Applied Ergonomics

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Lecture – 02

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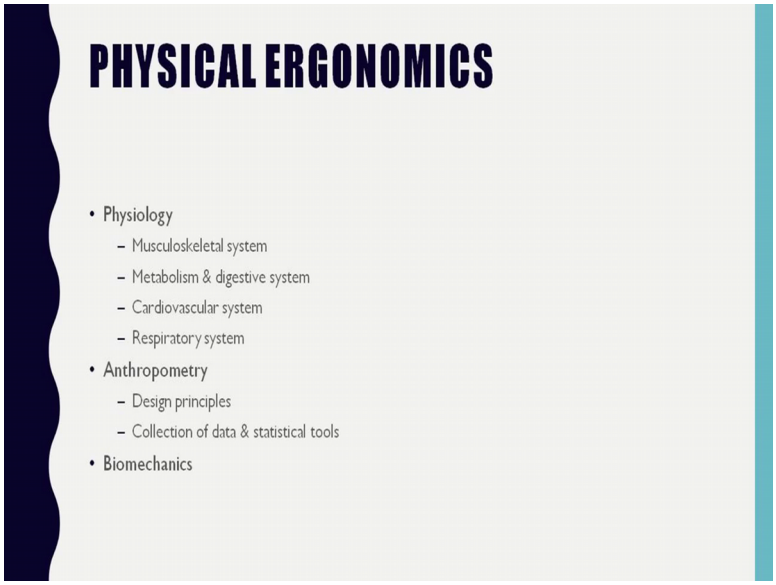

So, welcome to lecture-2. So, in continuation with our introductory lecture I would like to add some of the sub topics in economics. So, in that physical ergonomics, we will be covering some of the sub topics like in physiology musculoskeletal system in metabolism and digestive systems, cardiovascular systems, respiratory systems. And anthropometry, we will be discussing about design principles, collection of data in a statistical tools, and as well as biomechanics, we will be discussing basics to biomechanics also.

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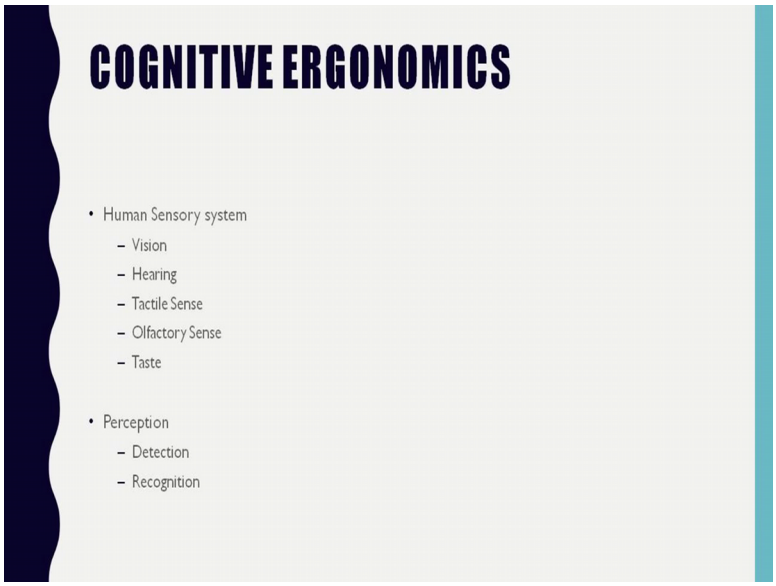

And in the cognitive ergonomics part, we will be discussing about the human sensory system in which we will be discussing about vision, hearing, tactile sense, olfactory sense and taste. So, these are the basic five human sensors through which we pursue the information and decides our course of action. And again in the next phase, we will be discussing about perception; in that detection and recognition will be discussed.

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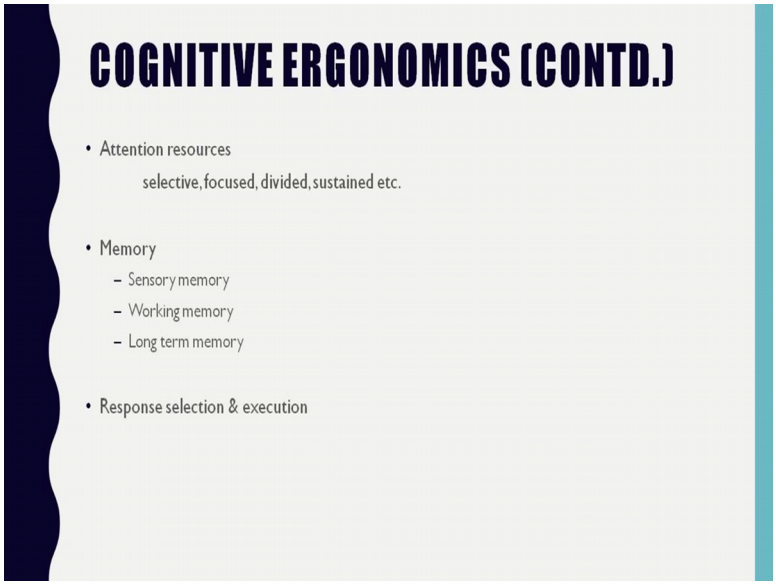

And in continuation with the this cognitive ergonomics we will be discussing attention resources. So, attention resources may be splitting into selective, focused, divided,

sustained and as far as memory is concerned. So, sensory memory, working memory, long and term memory that we will be discussing in the forthcoming lectures; and response selection and execution that we will also discuss.

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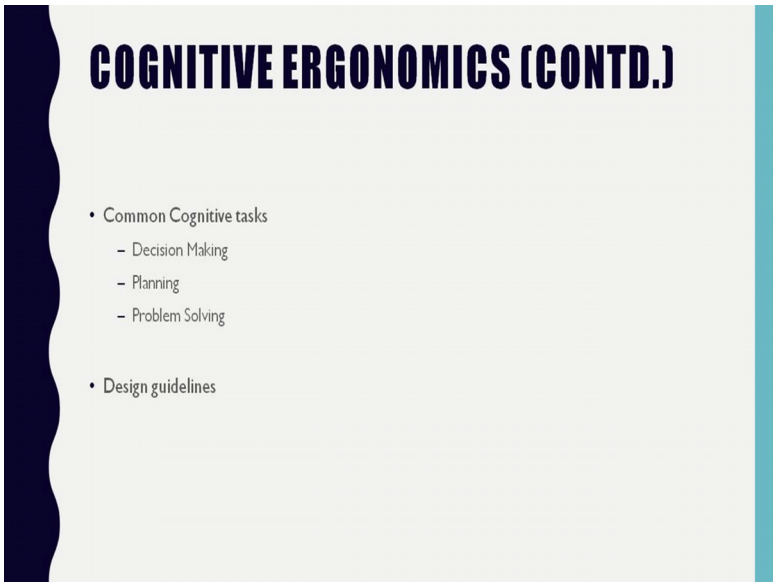

Some of the cognitive task those task are decision-making, planning and problem solving as well as the design guidelines while considering the cognitive factors.

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Apart from this physical and cognitive ergonomics, we will be discussing about the research methodologies that has been used while research and ergonomics. So, some sort

of experimental techniques analytical tools and numerical methods and some of the software that are available for the analysis of ergonomics. So, those things we will also be discussing next lectures. So, now coming back to our discussion about the various aspects of ergonomics and possible application areas, so there are basically two areas where the ergonomic research is focused, the first is work system design and second is product design.

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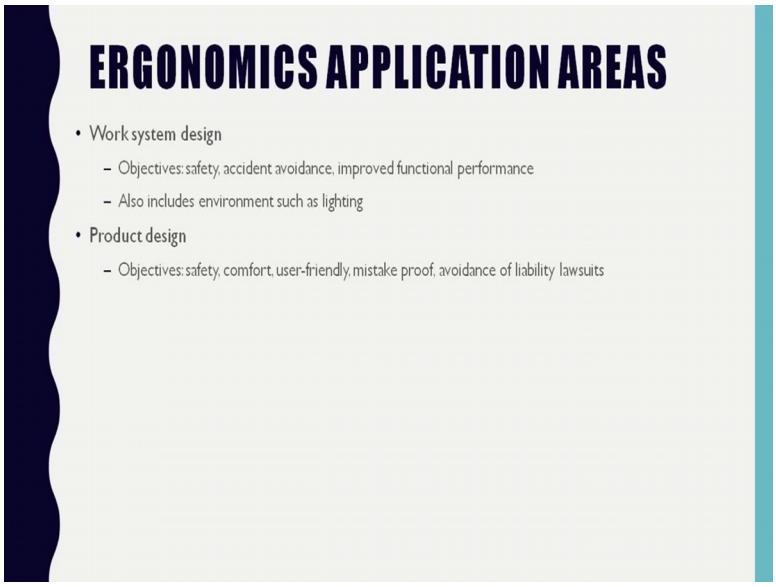

So, in that work system design, our objective is to take care of the safety, accident, we have to take care of the factors in order to avoid any accident and we have to also take care of improve the functional performance. And those in order to enhance the performance, we also have to include environment such as lightening and other factors also. So, in the work system design, it is mainly concerned with the interaction between worker and equipment used in the workplace. So, the work system design includes the consideration of factors related to the work environment.

And another area application area of ergonomics is product design. So, in that this particular area deals with the design of a particular product and that should be focused for its safety and more comfortability and more user friendly and obviously, without having any mistake and errors. So, in addition to providing greater customer satisfaction by means of adding these kinds of features and issue in product design is product liability law suits and their avoidance through the consideration of ergonomics. So, in a nutshell

these are the possible application area like a work system design and product design. So, in these two domains, you can split all the possible scope of research in these two categories.

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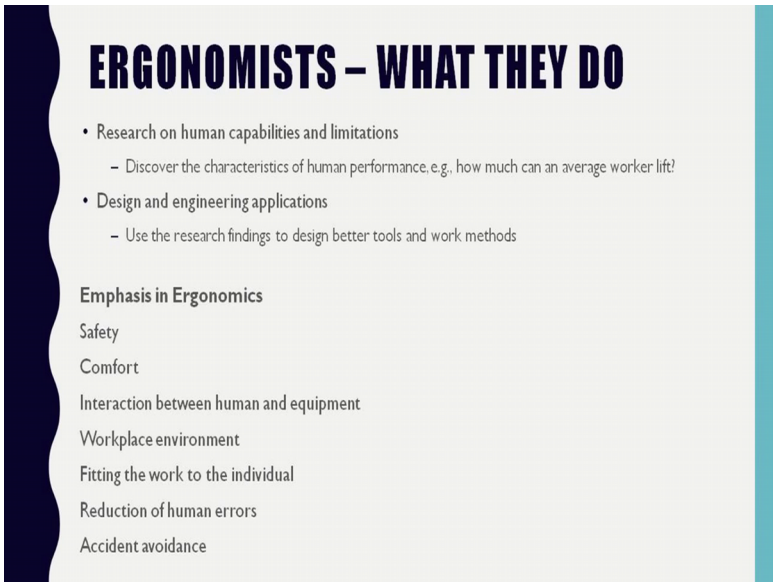

So, now then next question that often comes in our mind while tackling the supplied ergonomics course that what exactly this ergonomist do. So, the answer is the ergonomist perform research on human capabilities and its limitations. Second is it also as a design engineer it also design and make the product relevant to the engineering applications. So, what exactly it does it discovers the characteristic of human performance like how much can an average workers lift something and other factors also. And while designing that ergonomist use a research findings to design better tools and work methods.

So, basically the emphasize on some of the factors while dealing with this ergonomic those factors are which we consider while tackling this ergonomic thing as safety, safety of anything, comfort, interaction between human and equipment, workplace environment, fitting the work to the individual, reduction of human errors and accident avoidance. So, in that context, we have to decide the role of an ergonomist and we have to take care of the related performance. So, overall objective of particular ergonomist is to provide the greater ease of interaction between the user and equipment and it also takes care of the fact that any kind of error whether it will be based on human interventions or it would be of machine error. So, we have to as an ergonomist he has to

take care of those errors also. And as far as it should avoid user difficulty and it also has to take care of comfortability of a user.

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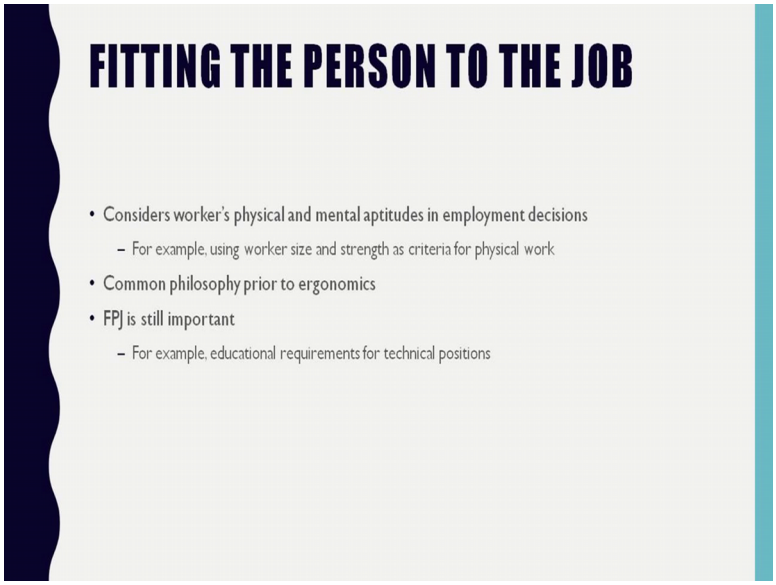

So, now there are while in an industry there are two prospects that use to come. First is the fitting the person to the job.

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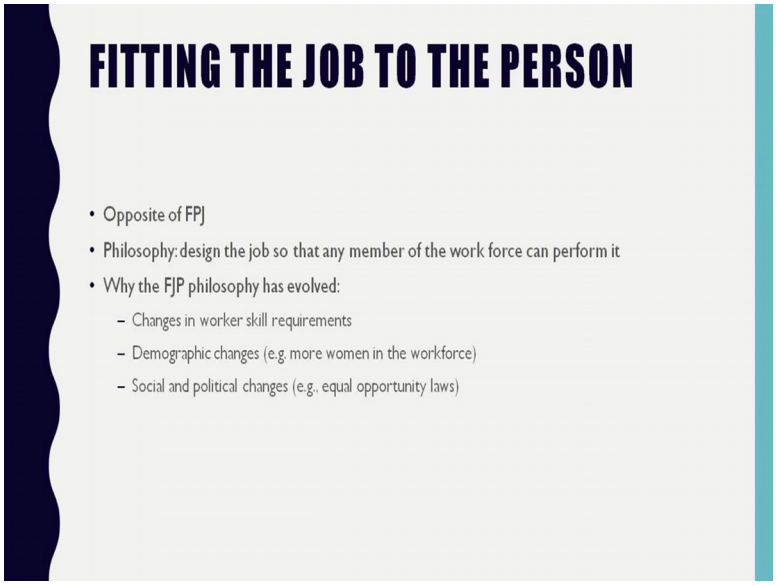

And second is fitting the job to the person. So, first we will discuss the fitting the person to the job. So, this is a common employment practice, in fact prior to the ergonomics was based on a philosophy that is known as fitting the person to the job. So, which

recommended that workers be selected on the basis of his mental aptitude and physical characteristics for a particular job requirement. So, in that context the organization used to conduct psychometric test that test for intelligence and personality characteristics and in fact our workers physical attributes were also used in the selection process for job requiring characteristics such as size and its strength.

So, FPJ that is fitting the person to the job is still considered among the eligibility factors for certain positions in many hiring situations today itself. So, this is not an ergonomic approach. So, here this is a common philosophy prior to the ergonomics and FPJ is still important. And as an example we can take that as any position which is opened in an educational institute, so the educational requirement for technical position is usually filled up based on this philosophy.

The another kind of philosophy is fitting the job to the person. So, the philosophy in ergonomics is like designing the job, so that nearly any member of the work force can perform it. There are several factors that explain why the new philosophy has evolved. And now occupies a first position that operates in parallel with an sometimes supersedes the FPJ approach. First is changes in the worker skill requirement, the second is demographic changes and third is social and political changes. So, in fact in Europe the ergonomic started seriously with industrial applications in 1950s and used information from work physiology, biomechanics and anthropometry for the design of work station and industrial processes. So, after discussing these two philosophy that FPJ and FJP, now we will understand one ergonomic system and its component. So, an ergonomic system is composed of interaction between in fact interaction among human, machine and environment.

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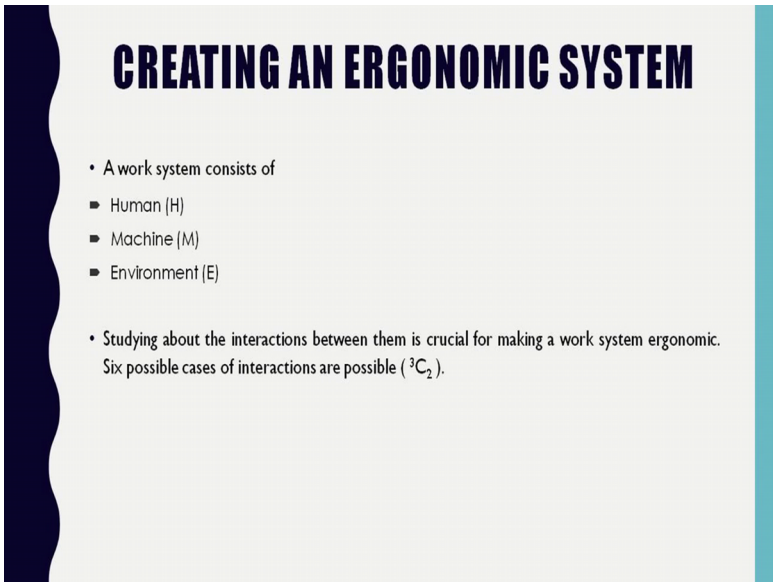

So, the work system consist of human, machine and environment. So, in that we perform work and so based on the combination of these three entities, the six directional interactions are possible. So, among these three entities human to machine that interaction may be possible, machine to environment that is possible, machine to human, machine to environment we have discussed, environment to machine and environment to human. So, in this way out of these six types of interaction, four of these involve the person. So, we will now try to understand this particular interaction and the evaluation of the concepts.

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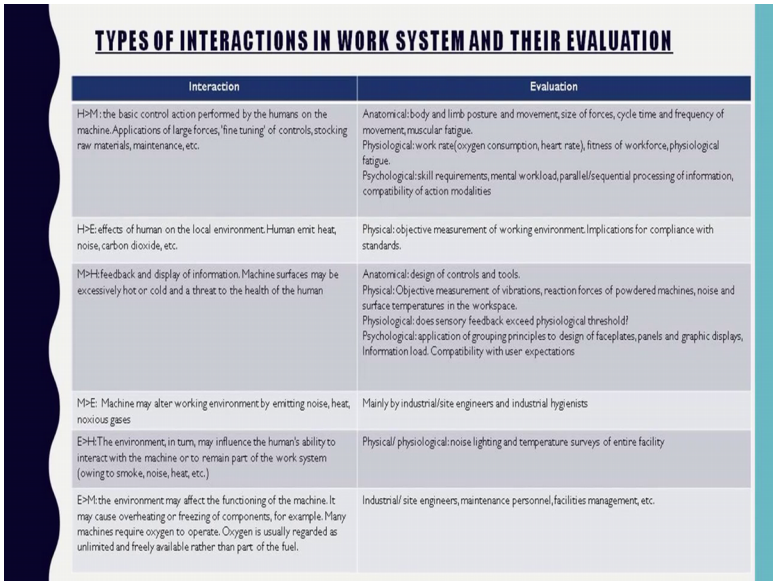

So, now since these three and ergonomic system, so now we will try to understand this kind of interaction in a work system and based on the interaction what could be the possible topics that has been immersed out for the understanding of complete understanding of the ergonomic system. So, now, here you can see that this is the table that has been divided into a two column the first column is having the interaction and second is the evaluation of the concept. So, each of the component of a particular work system may interact either directly or indirectly with the others.

So, as an example a machine may change the state of the environment by emitting a noise or heat for example, and this also affect the user. So, if we take here in this table the first kind of interaction is the effect of human or machine. So, H is denoting the human, and M is for machine, and E is for environment here. So, in the table wherever you are finding H you pronounce it as a human, and as far M is concerned it is machine and E is for environment.

So, now, you just visualize this table. So, the first interaction is effects of human on the machine. So, human may apply large forces to the machine which may cause damage to a certain part of the body. In opposite to that we may also think of the situation when human can also find tune the control over the machine. So, the effect may be evaluated, so the effect may be evaluated on the basis of body, posture and movement while handling machine and amount of forces applied by human or how much muscular fatigue human has faced. So, if the interaction between human and machine is taking place, so what could be the possibility of interaction how could they interact with each other. So, there is a possibility of large force application, fine tuning of controls, stalking raw material, maintenance etcetera. So, the evaluation will be like how we will evaluate those things in a bit technical way, so that ergonomic study could be carried out.

So, first kind of study that can be done based on the human machine interaction is anatomical. So, anatomical interaction or anatomical evaluation we can take place that can take place. So, in that body and limb posture and movement, size of the forces, cycle time, frequency of the movement and muscular fatigue, so these kind of analysis we can do while taking care of the anatomical study.

Another kind of thing that we can do as study part as physiological study. So, in that whatever the human is performing in terms of physical effort, we can calculate the work

rate that work rate can be defined in terms of oxygen consumption and heart rate. And we can also evaluate the fitness of the work force, and we can also for if particular person is working for a prolong period of time, so physiological fatigue can also be evaluated. There are other than anatomical and physiological concepts that is psychological. So, psychologically we have to also take care of the matter. So, skill requirement, mental workload, parallel and sequential processing of information and compatibility of action modalities, so these are the psychological part which can be evaluated while the interaction of the human and machine is taking place.

So, another kind of interaction is human in fact human to the environment, so that is effects of human on the local environment. So, that environment may be composed of the noise, visual light in which the particular human is performing work the amount of gases present in the ambient and as well as noise that we have told. So, in that interaction between the human and environment in fact the effect of the human on the local environment, so the things that has come out as a physical evaluation. So, objective measurement of a working environment, implications for compliance with the standards, so those things that can be immersed out from the effects of the human on the local environment.

The third kind of interaction is machine over human. So, in that interaction the feedback and display of information is can be carried out. Machine surfaces may be excessively hard or cold and a threat to the health of the machine. So, another kind of interaction is effect of the machine effect of the machine on the human. So, feedback and display of the information is the kind of interaction between these two entities. And machine surfaces may be excessively hard or cold and threat to the health of a human. So, because repetitive work and continuous work on the machine may deteriorate the part of the machine also and as far as wear and tear of the machine part goes. So, it can also in the in the longer period of time it may also threat to the health of a human.

So, in that design of control and tools is the study of interest and objective measurement of vibrations, reaction forces of powdered machines, noise and surface temperature in the workspace. And as far as physiological part is concerned it does the sensory feedback exceed physiological threshold. So, as well as psychologically application of grouping principles to design a face plates, panel and graphic displays information load compatibility with user expectation.

So, another kind of interaction is machine to the environment. So, machine may alter working environment by emitting noise, heat and noxious gas also. So, it is evaluation is like mainly by industrial site engineers, industrial hygienist. And another kind of interaction is environment to the human. The environment in turn may influence the human ability to interact with the machine or to remain part of the work system. So, in an environment, if temperature is exceeding certain limit, so human can also not survive up to beyond a certain limit, so that also we will discuss in the thermo regulation part in the physical ergonomics when we are going to discuss about physical ergonomics.

So, as far as there is a certain decibel label which a human ear can sustain, so that limit we will also discuss and noise lighting and temperatures are we have the entire facilities. So, another kind of interaction is environmental to the machine. So, environment may affect the functioning of the machine, it may cause over heating or freezing of components. So, as an example many machines require oxygen to operate. Oxygen is usually regarded as unlimited and freely available rather than part of the fuel. So, these are all about the interactions and we will slowly go into the detail of each and every interaction whether it be human to machine, or it be a effect of machine to the human or to the environment also as well.

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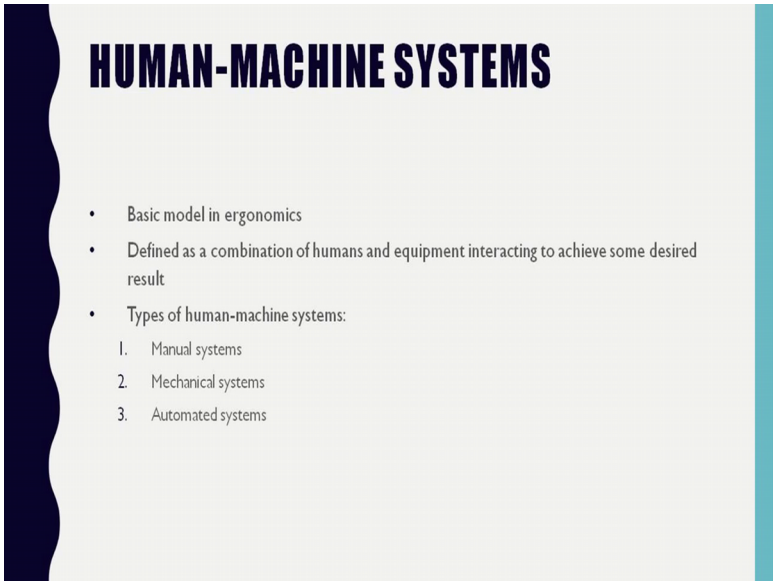

So, now we will discuss about the further about the human machine system. So, in that we will also discuss about the type of human machine systems, so the basic model in

ergonomics. So, the human machine system is the basic model in ergonomics in which the human machine system defined as the combination of human and equipment interacting to achieve some desired result. So, number of human can range from one to many and the types as well and amount of equipment can range from single handed tool to complex and sophisticated equipments or sophisticated collection of machines.

So, as an example we can take any product manufacturing in which the human is a operator and he is handling from easier to complex equipments. So, basically it is defined that human machine systems are defined as a combination of human and equipment interacting to achieve some desired result. So, there are basically three types of human machine systems, first is manual systems, second is mechanical system and third is automated system. So, in that context, we can elaborate in a in a bit detail like manual system, so that system involves a person using some hand tools or other non powered implement to perform an activity.

So, as an example we can take a farmer a work, who is using a pitchfork to load hay into a vehicle. As far as mechanical system is concerned, so that system refers to one or more humans using powered equipment to accomplish some job. So, the typical case is that equipment provides the mechanical power to the job. And as an example we can take the when a farmer is driving a tractor to harvest a crop. As far as automated system is concerned, so this system involves the performance of a job with minimum of human attention. So, the automated systems do require occasional human attention. So, if the like that is itself as a part of nowadays this automated system, so most of the human as far as human discovery is concerned, the research is going on to make each and everything bit automated. So, you can find a lot of automated systems in your surrounding as well.

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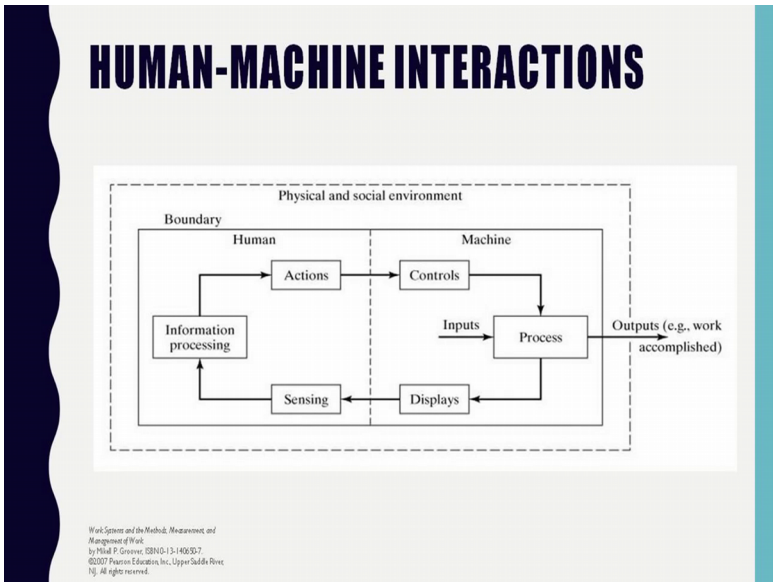

So, a key features of a human machine system is that interaction occur between the human and machine which is depicted in now this slide. So, here this figure is showing the block diagram model of the interaction in human-machine system. So, this particular human-machine system that you are seeing in this slide is having some boundary. So, that boundary which define that what components are included within the scope of this system for the purpose of analysis and design. So, as you can see from this figure that that is contain as a human and the machine. So, since human performs actions to control machine operations for processing and it goes for display, so there are some issues that need to resolve in order to optimize the different system interactions issues.

So, here as you can see from this like the action of the human to the control to the machine to the process and that again it goes to the display and the sensing and then information processing. So, as an ergonomist, if you can be participative in or in if you want to contribute in order to enhance the particular system, so you have to take care of several design issues. So, those design issues may be the location of displays, effects of lighting, noise level, vibration level, effects on the perception and cognition that is coming in the category of information processing. And issue regarding workspace envelop, skill levels, training, how much fatigue a person a particular person in that particular system is facing, and as well as motivational factors also and many other factors. So, in a nutshell the issues regarding the work space that may contain the training of work force, fatigue which particular person is having while continuous task

performance and so on and so forth. So, these issues is the are the responsibility of an ergonomist to take care while interacting with the human-machine system.

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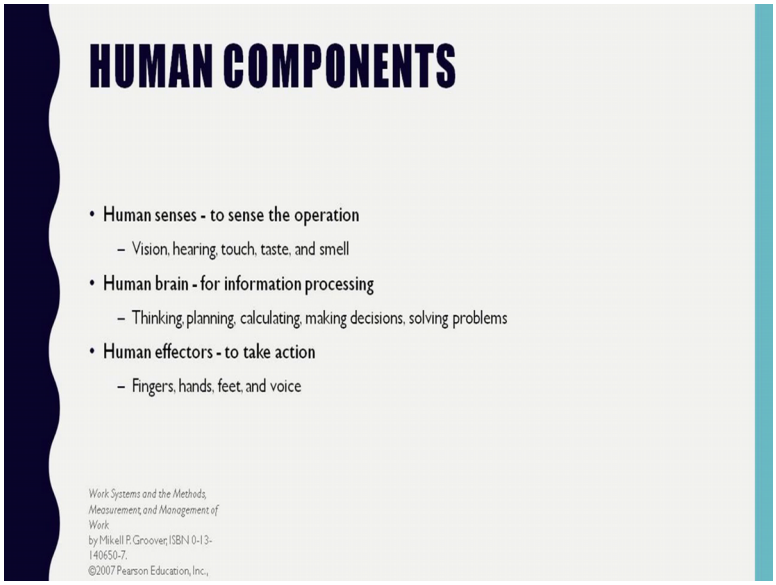

Now, we will go in the detail about this human-machine system. So, first we will take the human component. So, as suggested by the model of human-machine system in the previous figure, so human components of interest are those that perform basically three functions. The first is sensing the operation, second is information processing, and third is actions. So, these three I have pointed out in the slide itself that human sensors to sense the operation. So, human sensors are basically five, first is vision, hearing, touch, smell and taste. And as far as human brain is concerned which is responsible for human processing. So, in that the all the cognitive task or all the cognitive activities that is included in this information processing. So, thinking, planning, calculating, making-decisions and solving problems, so these are the activities which has been performed by the human brain and as far as for information processing.

Another thing that is in the human components is a human effectors it is just to take action. So, these are nothing, but your fingers, hand feet and voice as well. So, that effector is a body part which is having a muscles or group of muscles that actuates in response to some stimulus. So, the principle human factors in this are that I have mentioned before like in the slide itself the fingers, hands, feet and voice. Basically these

human effectors are supported by a muscular skeletal system of the body and the stimulus is provided by information processing occurring in the human brain.

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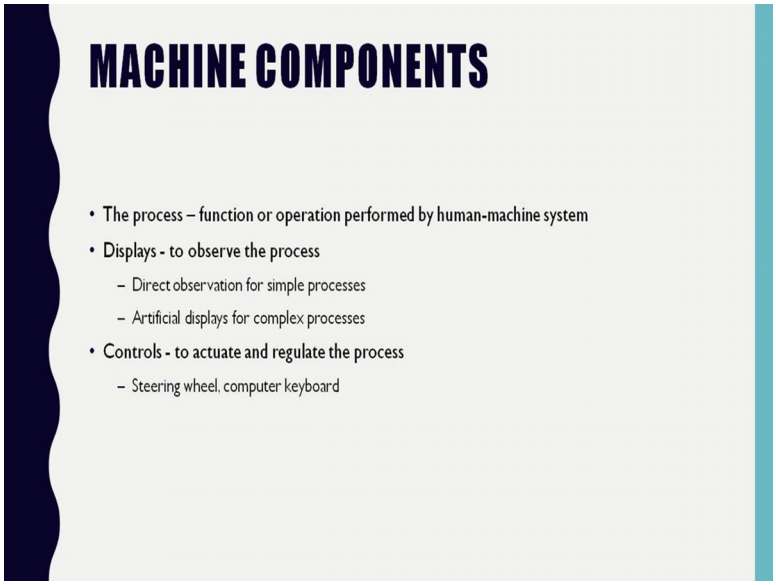

Now, as far as another thing is concerned that is machine component. So, as I have mentioned in the previous sentences that in the human-machine system can range from simple hand tool to sophisticated equipments. So, the typical model in ergonomics is one in which the interaction between human and machines are directly coupled. So, there are following common examples like a person which is driving a car. So, the driver continuously steers the car using steering wheel and control its speed using the throttle paddle and that car provides feedback such as speed, engine, rpm and direction as well. So, the connection between the car and driver are tangible as the car moves down the road.

Another example we can take as a interaction as the typical model of a machine components and in the human machine system. As like if a student is writing a writing an exam or in paper on his personal computer, so the student types in the text using like alpha numerical keyboard and the computer responds by displaying the text on the monitor and identifying spelling and a grammatical errors that has been done where by the student himself. So, that the involvement of the machine is here and the contribution of human and machine is directly coupled. So, the coupling is less direct and the interaction are less tangible in some of the cases also. Like a researcher, if he is using

internet in order to search for his article on any topic of interest, so the researcher interest keyword about the topic and search engine looks on the internet to find websites that provide links with the keywords. The search engine is guided by its own software independent of any further input from the researcher. So, as far as this machine component description is concerned, so the process displays and controls. So, now, the things are clear here.

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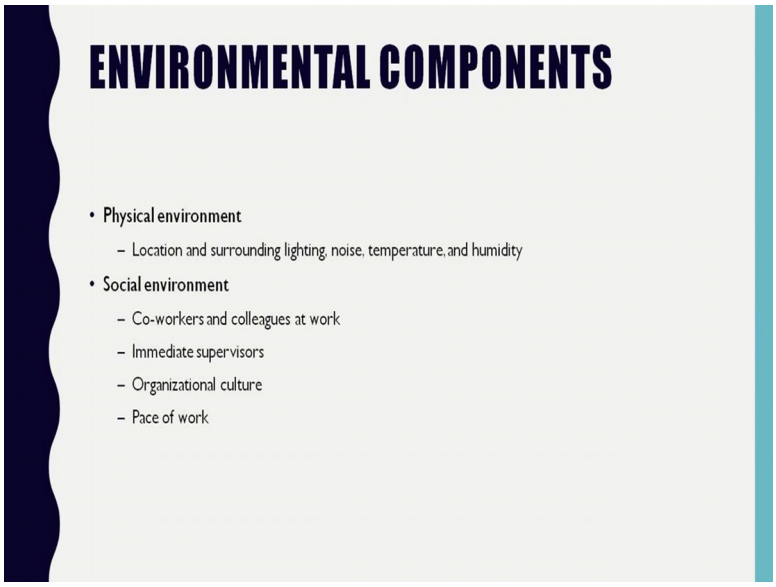

Now, we go to the environmental component. So, the environmental component, we can discretized into physical environment and social environment. So, in that physical environment which includes the immediate area of the human-machine system separated from the system by a defined boundary in the previous figure. So, the component of the physical environment usually include the location and surroundings like a lighting and noise, temperature and humidity. These environmental factors can affect the performance of a human machine system and or of interest to the ergonomist. So, for example, the work space of a fighter aircraft is its cockpit which imposes several limitations on the freedom of the movement of the pilot. So, the man control of the aircraft must be located within easy reach of the pilot.

So, as far as social environment is concerned, so your coworkers and colleagues at work, so that is also a important immediate supervisors organizational culture and pace of the

work, so that all the things that are in your surrounding positively or adversely affect your work system.

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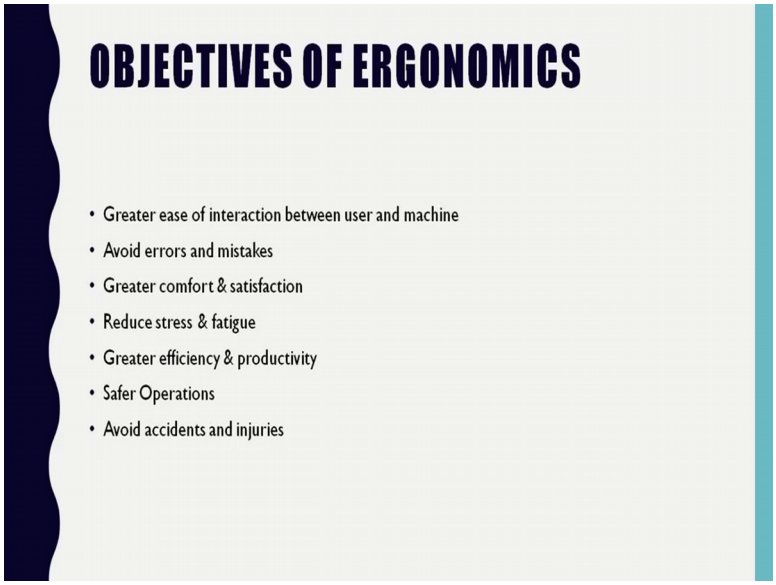

So, as far as overall objective of the ergonomics is concerned, so again I am repeating those points although I have covered in the previous slides like it is just for giving you greater ease of interaction between user and machine. It is also there to avoid errors and mistakes. It is also for providing data comfort and satisfaction. It is also to reduce stress and fatigue. And the objective of ergonomics is also to improve the efficiency and productivity. So, the objective of ergonomics is also to have say for operation in any job profile and as well as to avoid accidents and injuries. So, this is all about human, machine and environment components and its relation to the ergonomics and this was all about the human-machine system.

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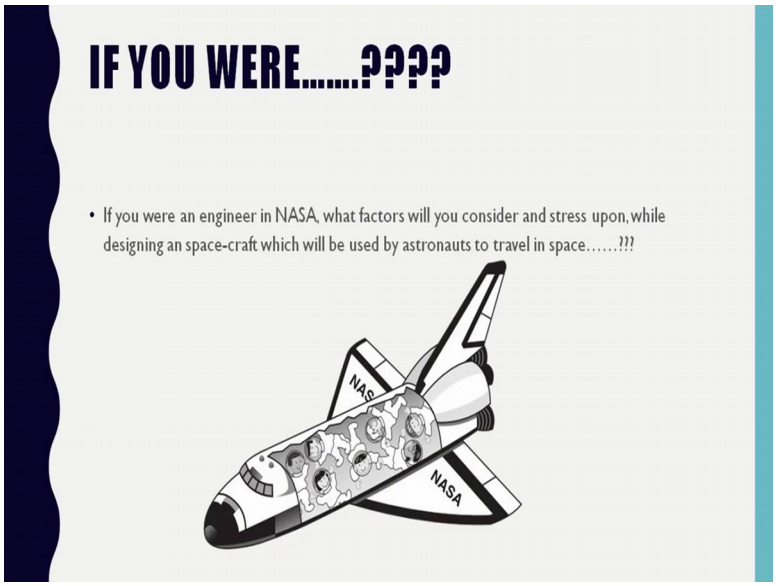

And now before closing this particular lecture just have a additional thing to enhance your curiosity towards this course such that if you were an engineer in NASA what factors will you consider and stress upon while designing an spacecraft which will be used by astronauts to travel in space.

Thank you very much, and please read human machine system from recommended reference books for a better understanding of next lecture.

Thank you very much.