Applied Ergonomics
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Lecture – 01

Hello, and welcome you to this course Applied Ergonomics. My name is Ankur Gupta, and I am faculty in the school of Mechanical Sciences at Indian Institute of Technology Bhubaneshwar. I and Doctor Shantanu Bhattacharya who is professor in the department of mechanical engineering, Indian Institute of Technology Kanpur will cover this course. This is the first lecture out of approximate 30 lectures decided for this course. I have collected the matter for teaching this course from various sources such as books, papers, internet search so on so forth. In order to make this whole matter easier to understand for all students irrespective of kind of disciplines of engineering and related streams. So, we have added facts, figures, graffiti, daily life examples, and try to present the matter in lovely manner. So, I hope you will like this course.

So, before introducing the whole syllabus which we are going to cover in this course, let us start with taking a most common example. Suppose you have been given an assignment to design a chair.

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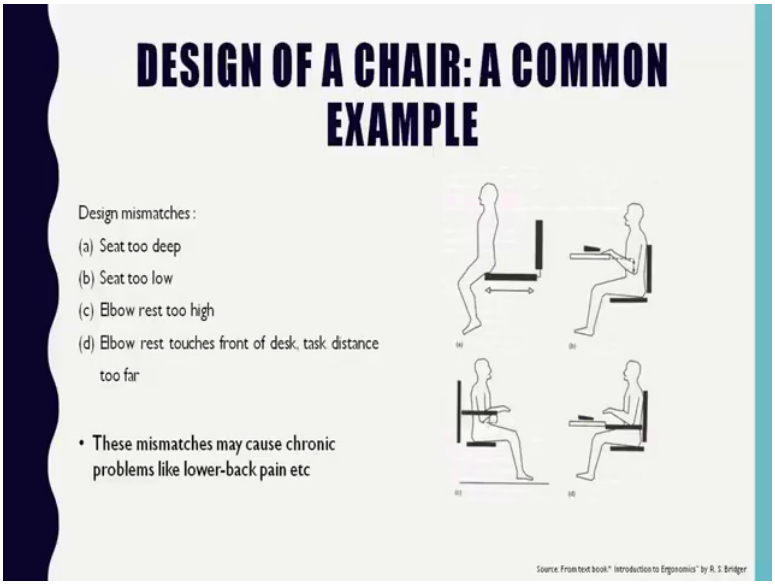

So, what will be your approach? What are the factors that you will be considering in order to design a chair. So, as you can see from this figure that has been put for better visualization of this designing a chair.

So, what will happen if the seat becomes too deep, what will happen if seat is too low and what difficulty will a user face when elbow rest is too high. So, as you can see. In fact, you can visualize all this situation in this figure shown. So, when seats are too high the feet can no longer be used to extend the base of support beyond the base of chair. So, these all sort of mismatches cause chronic problems like lower back pain etcetera. Let us have another example the figure. In fact, the picture that we are seeing here after designing a chair which is ergonomically perfect user sits and starts working for a prolong period of time.

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So, please see this picture in which a lady is sitting in chair doing her work, this is the most common situation where which everybody faces maintaining a wrong posture while working for continuous hours may lead to neck pain wrist pain and back pain. So, this is sort of musculoskeletal disorders, which may affect muscles tendons joints ligaments and nerves can be counted among the among the main reasons for sick leaves in industrialized countries.And in fact, there is a one of the most promising situation when people used to do work in in front of computer

So, those computer work stations are often at the top of one smile as an example, but also you can consider as a microscopic work stations carry the risk of staring the backs and next neck

of their users. So, for a prolong period of time if you are working in front of any machine let us say computer. So, that constant posture will give you a lot of disorders. In fact, this musculoskeletal disorder is one of the famous disorder now it is. So, this anthropometric mismatches it can have serious consequences for health and efficiency.

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In fact, I have put one more interesting picture that you can see from the slide that in which a son is asking to his father that; what is ergonomy. So, father replies that son it is making children tall enough not to have dads bend so much.

So, ergonomics is about taking care of user difficulties or in other words analyzing the factors responsible for decreasing the system performance and work on those aspects, thereby making system completely efficient. Now, after taking these examples we will start the about discussion about discussing the overview of this particular course ergonomics. So, now, we come to understand the definition of ergonomics. Ergonomics is basically composed of 2 Greek words. The first word is ergo which means work, and second word is nomos which means study or laws.

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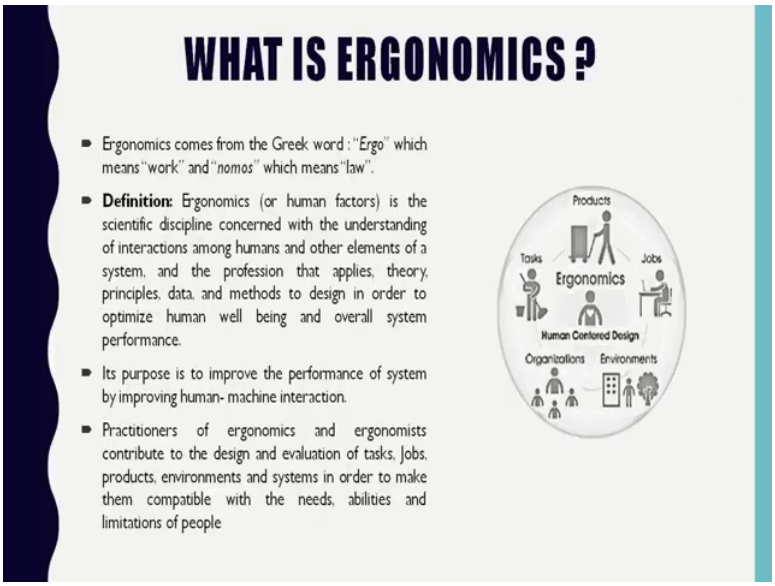

So, as a as a combination of these 2 words we can state the definition of ergonomics as study of the work. And as far as it is definition is concerned. So, it has the scientific discipline concerned with the understanding of interactions among humans and other elements of a system and the profession that applies theory principles data and methods to design in order to optimize human wellbeing and overall system performance.

So, overall it is purpose is to improve the system performance by improving the human machine and environment interaction. So, this basically the first time that ergonomic word was used by W Jastrzębowski in a polish newspaper which was in 1857 so in fact, in the US that particular ergonomics is understood as a human factors engineering. So, human factor engineering and human factors have been closed synonyms. European ergonomics has it is root in work physiology and biomechanics and work system design also.

So, human factors on the other hand originated from research in experimental psychology where the focus was on human performance and system. In fact, system design also so, but there are several other names such as engineering psychology and more recently cognitive engineering and cognitive system engineering. The later emphasizes the importance of human information processing for our size; so despite the difference between human factor and ergonomics in the type of knowledge and designed philosophy. So, basically the approaches these 2 approaches are coming closer.

So, as per the interaction of computers in the work space is going on increasing. So, basically to solve a problem that is related to computer work places and ergonomist must be able to identify. The problem analyze it and suggest the improvement in the form of a particular optimized designed solution. So, in a nutshell we can say that the primary purpose of human factors study and ergonomics is design. So, a ergonomics should be a good designer in order to have a solution to provide a solution in order to improve their performance of any system.

So, the course sciences from which ergonomics is drawn our psychology, anatomy, biomechanics some sort of physiology physics and physics mainly concerning with the mechanics and environmental physics. And obviously, engineering so, the practitioners of ergonomics an ergonomist contribute to the design and evaluation of task jobs products environment and system in order to make them compatible with the needs and ability and limitation of the people. So, overall this ergonomics is all about improving the system by involving themselves in the loopholes and the errors that has been caused previously in the system. So, it is all about improving the errors in the system and provided a efficient way of doing work.

So, as you can see from this circle this particular ergonomics is in the center and the product as well as product manufacturing is concerned, if you are performing any task, if you are in an organization and you are dealing with a team, if you are living in a in any kind of environment whether it is real or virtual or if you are sitting in a chair and performing your job. So, these all areas whether it be a product manufacturing task performance organization dealing environmental interaction and job ah doing job; so these all components belonging to ergonomics.

So, everywhere it is a need to improve the performance. So, where the system performance is coming into picture ergonomic is there.

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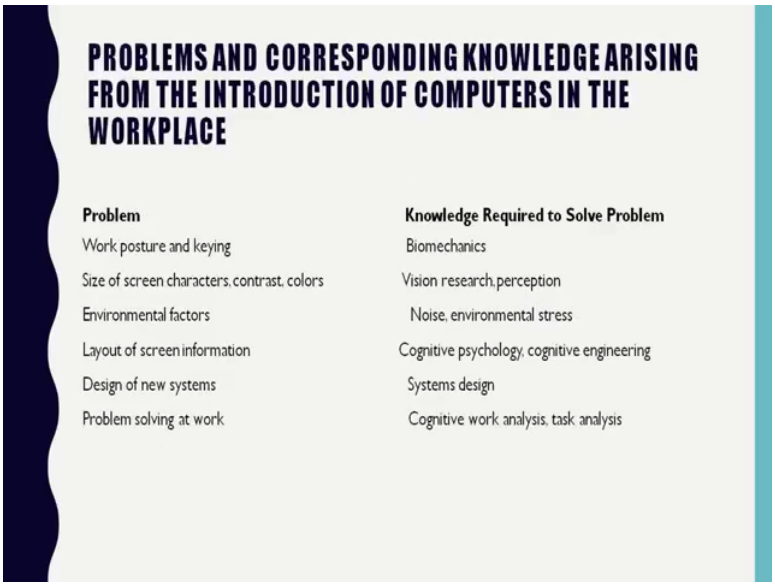

So, now we have to understand the problems and corresponding knowledge arising from the introduction of several work station let us say machine in the work place. So, we have lot of problems while working, whether we are sitting in a room or we are performing a job in any organization.

So, if we are facing a problem in a work posture, you have you should have a knowledge which is required to solve the problems lies in the area of biomechanics. If you are if you are tackling the problem with the size of the strewn characters contrast and colours. So, you have to gain knowledge in order to solve that particular problem. The knowledge is required of fusion research and perception, if you are facing troubles with environmental factors.

So, you have to have knowledge of noise and environmental stresses if you have dealing with the problem in designing a new system. So, you have to make yourself aware of the systems design, if you are dealing with any problem solving at work. So, you have should have a knowledge towards cognitive work analysis and task analysis; so all sorts of area which are related to problem solving; so as a term being provided. So, those areas like biomechanics, work physiology, cognitive engineering dealing with the physical work environment.

So, those areas as a whole if you want to give a particular name. So, that name will be ergonomics since these are in the applied area. So, the whole term that we can give as a as a substitute of all these areas is applied ergonomics. So, these are all the areas if you are sitting in front of computers or you are tackling any machine. So, analysis of human machine

interface requires inter disciplinary knowledge of all these areas such as biomechanics cognitive psychology system design methodology and as well as physical factors also.

So, now as far as implementation of ergonomic in system design is concerned. So, it should make the system work better by eliminating undesirable uncontrolled aspects such as fatigue inefficiency accidents or injuries or user difficulty.

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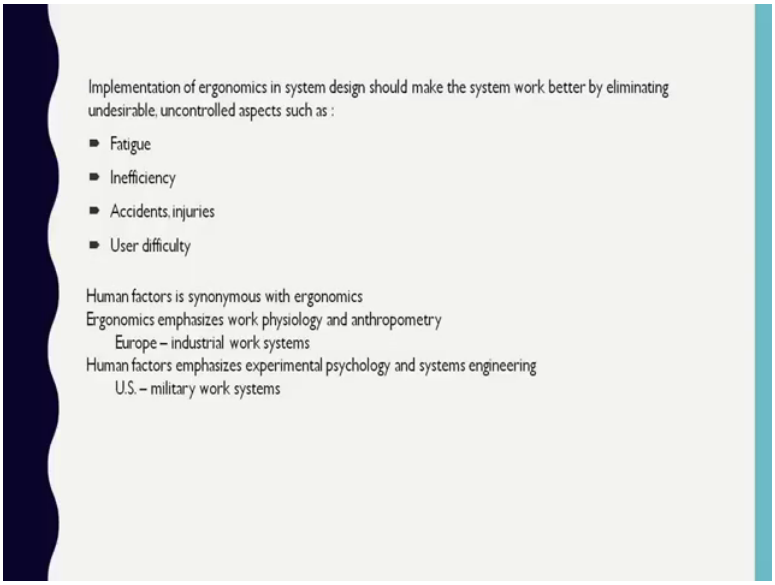

So, inter disciplinary knowledge is required in this ergonomic design for the following reasons the first kind of reason may be. In fact, this ah the following reasons like to formulate system goals to understand functional requirements to design a new system to analyze a system and to implement a system.

So, overall aim is to make the system better by eliminating undesirable uncontrolled aspects such as those have been listed down like if some work is if you are working for a prolong period of time and fatigue arises. So, you have to take care of those aspects and you have to provide the solution if you are inefficient; in fact, any of the aspect such as human machine or environment. So, if 3 s are leading to have inefficiency of the system. So, we need to take care of those aspects and in most in most of the cases most in industries accidents and injuries are also bit prominent.

So, we have to eliminate those factors in order to avoid accidents and injuries and we have to also take care of user difficultiesso in fact, these human factors we have to study and this is

synonymous with ergonomics. So, in Europe that particular term is known as human factors engineering and as far as this US terminology is concerned the word is ergonomics. So, the study the topics are which have been covered are more or less same, but the names are different.

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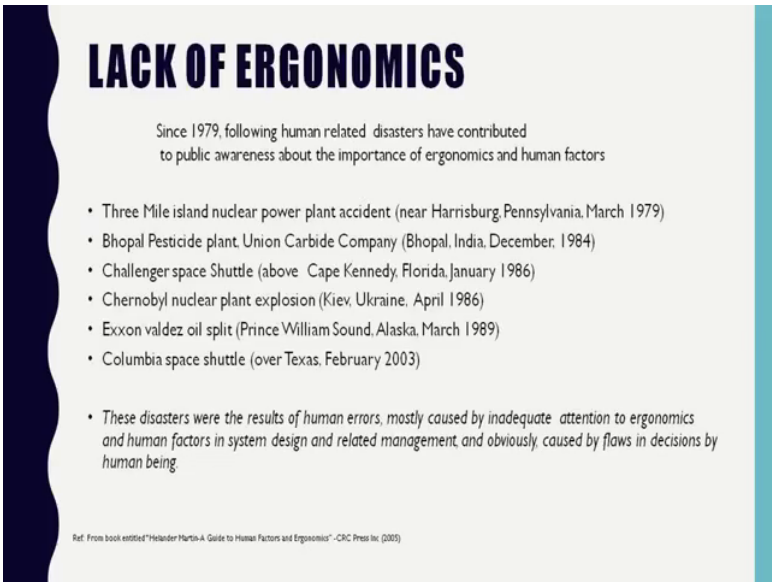

So, since we are we are trying to understand this ergonomics. So, the reason we have to make it more clear that why we are focusing towards system performance and various areas deliberately. We are putting into study these diversified topics which as a which in a combination is making particular course. So, since like in 1979 the various human related disasters have contributed to public awareness about the importance of ergonomics and human factors.

So, there are various kinds of disasters that have happened. Because of the human errors and that is why the focus of human being is now is to is to find out those factors and provide a possible solutions so that that human error can be minimized. So, there are various accidents which I have listed down. So, a 3 mile island nuclear power plant accident which has happened in 1979 near Harrisburg Pennsylvania. There is another kind of human related disaster which is bopal pesticide plant union carbide company which has happened in 1984. Challenger space shuttle in 1986 above (Refer Time: 16:32) Florida and other kind of explosion have happened in Chernobyl nuclear power plant, nuclear plant explosion, Exxon

Valdez oil split this has happened in 1989, prince William Sound Alaska and in 2003, the disaster has happened the Colombia space shuttle.

So, these all disasters were the results of human errors mostly caused by inadequate attention to ergonomics and human factors in system design and related management, and obviously caused by flaws in decision by human beingso in fact, if we go in the history. So, the human factors immersed as a discipline after world war second. So, in US many problems were encountered in the sue of sophisticated equipment's such as air planes radar and sonar stations and tanks as well.

So, sometimes these problems caused human errors with grave consequences. For example, during the Korean war more pilots were killed during the training than in actual war activities. So, this surprising finding led to a review of the design of airplanes as well as procedures and strategies in operation. So, several issues related to the design or ergonomics were brought up like how can information be better displayed. So, that pilots can quickly understand what the situation is and as far as this these disasters are concerned.

So, how can controls be integrated with the task that they were intuitive and easier to handle. So, these all research have emphasized the human emphasized the study towards human factors involvements. So, much research was done in human factors engineering to support new designs. And in fact, there are several government agencies also which have sponsored research on civilian applications of human factors engineering. So in fact, in the US there are many examples like the federal highway administration which is for the design of highways and road signs NASA for human capabilities and limitations in space.

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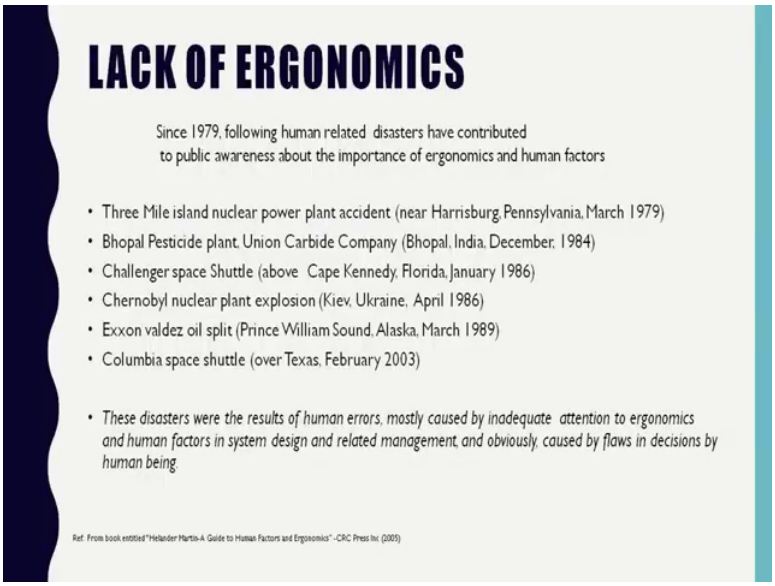

And another agency is that the national highway traffic safety administration which is taking care of design of cars including crash worthiness and effects of drugs and alcohol on driving.

So, these are all the factors which are related to the human activities as well as those human those related to the interaction between human and machine. So, based on that there are some flaws which has been occurred and which has been converted to several disasters and accidents as well. So, this is just because of the inadequate attention to the ergonomically factors as well as human factors in designing as well as the response which we have given and that particular required type.

So, that all sorts of things which includes the human decision incapabilities as well as inadequate information that has been provided to run the system; so these systems as a whole and in fact, the study of those information's adequate information and decision making those comes in the study of this particular course ergonomics. So, these are the disaster that I have listed down, which will give you an insight that if the proper attention or proper system design is not performed.

So, what can what maximum can happen? So, it may lead to heavier disasters in terms of accidents and injuries ah which is which is very unfortunate and these in fact, disasters that I have listed down have taken many lives. So, such a important that is why the study of ergonomics is important, because in worst cases it may lead to heavier damages.

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So, now, we come to the course outline where I will list down the topics that we are going to cover in whole syllabus of applied ergonomics.

So, first is introduction and human machine system. Then we will proceed to physical ergonomics. Then we will discuss cognitive ergonomics some of the biomechanics part which is directly related to the study of the stresses and forces causing damage to a certain part of the body. We will also discuss of the physical work environment because this work environment is very much necessary to study and to know. So, the awareness of the environment where we are working is at most important.

Some of the tools and techniques which is which has been explored. So, far in the regime of this applied ergonomics so that we will discuss and some of the research methodologies that has been utilized in order to perform research in ergonomics area. And lastly we will discuss some occupational safety and health. So, these in a nutshell we will be covering these topics in this particular applied ergonomics course. So, that was the slight introduction of this course. Now we will go towards overview of ergonomic course in which we will initiate with the brief history of ergonomics.

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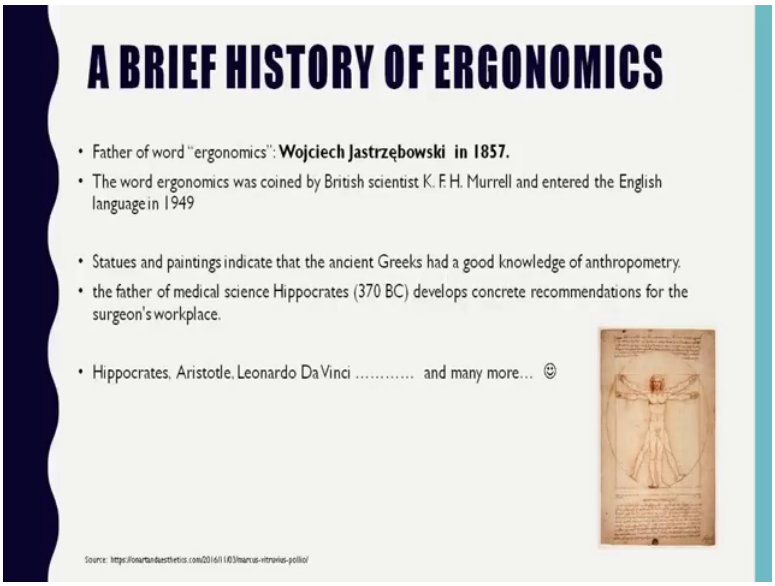

So, it has been quoted in Vedas that a disease in human being is caused by misuse of the body. And problem is usually 3 fold involving body mind and the spirit out of the harmony with the existing environment. So, almost every introductory lecture or a chapter in ergonomics explains that word ergonomic comes from word ergon and nomos which means work study or some sort of physical laws also. So, technology was also well developed in ancient Greece, it means because this particular ergonomic word has been originated from Greek dictionary.

So, although not many text are available about the technological knowledge of the time, but the archeological findings of objects of everyday use which maybe tools buildings ships statues or even automatic mechanism constitute valuable signs of high technological level achieved at in fact, achieved by ancient Greeks. So, there is a strong evidence that ancient Greeks design was human centered. So, but the credit goes to the Wojciech Jastrzębowski in 1857 which most of the book have referred as a father of word ergonomics.

So, the word ergonomics was coined by British scientist K F H Murrell and entered the English language in 1949. So, the statues and paintings indicate that ancient Greeks had a good knowledge of anthropometry. We will discuss in detail; what is anthropometrys all about and in fact, we have some separate topic to discuss about this anthropometry. So, so there are various researchers and researchers basically have contributed directly or indirectly towards this ergonomics.

So, one of the hypocrites who was father of medical science developed concrete a recommendation for surgeons work place. So in fact, the great hypocrites suggest that a surgeon may be either standing or sitting depending on the types of operation, but he always has to adopt the most comfortable posture. So, having describing these postures hypocrites determine the relative position of the surgeons the patient and the source of light both natural and artificial light; in order to facilitate the operation and avoid glare.

So, in some text he also suggested about the tools that tools have to be placed near to the operating hand of the surgeon, but at the same time they must not hinder the movement of surgeon. So, hypocrites also suggest that surgical tools should have such a shape size weight and construction; sdo as to promote ease of use. So, these all things that has that has been already been done in 370 b c and we are in fact, the following the same protocol and strategies that have been provided with our ancient researchers.

So, this properly in fact although the word ergonomic has come in this century, but the work has already been done by our ancient researchers. So, the list is big, so hypocrites Aristotle Leonardo da Vinci and many more. So, we all know we all are aware of the Leonardo da Vinci work. So, in which he has worked a lot and documented his findings on the anthropometry.

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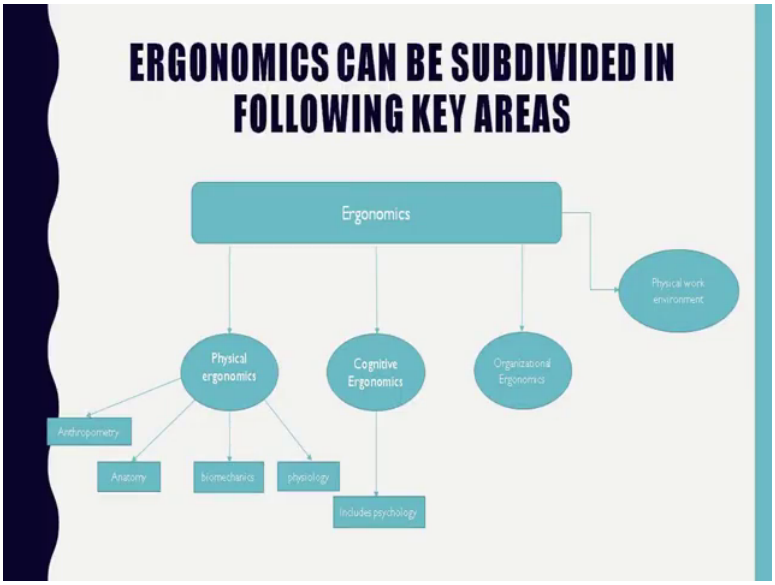

So, that was history that was a brief history. In fact, and so we are there are various key areas which as a as a sub division of ergonomic course. So, the ergonomics can be sub divided in

several key areas. So, it will be anthropometry, in which anthropometry is again a Greek word which consist of basically 2 Greek words anthropo and metron. So, it means measurement of man and women.

Ah we will be describing detail the anthropometric analysis also in human oriented design, topic physical ergonomics cognitive ergonomics organizational ergonomics and physical work environment. So, these are the following key areas which we will discuss in detail in later slides. So, this physical ergonomics basically also covers subtopics such as anatomy biomechanics physiology and it also includes some sort of psychology.

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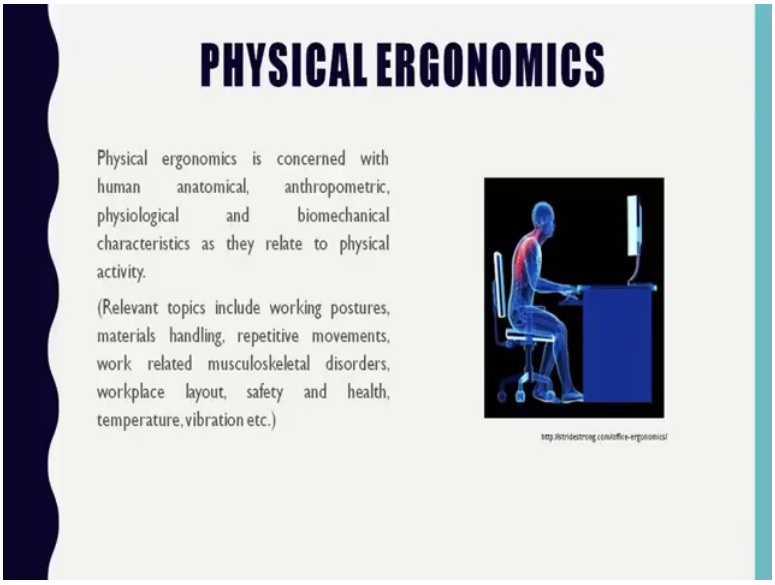

So, in a nutshell we will go to understand those sub topics. So, first we will try to understand; what is this physical ergonomics. So, this physical ergonomics is concerned with the human anatomical, anthropometric, physiological and biomechanical characteristics as they relate to physical activities. So, in a generalized sense, if you perform any work any work which is of which is related to putting physical efforts; so what are the effects what are the effects of that particular work on your body.

So, study of these effects on your body and it is positive and negative effects when we do study that study comes in the physical ergonomics. So, the relevant topics may include working postures. So, all of us work in a certain posture and, but if that posture if we are maintaining for a prolonged period of time. So, it may lead to some sort of disorders and diseases other physical efforts may include material handling repetitive moments work

related musculoskeletal disorders, work place layout safety and health and related to temperature and vibration also.

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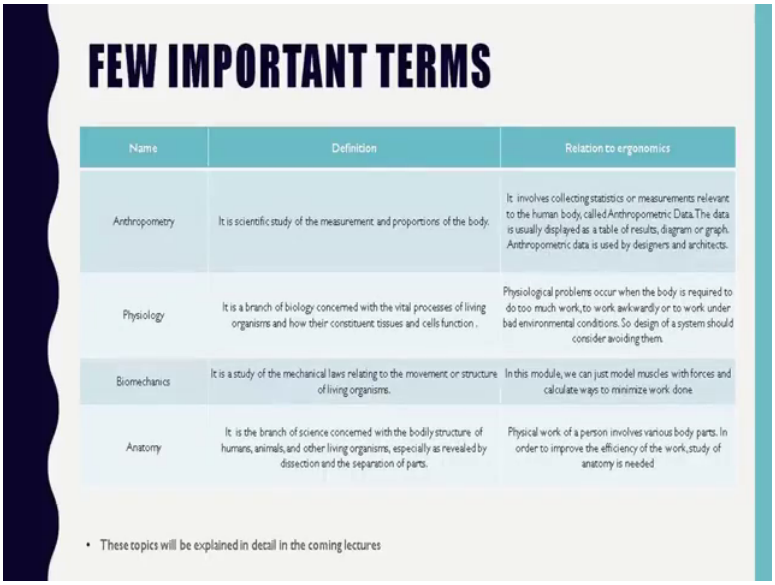

So, these all sort of physical efforts and related study comes in this physical ergonomics. So, there are basically few important terms which in a, in a general comes in this physical ergonomics. So, these are the anthropometry physiology biomechanics and anatomy. So, anthropometry is as a definition wise if we have to give a one statement. So, we will describe as a scientific study of the measurement and proportion of the human body and it is what is it is relation to ergonomics.

So, it involves collecting statistics or measurements relevant to the human body which we call as a anthropometric data. So, this data is usually displayed as a table of results diagram or graph. So, this anthropometric data is usually very important for designers and architects another terminology is physiology. So, as a definition wise we can state that it is a branch of biology that is concerned with vital processes of living organisms, and how their constituents tissues and cells function.

So, again the relation to the ergonomics is like those physiological problems occur when the body is required to do too much work. So, if we are involved in some continuous hour of working. So, and in fact, we are not maintaining the proper postureso in fact, we can say that we are working awkwardly or working under bad environmental conditions so that

physiological problems mostly occur. So, the design of a system should be considering to avoid those problems the next important term is biomechanics.

So, biomechanics is nothing, but a study of mechanical laws, which is relating to the movement or structure of various parts of the body. So, it is it is relation to ergonomics is we have we can just model muscles with forces and calculate phase to minimize work done. Another important term is anatomy. So, in anatomy we study the various body parts body structure of human being in fact and other living organisms also especially as revealed by dissection and separation of the parts. So, in order to improve the efficiency of the work this study of anatomy is needed. So, these topics will be explained in details in in coming lectures.

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So, like what is ergonomics and what are the sub topics that could be possibly covering in this particular course. So, another question arises here as why we are going to study this physical ergonomics. So, in industries or in any manual work let us say if you can see this example or in fact this figure. So, a last number of occupations require workers to expand a physical energy to perform their job.

So, manual labour is primary work activity in industries such as constructions agriculture mining and lot of manufacturing activities and other logistic activities are there. So, these work situations include a significant amount of physical work, which may include lifting carrying load from one place to another other manual handling task which include a sufficient significant amount of lifting carrying. And other manual handling task involving tools parts packages materials and containers. So, all those work which involves manual labour.

So, after continuous and repetition of that work that stress appears and that leads to some sort of disorders; so that is why the study of this particular physical ergonomics is very much important in order to have a survival of workers in an industry. So, another topic is that we are going to cover a cognitive ergonomics.

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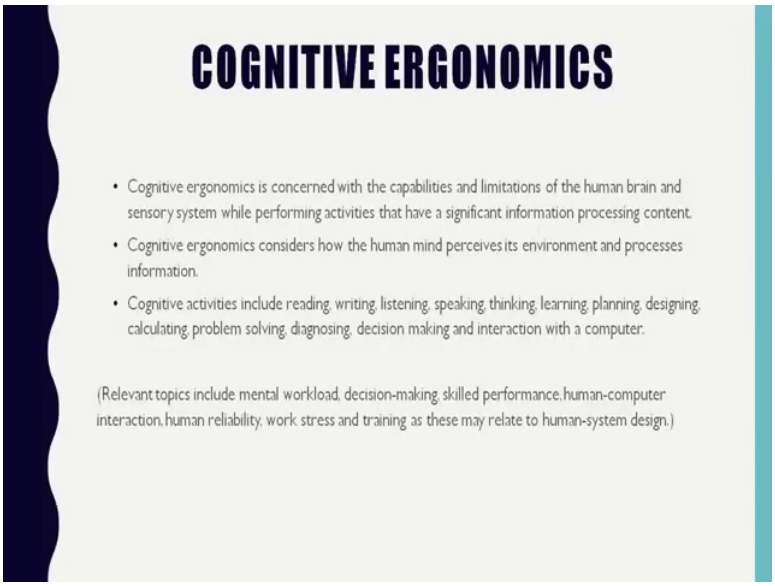

So, a cognitive ergonomics is the way we can understand. So, in a general those cognitive activities are when you read something when you write when you listen something when you speak when you think when you learn something. In fact, when you design something or when you calculate something.

So, those all the activities which takes assistance of brain that is coming in the cognitive activities. And the study related to this is known as cognitive ergonomics. So, cognitive ergonomics is concerned with the capabilities and limitations of the human brain. And we also do study of sensory system which is directly contributing to perform any activity and that is deciding your course of action. So, all sort in that cognitive ergonomics we will covering information processing model as well as the description of various parts of the human sensory system.

This cognitive ergonomics considers the how the human mind perceives it is environment and process information. So, the relevant topics which we will consider for discussion are mental work load decision making skilled performance human computer interaction human reliability work stress and training as you may relate to human systems design. So, all sorts of activities which are done with the help of brain comes in, this cognitive activities and we try to explore this in a much explicit way.

So, nowadays cognitive ergonomics is becoming much more important, in fact than physical ergonomics because the environment of doing work is the shifting towards the utilization of

brain, rather than seeking for manual efforts. So, because of the several trends in industries and technology this cognitive ergonomics is becoming increasingly important has become increasingly important relative to the physical ergonomics. As well as we are shifting towards mechanization and automation in physical task which requires workers to monitor uncontrolled processes that were previously performed manually.

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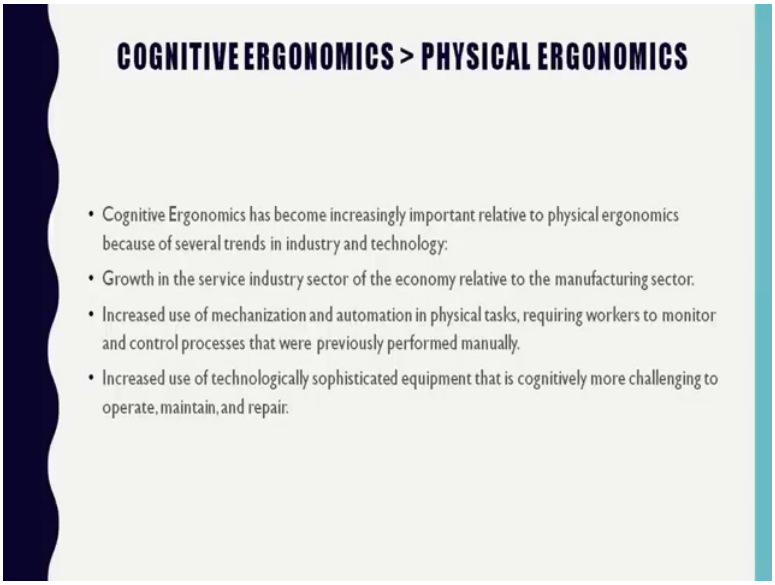

So, as well as increased use of technologically sophisticated equipment that is cognitively more challenging to operate maintain and repair. So, why the reason, why which is giving more important towards the study of cognitive ergonomics are these? Another topic that we are going to cover as a organizational ergonomics.

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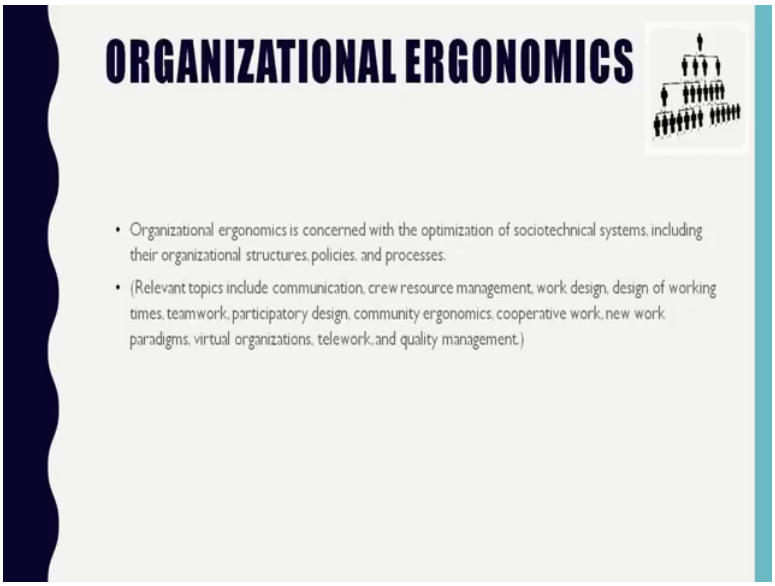

So, what this organizational ergonomics is all about it is concerned with the operation of socio technical systems including their organizational structures policies and process.

So, the relevant topics in this organizational ergonomics are communication the crew resource management, work design, design of working times, team work, participatory design, community ergonomics, cooperative work, new work paradigms, virtual ergonomics, virtual organization sorry and telework and quality management. So, these all the topics that in fact the all the sort of activities that are being performed in an organization and that are directly or indirectly affecting the performance of that particular organization comes in this organizational ergonomics.

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The next topic that we will be covering as a physical work environment; so the study related to physical work environment why this physical work environment study is necessary because whether work is a physical or it is related to any mental work. So, it is performed in certain kind of environment by making the physical components of the work as comfortable and distracting as possible. So, better job satisfaction and greater productivity are encouraged. So in fact, this environment is playing a very important role in this system performance. So, in that work environment we will. In fact, we have discretized that work environment into 3 aspects first is visual environment second is auditory environment third is climate control.

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So, in that visual environment, we will discuss about the physics of the light. We will also discuss about the visual performance visual activity and other sorts of defects also we will be discussing the lighting system, what could be the proper lighting a particular environment should have in order to a better working environment as well as auditory environment is concerned. So, we have to take care of the noise level and; obviously, that is permissible noise and we have to take care of noise control activities. So, that we will discuss in detail what are the factors responsible for this noise control and effects of the noise as well and we will also discuss thermo regulation, and what the effect of the heat stress and code stress over the human body and what is the reaction of that human body towards that reduced or higher temperature because ambient is very much necessary in order to have a in order to provide a best performance

So, another topic which we are dealing towards this course accomplishment is occupational safety and health. So, in that occupational safety occupational safety is concerned with the avoidance of industrial accidents.

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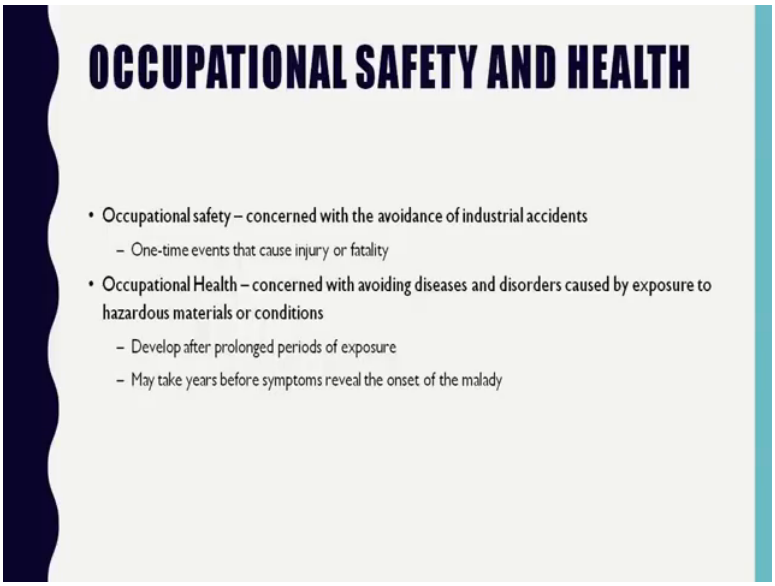

So, basically this occupational safety and health is a important national. In fact, global issue that affects virtually every person who works there are several federal agencies established to address these issues which are O S H A- OSHA (Refer Time: 41:40) form is Occupational Safety and Health Association and one kind of federal agency is NIOSH whose full from is National Institute for Occupational Safety and Health whose responsibility is to engage in research training and education in the area of occupational safety and health.

So, there are 2 aspects of this particular thing occupational safety and occupational health. So, occupational safety is related to the study which deals with the factors that avoids industrial accidents and like occupational health is also which is concerned with avoiding diseases and disorders caused by exposure to hazardous materials or conditions. So, these conditions most often develop after a prolong period of exposure, and it may take years before some terms reveal the on set of the melody.

So, and this occupational safety this is a one time event that cause injury or fatality. So, these issues need to be addressed because life is very much important.

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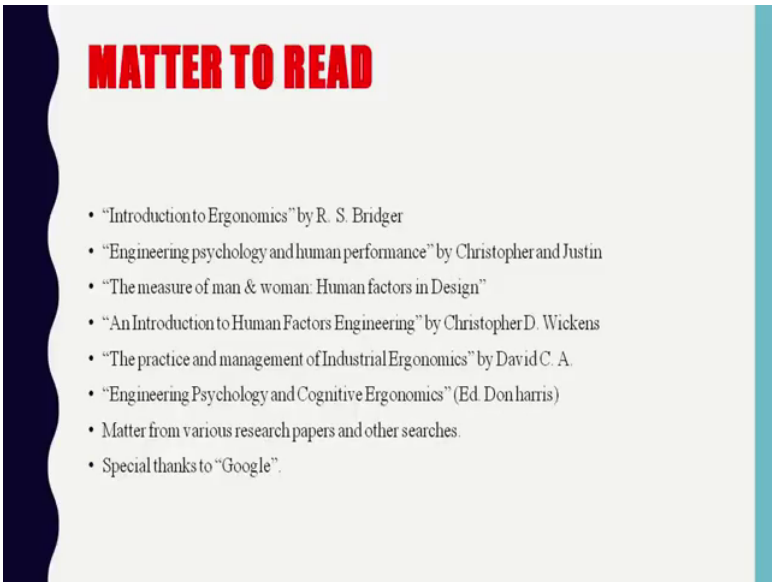

So, those were all about the brief description of the topics that we are going to cover in the next stage of this course as we are proceeding. So, the matter to read I have just listed down some of the books there are many books based on not exactly on the ergonomics, but the many books are available with some other names. Because this is a completely inter disciplinary subject. So, mostly the matter you will be getting in the form of engineering psychology human factors engineering measurement of human. In fact, measure of man and woman and cognitive ergonomics.

So, I have collected matter from various sources and I would like to special thanks to google that have given a lot of freedom for the matter to read and understand. So these are all the books which you can spend time in order to understand in a better way. This particular course and the topics affiliated.

So, with this I would like to finish this first lecture in which some introduction has been covered I hope the content discussed, so far have given you some idea about the particular word ergonomics. So, we will initiate with the description of various sub topics to be covered in this course as well as the human machine interaction in detail in next lectures.

Thank you.