Industrial Safety Engineering
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Lecture – 42
Human Error, Classification and Causes (Contd.)

Hello everybody, very good day today, we will continue previous lecture Human Error Classification and Causes.

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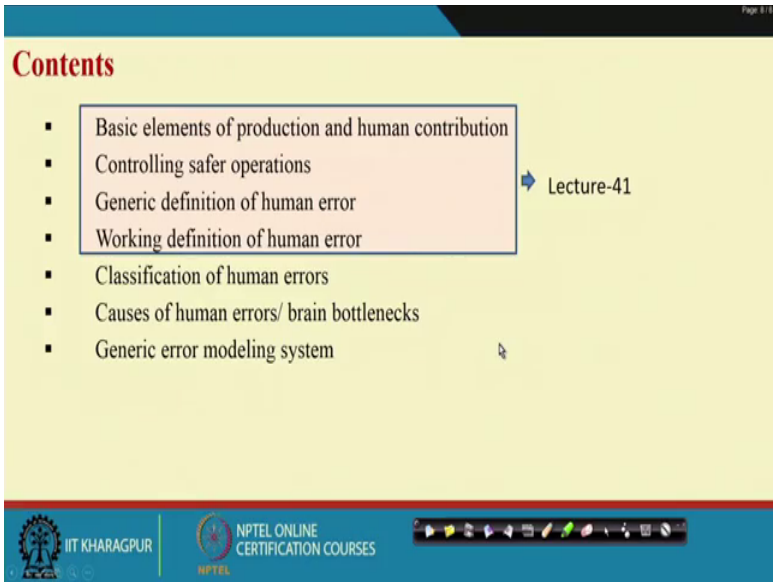

So, you have seen in my last lecture which is lecture 41, I explained these four points that related to production system. And, then how the deficiencies are different across different level is basically from human contribution point of few lead to accident. Then definition of human error was given to you from generic definition to working definition. In this lecture, we will discuss the classification of human error, causes of human errors and bottlenecks and generic error modelling system. May be 25 to 30 minutes of time we will finish this lecture.

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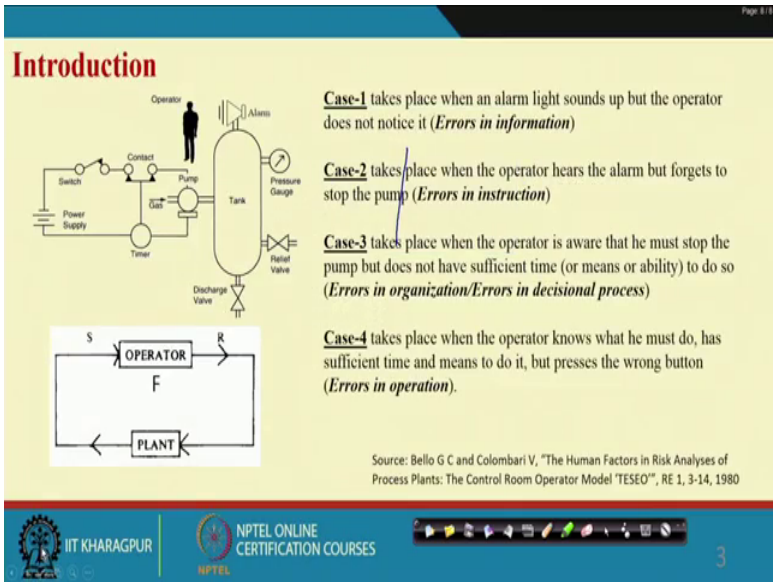

So, if you recall that in the last class I stopped by giving this example; I said that, that there is there is stimulus and then the operator function is there. And finally, accordingly based on stimulators operator function argumentally decide the actions which is basically responses. And, accordingly we have discussed error in information, error in instruction, error in organization or decisional process and error in operation and with reference to this example we have seen.

Now, I will carry forward this example further and we will see some of some more issues particularly from classification point of view. Then, if I recall my previous lecture; that is lecture 41 we have said to you also that, that whenever any work is carried out the there is n state which is basically the objective to be achieved. If an in order to achieve the objectives or the objective or the goal so, a set of series of planned physical or and or mental activities to be carried out; there can be problem or error in planning or there can be error or problem in execution.

So, if everything planned correctly and executed correctly, you will achieve the desired goal that is successful work. If you planned correctly, but not execute correctly, then what will happen it is basically execution error; primarily comes under slip and laps based on the region classification what we have seen in last lecture. Suppose your planning is wrong, but executed correctly then it will be lead to mistakes. And another one is what I have said based on this example; based on this concept that other suppose

planning is correct execution can be done correctly, but intentionally done wrongly that mean not followed the procedure intentionally, that is known to the person who is doing it that will go to the violation. So, in between successful action and violation there are human error in terms of slips and lapses and mistakes. So, with this basic frame work we will further process or progress.

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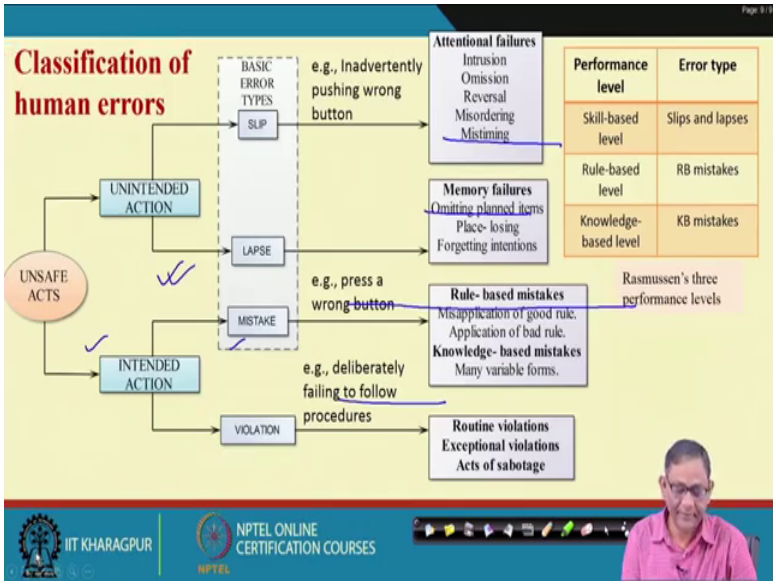

So, here let me repeat this case again. So, you have seen in the accident precursor in the last class, I said that based on this in this is also we have taken from Reason 1990 book. So, based on Reason that, unsafe acts when accident takes place immediately relate to unsafe acts there are precursors to unsafe acts; then these precursors are again a result of line management deficiencies. And line management deficiencies also influenced by the decision makers deficiencies or fallible decisions ok.

Now, if you investigate any accident and if you found or you when you inspect the work place, you may find out that there are some unsafe acts; which are basically the active cause of accident. So, the unsafe act can be unintended actions can be intended actions; as I told you the intended one comes under violation. So, SOP is created, so that they people know that what to be done, when to be done, how to be done all those things are there. Suppose you are not following those then, there will be violations, SOP is violated it may be routine violation, exceptional violations act or of sabotage etcetera.

So, so the I mean one end violations. So, when it is unintended unsafe act is unintended; if unsafe act is intended it is violation, if unsafe act is unintended then usually slip lapse and mistake. So, here basic error type that is why slip lapse and mistake. And, I have given you that when slip, when lapse and when mistake; inadvertently pushing wrong button is slip, deliberately falling to follow procedures is intention and press a wrong button is mistake. Because in the planning itself you have said press the button which was wrong so, that is mistake. But, suppose the suppose wrongly when it was not as planned; so, the during execution time suddenly inadvertently if you push wrong button that will lead to slip.

So, now slip takes place, because of attention problem; last class I should slip and lapse, but we have not differentiated the two in that manner. So, attention problem leads to slip, memory failures leads to lapse. So, intrusion, omission, reversal, misordering, mismatching these are all coming under attention problem. Omitting planned items, place, losing, forgetting all those things are coming under laps ok. And then, when you are talking about mistakes, the assumption has given three performance levels: one is skill based another one is rule based and knowledge based. So, there can be rule based mistakes, there can be knowledge based mistakes. But and if we talk about the slip and lapse these basically primarily at the skill level. So, we see assumption classification what happen again. So, there will be some routine jobs which may be you are doing regularly. And, other way I can say it is be almost habitual that you have to do these things and accordingly you develop skill and whenever giving that work you are doing it.

So, in that skill level work, slip and lapses can takes place. But, when it is rule or knowledge based, rule means there are some kind of if then rules. Do this, if a condition this do this, condition did do this, some if then rules are set. Then what happened the rule may be incorrect, not planned properly; so, rule based mistakes will be there. Knowledge based mistakes mean it is not rule; because there is no set rules that by which you will do. It is basically your total knowledge will decide giving the situation you process based on your experience and knowledge and take decision and do the and take actions.

So, then that will be knowledge based mistakes. So, if I said decision make a line management, they are primarily will be the knowledge based mistakes ok. So, may be the supervisor or at the line management means line management level there can be rule based mistake also. But a worker level there can be rule still what they are may be

primarily skilled, skill based work. Now, a rule based work if you do, suppose a particular work with the same set of rules you are doing several years; so, then finally it will be it will be converted to skill ok. So, that is why not only this slip laps and mistake you also required to know whether the activity is a skill based activity or rule based activity or knowledge based activity.

And then, that means, first level tasks classifies skill based task, rule based task, knowledge based task. And then, see that what kind of error that occurs; if it is skill based usually slip and lapse will be occurring; if it is rule based or knowledge based there will be mistakes and by the sense you know.

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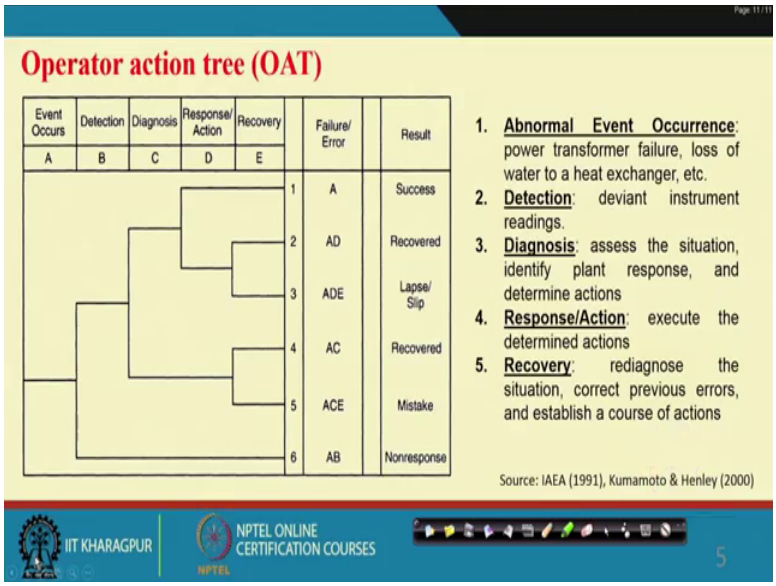

Now, to in order to understand little better manner, because how when human is involved. So, there is another concept called operator action tree it is some something like even tree diagram is developed. To further stress on the classification; so, that you will you will not fall you will you will be able to do it under identify the errors what kind of errors. What is this classification? This is some event occurs; then the what human will your you have to detect that event occurs, after detection you diagnosis that what it is and based on diagnosis you take risk action or response.

Then, what will happen depending on action there will be recovery or no recovery situation and finally, that failure will take place. So, abnormal event occurs; this is the first way. For example, power transmission failure, loss of water to heat exchanger. In

our case, over pressure condition in the pressure tank example so, how do you know abnormal mean event occurs suppose alarm sounds alarm sounds.

Because this is a indication of abnormal event that over pressure condition; then, what is the this is then you have to detect each operator see the pressure gage. So, detection deviant instrument readings; pressure gage says yes over pressure condition has taken, means pressure gage there is deviation from the normal. Now, diagnosis the operator will after seeing the reading is to (Refer Time: 14:16) what should be what should be the response to be taken.

So, there can be diagnosis problem by the operator and then or it diagnose it fully that yes it is over pressure situation; then he ultimately close the or the open sorry close the pump means open the contact. So, this is my giving the abnormal situation; this is the successful one, this is success. Now, what happen alarm sounds and ultimately detection is not done, this situation this is non response. Why detection is not done, that that depend whether it is non response; it is because of violation or because of any mistake, but ultimately these are the things to be done.

So, in between you find out there is, there is mistake there is slip and lapse ok. And another term will be using here which is recover. So, what is diagnosis? Diagnosis is assess the situation, identify plant response and determine actions. So, what diagnosis; it will a pressure gage shows that it is basically beyond the limit ok. So, what diagnosis that mean that mean diagnosis means you have to open the contact. Suppose operator fail to open the contact, because he thought that the operator will be timed out soon and whatever excess pressure is there that will be that will be released by relief valve ok; that situation may happen.

So, what happen when the diagnosis is successful, but the action was not taken; means contact was not made open. So, in that case if relief valve occur the relief valve sorry if relief valve works, pressure will be released and suppose timer at that time also get disconnected then recover. But if that will not happen ultimately lead to over pressure situation and which ultimately may be after some time; it will lead to tank rapture, but this is that mean the actions was this action actually recovery has taken place even though wrong action is taken place. Another one wrong action no recovery that is slip and lapse. So, let me repeat again; if first is alarm sounds, pressure gage, alarm, pressure

gage successful, diagnosis successful; then response is contact open success. So, here response; so, diagnosis successful contact is not open that mean action is not taken correctly.

So, in that case what happened, if relief valve works timer timed out also what will be up may be within that minutes; then, recovery another one action not taken, no recovery no recovery it lead to it is basically slips and falls laps and slip. Now, diagnosis is not taken failure diagnosis failed. So, even in that case what happened; the relief valve and timer may relief valve release the pressure and timer may get disconnected. In that case, again another recovery will take place, suppose that recovery will not take place then it is the mistake.

So, diagnosis is failed; that means, these are steps to be carried out, but during diagnosis failure is taken place that mean diagnosis the procedure the plant the steps was not correct step was not there. So, it is a mistake other one is response. So, this is what is the classification. This one we have taken developed by this IAEA 1991 and it is given in Kumamoto & Henley we have taken from Kumamoto & Henley. This is a better one from execution point of view. Because the engineers will be interested in this slip, lapse and mistake and all those things the definition is one; and here basically this is the actual actually what will happen during that time what is the actions to be taken, from that point of view it is given. So, it basically help you to do the work in a better manner; because engineering point of view ok.

But none of them are basically inferior to other they are complementary to each other; and the slip, lapse, mistake, classification that from the psychology point of view; the how brain works that point of view and this one basically more working point of view. So nevertheless, we will use both the concepts and we will try to take one which one most suited to the given conditions given work.

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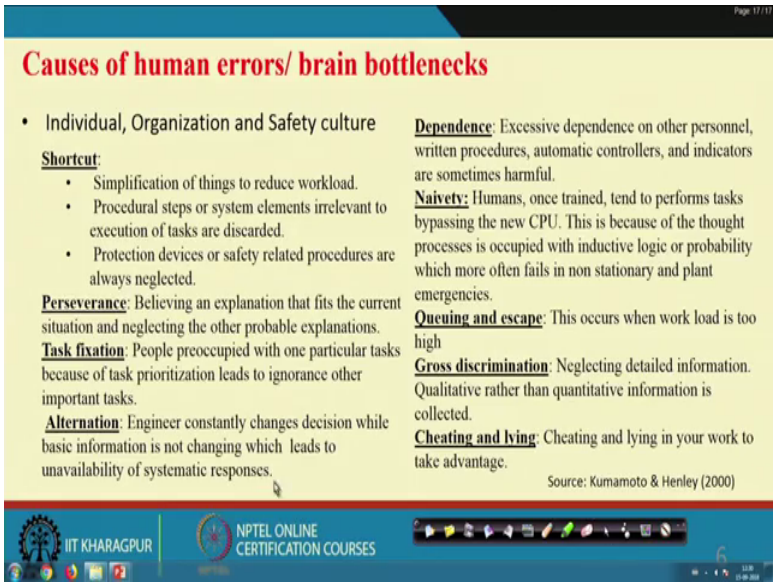

Then, I will come to the that why this kind of errors occur; broadly individual organisation and safety culture are responsible for this. Now, what are the individual factors, what are the organization factor, how safety culture will ultimately lead to this kind of error or erroneous situations; that there are lot of literature available. And you will find out the plenty of factors in many; in fact, in performance will be discussing later performance safing factors; so, there we will discuss further. Here basically, that from as we are dealing more on the that slip, lapse, mistakes those point of view. So, we will discuss little bit of brain bottlenecks here. This one I have taken from this book Kumamoto & Henley, and their they have basically giving the human and computer analogy that there is short memory long term memory.

So, there is old CPU and new CPU, CPU mean Central Processing Unit; and new CPU is basically the short term memory and their it is given that the new CPU is the problematic one. And it creates lot of problem, means from the human error occurrence point of view; it has the maximum contribution ok. So, in then they have describe the brain bottlenecks; I will just read out the brain bottlenecks here, because it is impossible to give each and every case the example, but this descriptions are simple; so, you will be able to understand it. And given a case you just find out what actually happened and accordingly take the actions. First one is shortcut, that is brain bottleneck what does it mean? Simplification of things to reduce workload for example, I can tell you; suppose when

alarm sounds the operator see the pressure gauge and then contact the contact should be open, suppose this is the SOP.

So, and you think that why should I see the pressure gage alarm sounds. So obviously, there is work pressure then you open the contact. So, what will happen ultimately tank will be tank will be charge with gas, but below the desired level of pressure. Then procedural step or system element irrelevant to execution of task are discarded; system element irrelevant to execution of task are discarded.

So, some steps, some elements may apparently maybe you are thinking that it is not relevant. So, there you started discussing discarding, because to same time. Protection devices or safety related procedure are always neglected. You assume that protection is there it is working. For example, in case of (Refer Time: 24:28) injury; so, there is one that mitigation mechanism is there will be the (Refer Time: 24:36); so, immediately the person any kind of (Refer Time: 24:39) you will be you will be put under the shower. And this is a protection device or let it be the working near the welding machine; so, the eye protection.

So, many a times what happen those protection devices (Refer Time: 24:58) these are neglected; so, that ultimate resultant resulting into safety problems. So, shortcut is one of the brain bottleneck we used to do it. Second one is perseverance, believing an explanation that fits the current situation ok; that fits the current situation. So, given a situation you have you have several explanation, but you believe you have a particular believe ok; the student suppose the student is absent to the class then you as a teacher if you believe that he was definitely sleeping; and then accordingly you take actions, but actually it may be a medical reason because he was not feeling good, but even though he has come to the class.

So, there may be other possible reasons you will forget; you will simply believe that that this explanation fades several time; so, it is the explanation, that is basically perseverance. Third one is tax fixation people preoccupied with one particular task, because of tax prioritization leads to ignorance of other important task. So, that it is as I told you that the entire end go objective will be achieved; only when you will basically do the all the task activities given to you, that is can be further broken down into activities also. Now, what do you mean, but you like some or some task or you give

priority to that task; and you start doing that one what you like or what you then accordingly you prioritize.

So, and then you neglect the other important task; so, ultimately that also lead to your human error. Then, alteration engineer constantly changes decision; while basic information is not changing, which leads to unavailability of systematic responses; this is interesting one please see you are not getting the suppose desired result, you change decision while basic information is not changing you have not collected any further information. You are you are taking decision based on previous or old information and you are again changing it without collecting other information; so, what will happen ultimately you will land into wrong decision making.

Then, dependencies excessive dependencies on other personnel, on written procedural at automatic controllers in indicators are sometime harmfuls. Suppose alarm sounds that means over pressure, but alarm can be a erroneous false alarm, (Refer Time: 28:09) alarm. So, it should not be dependent on alarm only because you are given another steps check the pressure gauge. So, there is possibility of both failing is much much less, but you have seen earlier that ok; whenever alarm sounds you found out of hundred times of you have observed and you found that ninety five times it works or ninety nine times it works. So, you have you have dependent on it. In that case, overpressure condition can be protected, but under pressure cannot.

The Naivety humans, once trained, tend to perform task by pressing the new CPU, that is basically short term memory as I told you what does it mean basically. Basically, that you have suppose you are trained to do something and long back you done; it is it has gone to you let it be long term memory likely. But new information comes you have ignored that new information; you have simply because of your based on your previous training what is there you started doing this. In that case, this is because thought process is occupied with inductive logic and probability; which more often fails non stationary and plant emergencies.

Then, queuing and escape it is happening to me now, because I have so many work. So, what I am doing, as I am not able to cope up with this load; what I am doing I am saying save this work or write down some or some piece of paper you will do later; that is basically you are making the queue of work and ultimately you are not doing you are

escaping; so, this occur when work load is too high. So, this is the precursor to work load high work load is precursor to (Refer Time: 30:17). So, you are not doing it you are basically queuing it and you escaping it. Then, gross discrimination neglecting detailed information qualitative rather quantitative information is collected, because quantitative information collection is a difficult one, time consuming one because there is a measurement involve. So, better you ask some people some information some qualitative information you will get and then what happen accordingly you take actions. So, that will also lead to human error. Cheating and lying no need of explanation what is cheating and lying.

So; so, when you analyze human error when you analyze accident due to human error then, suppose you want to also find out the that how to recover from those errors then these brain bottlenecks if you analyze and finally you are able to link to this, then perhaps your analysis will be not perhaps your definitely your analysis will be much stronger.

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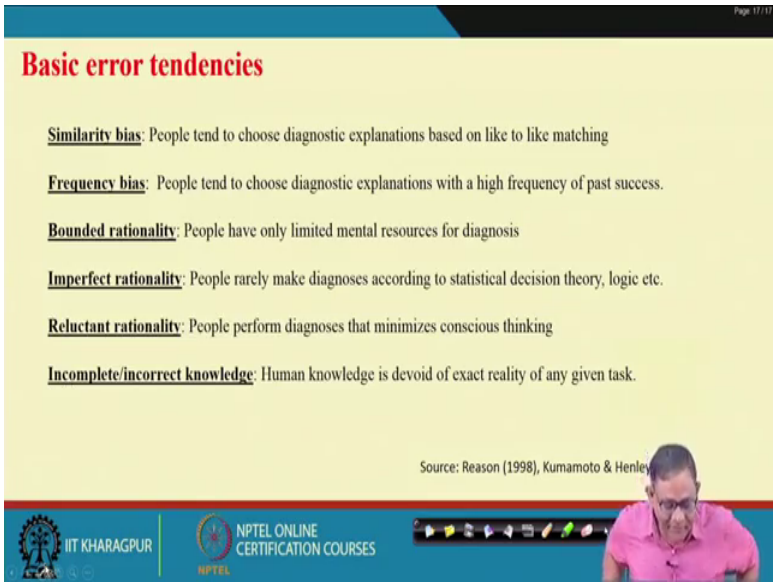

Then, then another important classification here, that is in terms of a error tendencies which is basically given by Reason 1998, that he found out that what are the one how human (Refer Time: 31:54) to error that is the tendency to commit error. Similarity bias, similarity bias we use to face this problem, because if you find that similar situation and which is which can be explained with earlier case some matching is possible; then we

consider that ok; so, this is the reason. So, but it may not be the reason, reason may be something different; so, when we basically diagnose something that in soon as we get some matching with the precious experience we say yes this is the case.

So, this is known as similarity bias; frequency bias which happens many a times. Suppose we match with the how many times does a similar situation occur; with the highest probability one we will consider. So, it may be the case a unique case which is not a not having any previous occurrences. So, in that case you will face problem; this is basically the pattern matching first one is pattern matching, second one is highest probability high frequency, third one is bounded rationality. People have only limited mental resources for diagnosis, because of this because you giving a situation I will ask you if you are which said that you tell what are the possible ways it can happen; and you will find out that after one or two you are nothing to more to say why it is happening.

There are some people who can tell ten different ways, that this may happen; but there are many who basically after one or two you that memory; that means, (Refer Time: 33:57) just it. That mean that is bounded rationality your rational, but your knowledge your mental process, diagnosis process, your resource total resources is limited. Imperfect rationality people rarely make diagnoses according to statistical decision theory logic etcetera ok. And in fact, if you try to tell that what is the what is the evidence; then you will say a everything cannot be judge by evidence if this happens like this; if proof yes imperfect irrational thing to rational also sometimes. Then, reluctant rationality people perform diagnosis that minimizes conscious thinking you do not want to (Refer Time: 34:56); why unnecessarily putting lot of things in the brain and you have to (Refer Time: 34:59) what diagnosis.

So, you want to minimize the cognitive load; so, then that will be reluctant rationality. Incomplete and incorrect knowledge so, even if you see all the engineering that concepts not concepts all the engineering applications at when you basically talk about the many of the concepts we basically discussed. For example, elasticity suppose we are behaviour of for example, root fault in underground mind roof fault takes place. So, the root behaviour that one we want to judge, but we do not have complete knowledge of root behaviour; we have some theoretic theories the modal elasto plastic model, but they are basically they are not the exact reality they are approximation of the reality. So,

approximation of the reality means there is incompleteness correctness; so, that also lead to human error

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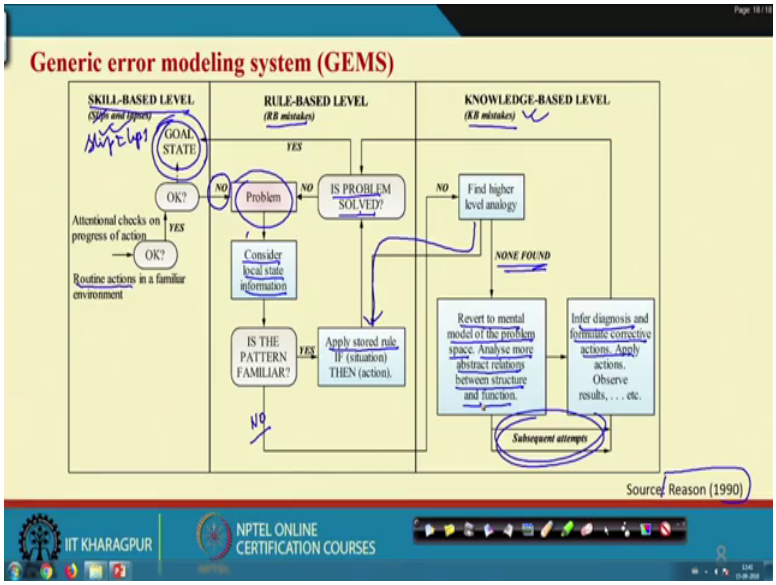

So, after this I will just finish today's lecture, with this generic error modelling at system developed by Reason. So, in fact I have taken from his book Reason 1990. So, here interestingly that the skill knowledge and rule based task; as well as the slip, laps and mistake that both are both are combine together. And then, when it is skill based work then slip and slip s l i p slip and lapses can takes place. Rule based mistakes and knowledge based mistakes. So, how do you basically, model the human error with this classification and what when you say it is rule based mistake, when you say it is slip and lapse, when you say it is knowledge based mistake. So, this broad modelling framework is given by Reason.

So, when we said is skill based, then basically it is a routine actions. Routine things you are doing an everyday and ultimately it is converted to I mean it is skill means given a time you can do any time you can do this that is why it is skill; you have the skill giving that one you will be able to do it. And we have seen that in the skill based case, previously I have I have given you that there are two kinds of problem: one is attention problem another one is memory problem. So, giving the routine based routine actioning familiar environment; then you are asking that attentional check on progress of the actions is there attention problem. If it is then, then it is or not ok.

So, attentional checks on progress of actions is attentional check taken place; so, if it is then ultimately the goal state is there. So, that mean routine work, attention work, and memory lapse of type of work that you first check and if you attention laps all those things to take place; so, then you are understanding that attention check on progress of the action yes that then, if it is not that no then what will happen there is a problem; means you are when you are not able to relate these routine actions with attention and lapse memory power. So, then what you required there is higher level problem. So, this problem when you analyze consider local state information; is the pattern familiar if then role is there is the pattern familiar.

So, you analyze these with the local information and are you able to find out some kind of patterns; if there is a pattern then ultimately some there will be some stored rules, because of different patterns rules are given ok. In fact, we have discussed safety ontology much earlier, where we have derived certain patterns; if these, then these, then these this is going to happen. Suppose you are this (Refer Time: 40:30); so, when you are analyzing then you are able to find out the similar pattern when do your activities or task in the performing you are able to find out this pattern. Then, you have you apply that if then that rule, if the problem is solved then you go to goal state.

And after applying the rule suppose the problem is not solved, then you again check the problem ok. Now, what will happen here when after analyzing the problem with local information; suppose you are finding out that there is no pattern one is there is pattern there is no pattern. So, when there is no pattern no rule can be framed; so, it is a issue of knowledge base. So, then you recall is there any other higher level analogy which can be applied here and then some rule can be generated some pattern can be identified; so, this lead to this.

So, if there is some analogy found again it that rule can be extracted and you will be applying a problem solve fines otherwise again you repeat this. But suppose there no higher level analogy which is available to you. So, then use a none found. And in that case, it is purely your knowledge will work revert to mental model of the problems space. Analyze more abstract relation between structure and function, and then infer diagnosis formulate corrective actions like this and this is your ultimately this again is the problem solved if not go to problem and repeat this. And, subsequent atoms in between atoms will be there ok; very abstract way I have described these without any

proper case with this case, because this kind of case development is a time consuming task also. And, our sole purpose is to give you these information; and with those information or those techniques or the modelling concept will be able to use it in a in future and that is our belief and our expectation problem also.

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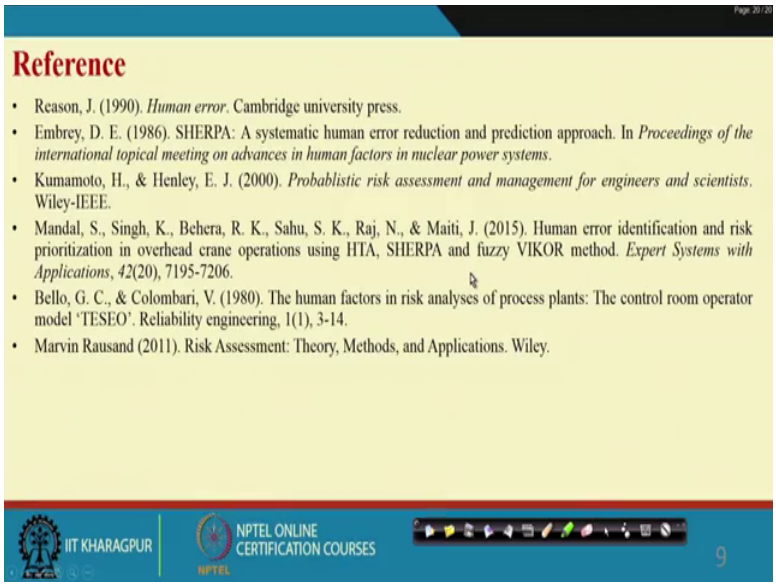

And I must say that this is the book, which I rely on for this lecture as well as this previous lecture heavily; and I have taken material from this book while understanding the concepts also. Then, this is another that paper publishing liability which also you have used and in addition I have read all those paper like Marvin Rausand this book also, as well as our own paper that the from there also we have gather some information.

But mostly if you ask me, but that this present lecture as well as the previous lecture I will tell you that please go through this book; the relevant chapters and go through this with the relevant with this paper. And I hope that you will be able to understand the concepts and the theoretical underpinning what you have done here for human error.

So, in next substitute classes, we will go in to more engineering way of understanding, identifying and quantifying human errors. And, the psychological part is also very very important when we are talking about the human error, but we want to identify human error, quantify human error and at the same time we want to prevent that human error should not occur. And we will more rely on the engineering intervention of engineering

way of doing things and accordingly, we will also discuss human reliability analysis in some of the lectures.

Thank you for listening.