Applied Ergonomics
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Module - 03
Lecture - 11
Industrial accidents

Hello, and welcome to this new lecture on Applied Ergonomics, lecture 11. This lecture is intended mostly on industrial safety studying accidents and human errors. And what are the causes.

So, we are going to do a taxonomy sort of an organized classification of how you can involve various components, which we have discussed earlier related to work systems and their corresponding involvement in creating unsafe work practices which could be avoided. And in incase of certain unsafe were practices we can classify them as human accidents or may be even accidents related to equipments or methods.

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So, let us talk about industrial safety. So, the first thing I would like to emphasize here is a sort of a need finding steps as to why safety is quite important in almost daily life experience of work systems. So, each day an average of about 16 workers die from

injury that occurs during working. And this is only data related to you know the OSHA document operational health and safety agency and this is not a global data. So; obviously, this is more data for United States and it can probably spread across the globe or this number will definitely increase because of that.

So, these deaths if we look at and the kind of cost that the society would have the cost impact the society of have apart from the; obviously, the emotional value and the you know and the value related to the family support system. More than about 1100 billion dollars per year is spent in certain such personal tragedies related to workers dying at work. And the so many families involved, so obviously, this is not very good practice that can be sustained. And therefore, there has to be a 0 tolerance for such issues and this 0 tolerance really lies on the way that technology or engineering can address. Some of these safety issues with a lot of relevant idea is that make a system which is so full proof which has 0 accidents and all though it is easier said that done, but technological issues these days do emerge as less as possible deaths or injuries related to workers.

However, whenever there is man and machine system involved one has to also understand that the human component may not be as much as in rhyme. And rhythm with the machine component and there may be chances of non compliance to guidelines or particularly in a repetitive cycle kind of situation, where it is prudent that some of these accidents do happen. And so definitely we need to develop 0 tolerance systems as well as occupational safety is concerned. And occupational hazards are concerned and you want to develop systems which have very safe possibly with a full proofing step. So, that there is no recurrence of any major event which leads to causalties among the various stake holders related to work system.

So, each day an average of about 9000 workers in us alone suffer injuries on the job apart from these deaths which are actually fatal casualties. And you know there are; obviously, many fall out including work days which are lost because of such occupational injuries. And if we looked at the number of work days alone in united states from the osha data, it is close to about fifty million per year you know that such kind of work days are loss because primarily because of occupational injuries.

So, each day an average of about 137 worker dies from work related diseases. So, this could be. So, this slightly different than workers dying of injury where actively some

accident has taken place. So, people particularly working in hazardous industries exposed to chemicals let say working with mines or some areas related to excavations. They do have lot of fall out in terms of post job infection or diseases which again are quite fatal. So, this could also be in a way linked to the occupational safety domain.

So, the so we see that from these statistics that the total amount of information which is there on all these point out that, there is a very important need of maintaining safe practices and safe methods. So, that such casualties from injuries or work related diseases or even you know injuries which could be fatal should be by and large avoided while designing by making the system itself robust design with mostly full proofed kind of mechanisms. So, that such occupational safety is of is enhanced.

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So, let us look an industrial accidents to unexpected and unintentional events that disrupt work procedures and have a potential to cause a damage to property and injury or death to the workers can be classified as the definition for industrial accidents. And we can further classify an accident into 2 different types one which actually causes damage injury or death and another which has only the potential of having these consequences. So, basically something which is of a preventive sort of strategy has to be followed in one case to identify which is happened post occurrence. And another case to sort of proactively do it in identical situation which may otherwise happen if the processes out of control.

So, therefore, you want to create in in one cases a study group which who are looks at the existing work systems and finds out potential sources of you know creating damage or injury or death to the worker subjects associated with the system. And another one which actually on a case to case basis after the activity has been carried out or an accident is occurred do the investigations. So, these are the 2 separate routes which you should try to follow when we talk about studying of industrial accidents.

So, the objective in occupational safety is really to reduce the incidents of accidents. And that can be also done by reducing the hazards that precipitate from them.

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Obviously if I wanted to define hazards in more appropriate term it is a condition or set of conditions that has potential of causing an accident or other harmful outcome. And the danger posed by such a hazard could be something like relative exposure or liability to injury it could cause death you know it could cause damage from a hazard which otherwise you do not know while you doing the job that is causing this damage, but there may be later on consequences.

For example, look at the problems silly causes which happened to people in as best at industries working for as best at systems people really dint realize before proper diagnose were made that why there are lung related issues, and breathing troubles among those people who are working in a systems which generate a lot of dust. Particularly if we look at even you know in our own country aspects related to occupational safety and

then somebody figured out that this deposition of silica particles in different alveoli or different channels of the lungs cause this kind of an condition. And so there are again cases where it may not be directly tangibly apparent, but may happen later because of such potential hazard. So, the danger posed by the hazard somehow has to be removed along with the hazard and this can only be done by proper systemic design.

So, one of the examples for some system which could pose potential hazard is a railway is a rail road crossing you know, but it is poses little danger. So, long as the crossing signals works and people pay attention to it, but the moment there is some issue related to the signals not getting activated properly, it may lead to some noncompliance and it may lead to some accident. So, there can be. So, people realize later that the lung infection that they were getting and the other breathing issues they were getting typically from posed silica in the small capillaries within the lung. So, these are some of the dangers which would really do not realize was the system is in place and people are associated with the system, but then there may be fall outs there are other kind of potential dangers being posed by a hazard, which is otherwise not making an accident happen because probably the system is more compliant.

For example, let us look at a rail road crossing and typically the any rail road crossing is the hazard. Because it is about a criss cross of road traffic and rail traffic and if a signaling system is not properly maintained or people do not pay more attention to it there can be it does not take a minute for the hazard to come up you know in terms of fatal accident. So, such systems where there is some degree of hazard being always posed and it is made under control have to be enforced. So, much in terms of the control and more attention and has to be more automated in the manner. So, that such full proofings will result in very less accidents and fatalities.

So, the organized study of such occupational hazards becomes sort of a pre condition for laying out any work system and for again maintaining and carrying out activities associated with the work system. So, let us look at some data.

So, if you look at frequencies of the fatal injuries per 100,000 workers, let us say in different industries and this data pertaining particularly to the United States again if I had let us say mining industry there about close to 23.5 workers per 10000 workers who have had fatal injuries.

So, it is one of the highest; obviously, mining is quite bit of challenging task where the environment of the people would work in typically very hazardous very unpredictable you do not know how the earth crash where some of this minerals have been excavated from behave it is it is having a high degree of randomness. So, nothing can be predicted there is also a lot of fatality in the agricultural sector about 22.7 per 100 1000 workers suffer through such fatal injuries particularly in the agricultural sector in the construction sector this number is about 12.2 transportation it is about 11.3 manufacturing sector still is in quite bit of control. Because you know you can design work systems where external influence of environment may not be that great.

You see for example, in the first 4 types where this number is very high there is a substantial influence played by the environment in which the operators work can be manufacturing the advantages that it is a controlled system where we can if; so if you wish so and if you desire. So, try to make it as much unresponsive to environmental changes or challenges. So, that there can be a steadiness in terms of whatever has been laid out on the work system. So, there about 2.4 per 10 1000 workers in the wholesale

retail business 1.7 in the services business and finance insurance or real estate is very small about one and 10,000 100,000 workers. So, this looks at some numbers associated with what kind of fatal injuries or how what are the numbers of fatal injuries which may happen in a sartorial manner.

If you wanted to look at the non fatal injuries, you know they crop up only for about per 100 workers and they are quite high in number.

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Because these are probably the once where not very significant amount of attention is posed by the administration or let us say, the designer because these are probably due to non compliance mostly of the workers in terms of you know ability to fail on doing certain routine task because of the repeated nature of the task attention disorder so on so, forth.

So, if we look at this numbers these number are for any 100 workers and in construction such non fatal injuries could be about as high as 6.9, similarly manufacturing about 6 point 4 agricultural 6.0. So, I see you see in this particular sector in the mining area or the non fatal injuries are quite less in comparison to the fatal injuries of course, over large number of workers, but it does indicate; what are those sectors which really are very concerning in terms of fatal injuries where the non fatal injury may not be. So, much in comparison to the other sectors and it really emerges as a theory that wherever

there is a significant environmental influence on the system the fatality increases in in comparison to what we can record as non fatal injuries.

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So, you know we also have a sort of classification based on what are different causes of workplace that is an injuries. For example, the injuries could be typically related to over exertion and because of over exertion non compliances to some routinely followed processes and systems. It could be because of impact accidents it could be because of falls from tall structures, it could be because some chemicals may bodily react you know which is a true for those people who are working in hazardous chemical environments. It could be due to compression it could be due to motor vehicle accidents, it could also be due to exposure to radiations and caustics this is major problem in the nuclear industry. It could also be the injury could come from various rubbing and abrasions which may be while manufacturing something or may be even if somebody is not paid enough attention there is a chance of such rubbing and abrasions almost always could be exposure to extreme temperatures. So, these are different causes which could cause injuries.

Whereas the causes mostly, where there is almost immediate fatal injury and death could happen due to motor vehicle related accidents big falls, you know where the falls may result in such fatal injuries. It could result to high voltages high currents people who are who suffers severe shocks from such systems could happened. Because of drowning could happen because of burning you know particularly to fire related activities or fire

related events, it could happen due to crashes etcetera associated with machines enable to fly. So, all air transport related casualties and the majority of them do convert into fatal injuries it could happen due to some kind of poison, this could mediated through consumption of either fluid or even breathing such poison can come into picture because of some non compliance again related to chemical industry or related to some bad consequence.

For example, we know of a recent case where there was a closed automobile which was placed for a long time under the sun and because of toxic fumes which generated from the plastic components of within the automobile. And the paint there was a death of an infant who was transported into the automobile without proper bleeding of the internal cabin air. So, these would result in some fatality. So, again there are deaths related to water transport or some other means. So, these are some classifications or these are some sort of causes that one can think of to classify events, which might be leading to fatal injuries leading to death or just injuries which could be treated.

So, if you look at the cause of industrial accidents. So, there are typically 3 different classifications why accidents must happen one is because of human error.

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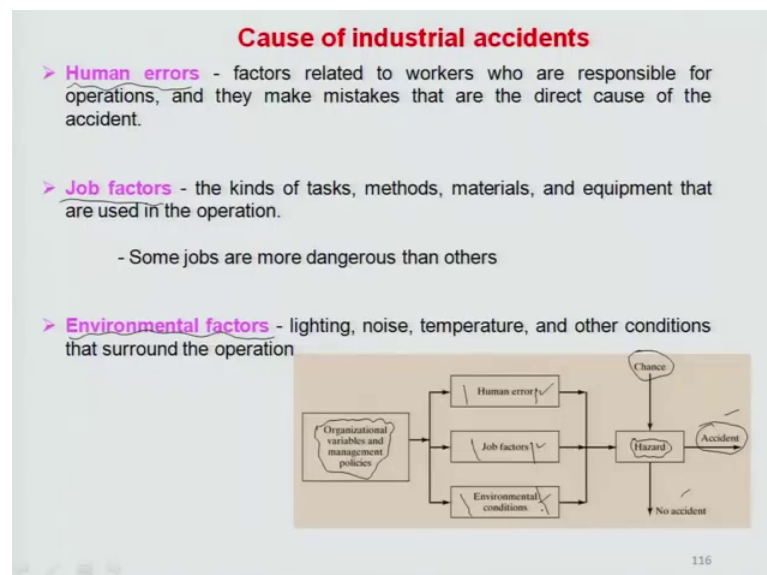
Then there can be something related to the job factors some jobs are more dangerous than others and then; obviously, any factor which associated with such a job including the method of doing a job materials, which are involved in the job or equipments which

are involved in the job are individually causes of such non compliances, where there would be safety issues popping up there also a environmental factors which sometimes come.

For example, look at lightning to an air plane what kind of damage it may do. So, the air plane is not in able to handle the lightning it could cause into a air plane fire while in operation there could be a very big noise which could cause deafening. So, there are guidelines associated with such noises. So, there are environmental factors also which could cause such industrial accidents from happening.

So, typically if I looked at all the organizational variables and management policies which are in the area of occupational safety they can be categorized as factors related to human errors factors related to the job design itself or factors related to the environmental condition. And all these factors do pose something called hazardous situation or a condition, which can lead to an accident which may, but chance not lead to an accident and it could be a chance causes as well, but then there is a possibility of getting into this domain. And therefore, it is important to organize and classify the knowledge in these particular areas. So, that we avoid most of these unpleasant industrial accidents from happening. So, let us actually look at now these individual factors and try to see what are the different issues involved in such work systems which can cause human errors or for example, non compliance to all these job factors or environmental conditions.

So, when we talk about human errors, it is really a misnomers it cannot be completely a human error and the error may typically happened, because of challenges like poor design of a system or may be even poor practices of management.

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For example, let say a worker is over excited by putting into more than one shift without giving him enough rest time in between. So, these kind of things may always happen as bad administrative practices which may create, over burdening and then you know not because of the over burdening issue not following of certain laid out guidelines particularly for repetitive tasks. Which may result in some human errors and then also it can be violations of use and maintenance of equipments which may generally lead to the unsafe practices.

So, errors usually are triggered by other things it may not be that. So, even if you are calling it human error it may not mean that it is related to the concerned human being it be may be a n number of reasons. Because of which an errors has happened because otherwise the human subject is the most intelligent subjects and prudent to take the right decision at the right time in a very quick let us say time cycle involving a very quick time unit. So, generally the human errors would happen because of some other causes. So, error is the end result of some of these problems I just indicate these problems in the last step here.

For example, if you look at airplane accidents the pilot error is only about 70 percent of all such accidents or the operator error blamed on over 60 percent of nuclear power plant accidents. Or for example, error is done by doctors or nurses in icus occur at the rate of about 1.7 patient per day. So, if you looked at such data highlights that does indicates

that thirty percent of the cases because of the machine problem right the air plane itself is a problem or in this particular case about 40 percent of the accidents happened because there were problems related to the power plants and the safety measures which are involved in. So; obviously, there is some operator judgment which may be a source of an error, but then there are lot of other factors which contribute to augment in this human error. So, if we wanted to classify the different types of human errors.

So, we can actually outlet them in 2 different broad categories one is called the error of omissions, which mean that the operator fails to perform certain procedural steps because of which an error happens leading to such an event such an accident event. And then there can be a error of commission where the operator performs an extra duty or extra steps and performs it incorrectly and so because of such performance adding extra work, but in a incorrect manner there may be a possibility that there is a human error.

So, this is actually more related to the cognitive aspect or the knowledge domain. Let say of an operator and you have to classify this whole business of errors you know errors into very organized manner as to where it is copping up from a knowledge domain or where it is copping up from a let say a rule, which you are using, but following it wrongly and then where it is happening because of a slip. For example, those work elements where the typical operator will say oops I did something wrong. So, those kinds of issues have to be classified in a different you know context so that I can have a good standard way of looking at the sources of generations of such human errors.

So, let us look at the taxonomy of the human errors. So, we see that there is a stimulus which is an evidence for us to sort of start analyzing situations, which is happened or arrived at which is unsafe. And so first of all we if we have this stimulus we will start acting upon. So, that a particular step or an action of a work system is carried out. So, we will interpret that what is the stimulus what we are prompted to do. So, that the next step gets the output from our side, and then we do a situation assessment and then based on that we can have a plan and an intention of an action.

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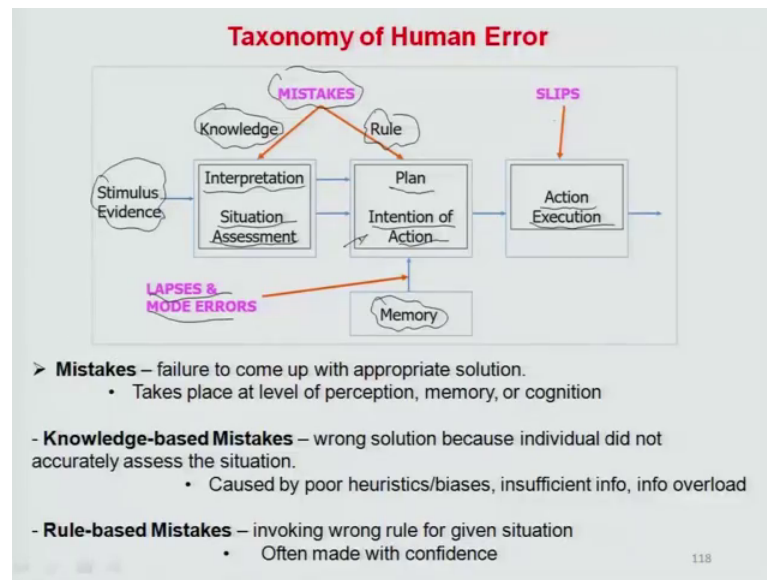
So, this is the cognitive part of the worker component which is involved in such work systems that whenever there is a such a stimulus, that I want to start doing this activity or this work just because I got the material from the last step or let us say I got the resources or a command from the last step. So, you first interpret that command and access, what is the situation that you are in and what you mean to do or what is your intention of or intended plan of action for the next step. And so you basically plan out and also draw out an intent of acting upon. So, that you can have a action by executing the action. So, in in process of doing it you use a lot of external you know cognitive sources.

For example, there is a memory of a concerned subject which is involved in it. So, have you done anything prior of this type. So, the person the human brain will take a decision based on that, if a somebody has done something earlier and is in memory we can think of putting this memory back into you know into place. And so there may be some lapses and errors based on such memory there also can be a sort of a mistake, because you know the knowledge that the concerned operator had about accessing the situation and interpreting what you have to do may be inappropriate or the rule that you applied to do it also may be inappropriate, because of lack of knowledge and there can be many slips on the ways.

So, I will probably come and explain these concepts little in in in little more details probably in the later on lecture. So, today I am going to close this lecture here, and the

next lecture take up again from taxonomy of human errors and try to explain the different other causes of error like errors related to job methods as well as environmental impacts.

Thank you very much.