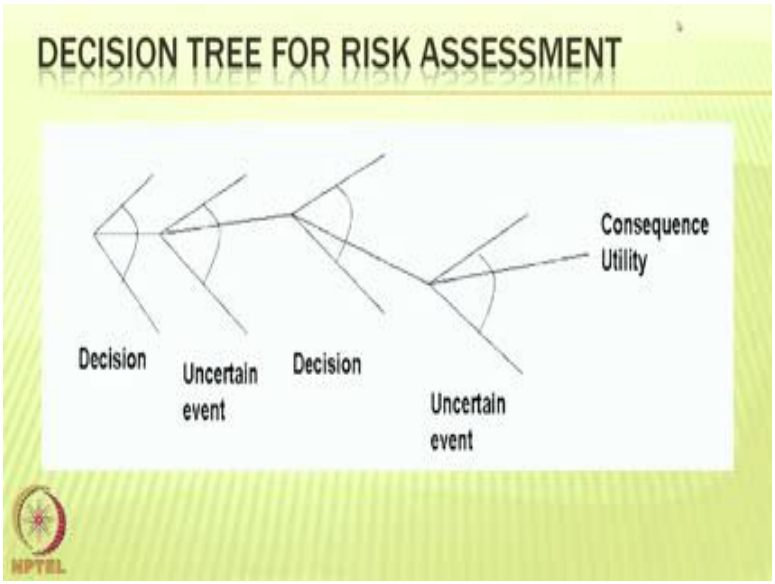

For example, we have a decision tree where want to really say about uncertainty of an specific event then take a decision. Then you also decide about for example, what is a uncertainly in the specific given further coming forward and depending upon the uncertainty in the event what would be the consequence in the utility or be happened because of uncertainty present in the specific event. So, one has to keep on taking decisions at different levels.

Once the output from a decision tree may be yes or no, true or false whatever maybe the output coming out from the decision tree, one need to actually follow up in such a manner that what would the consequence of those uncertainties involved in the event should be clearly marked and logically analyzed what we call as a decision tree for risk assessment.

Therefore, a typical decision tree is constructed as consecutive rows of decision followed by uncertain events as we just now saw in the figure this reflects that, the uncertain events have an outcome possible action which may follow from the decision. Reflects the fact that, the uncertain outcome of the possible actions may follow from the decision. At the end of the decision tree consequences are assigned.

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In accordance with the decisions made, also depends on the outcomes of the uncertain events depending on the number of decisions and the action involved in the decision analysis, decision trees are classified. Their specification represents various types of decision analysis that are required for the classifications of the decision tree represent, also the type of analysis required.

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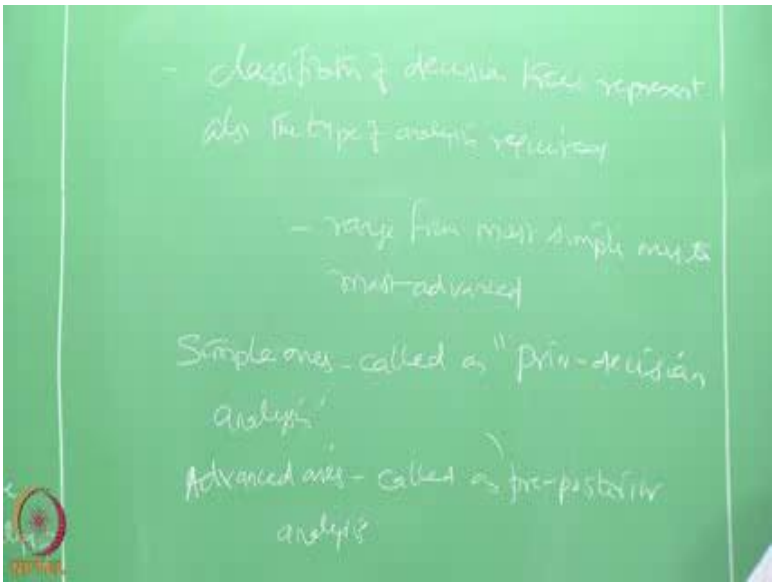

It can range from the most simple ones to the most advanced one, simple ones are called as prior decision analysis, advanced are called as pre-posterior analysis.

Resulting from the decision tree which results in the outcome from the uncertain events, or the decision depending upon the regulatory issues which are predefined in the beginning of the analysis probability of different events that are represent in decision tree may be assessed.

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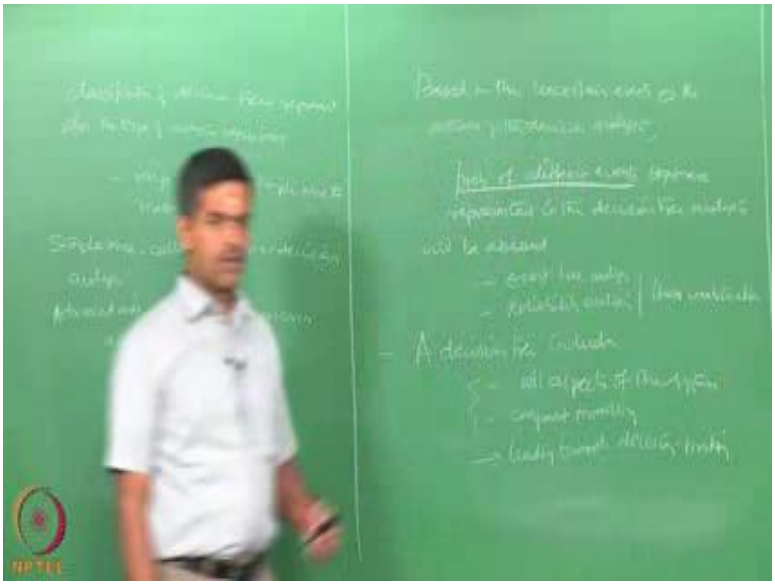

So, based on the uncertain events or the outcome of the decision analysis probabilities of different events that are represented in the decision tree analysis or we will be assessed. They can also be a part of event tree analysis or they can be even a part of reliability analysis because we are talking about probability of different events which lead to uncertainties which can amount to the failure therefore, it can a part of reliability analysis as well or their combination. Therefore, a decision tree includes all aspects of the system that is very important; therefore, a decision tree includes all aspects of the system, component modeling, in addition to leading towards decision making.

Interestingly, in this lecture, friends we discussed about event tree analysis we only compared event tree with fault tree in terms its possible outcome. We also discussed about the importance of cause consequence charts in a logical tree analysis. Then we extended our discussion for interesting the decision trees which follows under the framework of decision making. So, we all know that in offshore structure systems risks are predefined and should be declared in public domain and they should be audited and acceptable by the competent authority. So, all the time we always estimate the risk in a given system and try to compare that risk with that of the predefined acceptable level and state whether it is risk mitigated or risk control or risk is really going to cause concerned for the society and for the plant.

So, risk assessment is going to be a comparative tool in terms of decision making were decision theories are employed which is the most common practice in offshore structures, because any risk assessed in a working plant in offshore industry need to be always compared with a threshold value or acceptable value of that risk which is predefined by various international regulatory agencies. We have got always assess and evaluate risk in that manner and then recommend actions as a third party auditor to improve on the situation or let us say to control the adverse effects of risk produced in a given system.

Thank you very much.