

Ergonomics Workplace Analysis
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Lecture – 01
Introduction to Ergonomics Workplace assessment – I

I welcome you for the course of MOOCs named Ergonomics Workplace Analysis. I am from Indian Institute of Technology, Guwahati and I am Urmi, I will be the course coordinator for this course. So, as this particular course talks about various ergonomics workplace analysis, let us first explain what ergonomics is. Once you start finding definitions of ergonomics in various textbook, in various internet websites and various other sources you will get various definitions. There are n numbers of definitions available because, these definitions are given by various researchers, various organizations and various associations.

So, I will take you first to that definition which is being defined by International Ergonomics Association. This is the only association internationally accepted where all ergonomic bodies of small-small individual countries are involved. And, they have various specific domains of researchers who keep on updating this particular knowledge field. So, I will take you to this particular definition.

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International Ergonomics Association (2014)

Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theoretical principles, data and methods to design in order to **optimize** human well-being and overall system performance.

Definitions of Human Factors/Ergonomics

Practitioners of ergonomics and ergonomists contribute to the design and evaluation of tasks, jobs, products, environments and systems in order to make them compatible with the needs, abilities and limitations of people. Ergonomics helps harmonize things that interact with people in terms of people's needs, abilities and limitations.

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This particular definition is quoted in 2014. That is: ergonomics or human factors is a scientific discipline concerned with the understanding of interactions among human and other elements of the system, which is very important. And, the profession that applies theoretical principles, data and methods to design in order to optimize human well being and overall system performance which is a very important aspect whenever we are studying ergonomics.

So, being a practitioner of ergonomics there are other definitions as well. What other says? It says practitioners of ergonomics, an ergonomist contribute to the design and evaluation of task. Design and evaluation of task, which we are going to do in this particular course, job, products environments and system are done in order to make them compatible with the needs which is very important.

Next is the ability and limitation of the people because, ergonomics always talks about the human being and other working environment and the equipment or machineries whatever is available in that environment. So, we are talking about needs, abilities limitations of people. Ergonomics says that it helps to harmonize things that interact with people in terms of people's need, abilities and the limitation.

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Definitions of Human Factors/Ergonomics

International Standard Organization

Ergonomics produces and integrates knowledge from the human sciences to match jobs, systems, products and environments to the physical and mental abilities and limitations of people. In doing so it seeks to safeguard safety, health and well-being whilst optimising efficiency and performance.

Wilson (2000)

"we can see ergonomics as comprising elements of craft, science and engineering; it has aims to implement and evaluate (craft), to explain and predict (science) and to design for improved performance (engineering)."

We have some more definition: International Standard Organization, ISO, they also defined ergonomics. This goes like this: Ergonomics produces and integrates knowledge from the human science to match jobs, system, products and environment to the physical

and mental abilities and limitation of people. In doing so it seeks for safeguard, safety, health, well being while optimizing efficiency and performance. All these aspects of this particular definition also we are going to follow in this particular course. Wilson who is very famous in the field of ergonomics he also tried to define it in his own way.

What is he saying? We can see ergonomics as comprising elements of craft, science and engineering. It gives an indication that this particular course is all about interdisciplinary section. So, we are from various discipline and we can give input for this particular discipline. So, this is a very important aspect that it comprises all elements of craft, science and engineering. It has aims to implement and evaluate to explain and predict and to design for improved performance which is very critical aspect of this particular discipline.

So, when we are talking about ergonomics let us explain what are the varieties of domains available in this particular field. When we started practicing this particular field, it started with mainly physical ergonomics. So, what is it?

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The slide is titled "Classifications of Human Factors/Ergonomics" in a bold, black font. To the right of this title, there is a sub-section titled "Physical Ergonomics" in a red font. Below the sub-section title, there is a paragraph of text in a smaller black font. The text describes physical ergonomics as being concerned with human anatomical, anthropometric, physiological, and biomechanical characteristics as they relate to physical activity. It lists relevant topics such as working postures, materials handling, repetitive movements, work-related musculoskeletal disorders, workplace layout, safety, and health, citing (IEA 2019). Below this paragraph, there is another line of text listing factors like fit, clearance, reach, access, manual handling, workload, tolerance, health and safety, workplace layout, product and equipment design, display and control, environment, and tools. The slide has a light gray background.

Classifications of Human Factors/Ergonomics

Physical Ergonomics

Physical ergonomics is concerned with human anatomical, anthropometric, physiological and biomechanical characteristics as they relate to physical activity. (Relevant topics include working postures, materials handling, repetitive movements, work related musculoskeletal disorders, workplace layout, safety and health.) (IEA 2019)

Fit, clearance, reach, access, manual handling, workload, tolerance, health and safety, workplace layout, product and equipment design, display and control, environment, tools.

So, physical ergonomics is concerned with human anatomical, anthropometric, physiological and biomechanical characteristics as they are related to physical activity. Relevant topics for this particular physical ergonomics include posture, material handling, repetitive movement, work related musculoskeletal disorder. I think many of us are aware about all these terminology from workplace layout, safety and health. So,

this is being very specifically defined by IEA at the beginning of 2019. This particular domain talks about fit, clearance, reach, access, manual handling, workload, tolerance, health and safety, workplace layout, product and equipment, design display and control, environment tool etc.

So, here in this particular course we will be learning many of these when we are going to analyze the particular workplace. How are we going to take into consideration of these factors and then finally how are we going to evaluate them. The second component of ergonomics or one of the major domains of this particular field is cognitive ergonomics. When physical ergonomics exist in a particular workplace, cognitive ergonomics also exist in the same context.

Once we talk about physical ergonomics in the same environment or same workplace, cognitive ergonomics evaluation also exist; means we can also study cognitive part of this particular field. So, I will first tell what it is and then where we can apply and what the examples of cognitive ergonomics are. So, first let me explain what cognitive ergonomics is.

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Classifications of Human Factors/Ergonomics

Cognitive Ergonomics

Cognitive ergonomics is concerned with mental processes, such as perception, memory, reasoning, and motor response, as they affect interactions among humans and other elements of a system. (Relevant topics include mental workload, decision-making, skilled performance, human-computer interaction, human reliability, work stress and training as these may relate to human-system design.) (IEA 2019)

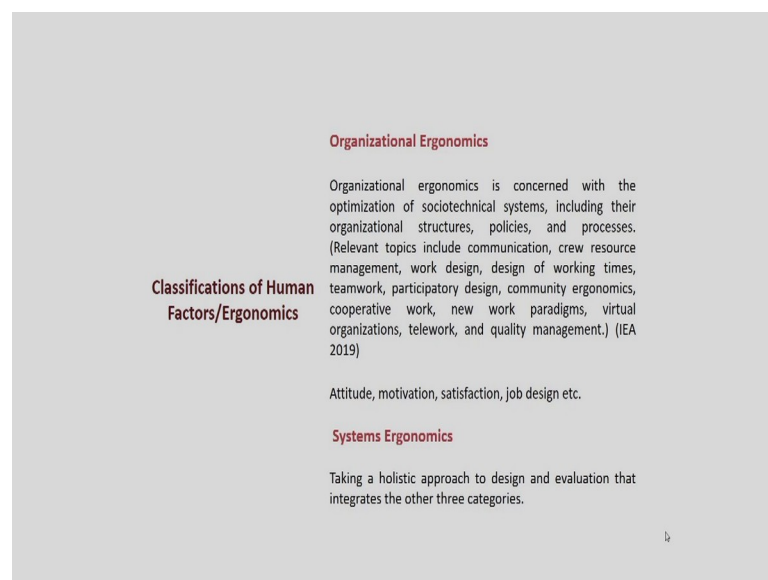
Information processing, sensing, perception, mental workload, problem solving, decision making, reaction, fatigue, stress, interface design, reliability, communication, fault analysis.

It says cognitive ergonomics is concerned with mental processes such as perception, memory, reasoning and motor response, as they effect interactions among human and other elements of the system. So, relevant topic for this particular domains include mental workload, decision making, skilled performance, human of computer interaction,

human reliability, work stress and training as these may be related to human system design. Again this particular definition of this field is given by IEA in 2019 in their website.

So, the topics or the field we can cover in this particular domain is information processing, sensing, perception, mental workload, problem solving, decision making, reaction time, fatigue, stress, interface design, reliability, communication and fault analysis and many other things. Few we will be covering and this is a very specific domain. The other one is not very specific as physical and cognitive and more of a combination when we are working. It is called organizational ergonomics.

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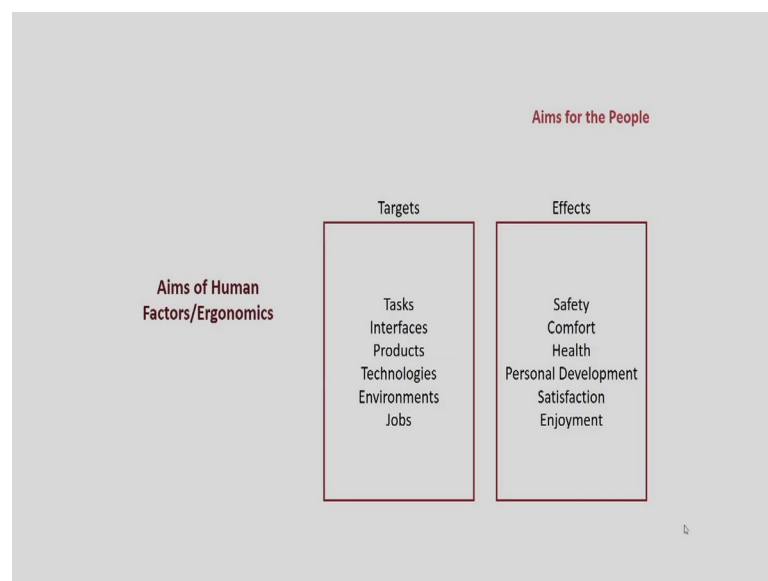
The definition, organizational ergonomics is concerned with the optimization of sociotechnical system. So, optimization- this particular terminology in the field of ergonomics is very essential. What is optimization? We may not reach maximum or we may not minimize the risk as many times it is not possible. So, always we need to do an optimization. When we are practicing, optimization is very important; which is implemented in this particular organizational ergonomics definition.

Organizational ergonomics is concerned with the optimization of sociotechnical system including their organizational structures, policies and processes. So, relevant topics which we will be covering in the organizational ergonomics includes communication, crew resource management, work design, design of working system, teamwork,

participatory design, community ergonomics, cooperative work, new work paradigm, virtual organization, telework and quality managements. During studying this particular domain we need to learn about attitude, motivation, satisfaction, job design etc.

Sometimes we define another particular domain but it does not have much clear demarcation which is called system ergonomics. It says taking a holistic approach to design and evaluation that integrates the other three categories like physical ergonomics, cognitive ergonomics and organizational ergonomics. So, when we form a particular ergo-system, which will be explained in next few slides, we are actually talking about the system ergonomics. Now, I will take you to the next slide or next part that is why we study ergonomics and what is the aim of ergonomics. Because, when we are talking about ergonomics workplace evaluation we are actually talking about why we need to do that particular evaluation. So, let us explain that aim of ergonomics.

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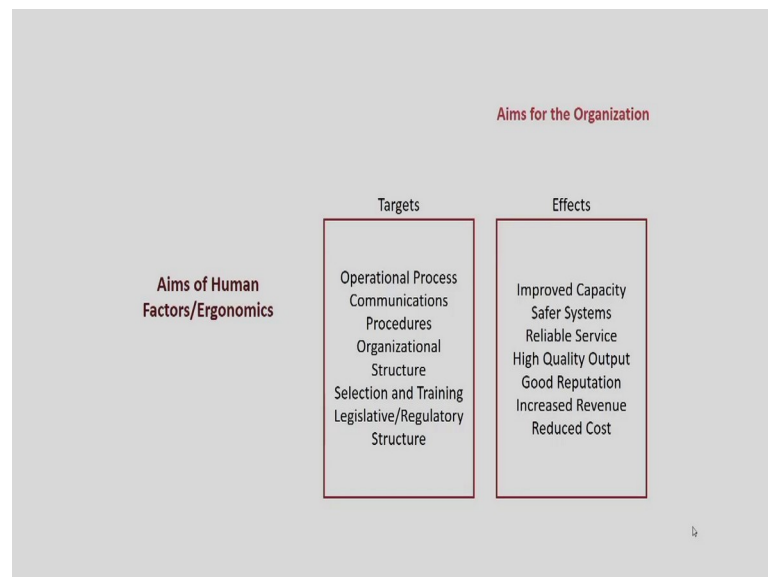


So, here I will take two separate set of terminology. So, first is target another is the effect of those thing on something. When we are talking about targets it includes task, interfaces, products, technology, job, environments, jobs etc. We will be designing it, we will be evaluating it, we will be modifying it, and we will be doing a lot of implementation over here. What will be the effect of it? The effect will be safety, comfort, health, personal development, satisfaction and of course, the enjoyment.

When we are talking about aim for particular people, when I am doing this particular evaluation or workplace analysis or any ergonomic implementation or ergonomic intervention, these things will be implemented for people. And, why are we practicing ergonomics? We are practicing ergonomic mainly to improve the whole system performance and reduce or minimize the human risk. The risk which people are getting from various systems, we are trying to minimize it. Also, as mentioned earlier, optimization is very important because when we are talking about implementation of ergonomics or intervention program of ergonomics it says that it requires a cost.

So, when we are doing all these varieties of exercises it is very important that we are optimizing it: optimization of human health, human comfort, human efficiency and the productivity or performance of the whole system. So, everything is in balance and we will be in a good position to promote that particular system. These are the effects for the people. Now, I will take you for the organization as well because people are where? People are at any organization. Organization does not mean that it is only on office or it is a it is a bank or something. Organization means where we are working, work can be anything that I will explain you in the next few slides.

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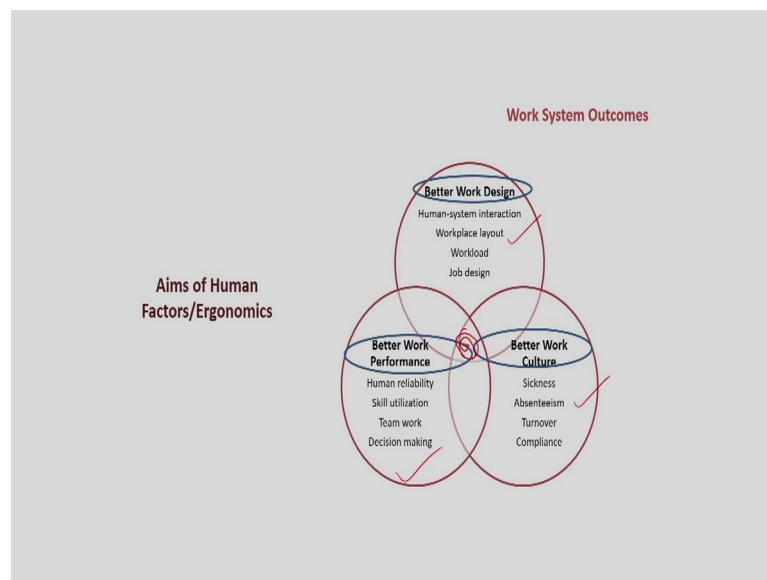


So, for organization when we are talking about ergonomics the targets are operational process, communication process, procedure, organizational structure, selection and training, legislative and regulatory structure. So, when we do the modification when we

do the analysis or we do the changes over here what are the effects? Effects are improved capacity, safer system, reliable service, high quality output, good reputation, increased revenue and very important aspect reduced cost because all of us are only doing or only working because of money.

Cost is a very important concept when we are talking about implementation of ergonomics in any kind of workplace. It may be at home, it may be at office, cost is very important. So, these are the aim when we are talking about the organization. Now, let me explain that how the whole work system actually interact and what are the outcome of it.

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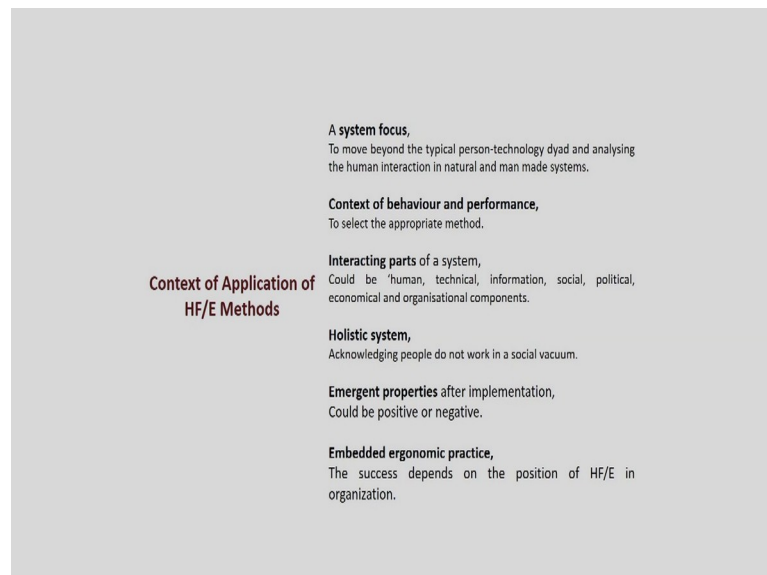
Here I am talking about better work design, better work culture and better work performance. How do you do that? Once we evaluate our workplace as far as ergonomics is concerned, we may improvise on the existing situation or existing scenario. So, if we want to improve or do a better work design, what are we going to do? Human system interaction, workplace layout, workload, job design etc. All these things we are going to study or we are going to learn in this particular course. Next is better work culture which is mainly in the field of organizational ergonomics. How do you analyse? We study sickness, absenteeism, turnover, compliances and many other things.

Also we have the better work performance because when a person performing then the whole system will perform. So, we are talking about human reliability, skill utilization,

teamwork, decision making etc. Now, these three factors interact so, if you find these particular domain; these particular domain says that all are interacting with each other and if we do something over here; here or here it may have a final effect in this particular zone, which is very important.

Now, when we are talking about ergonomics, different methodology, different strategy etc. it is very important to understand the context of application. First whoever is doing that particular research or study they need to understand what is the system focus, that is, what is the focus of that particular system.

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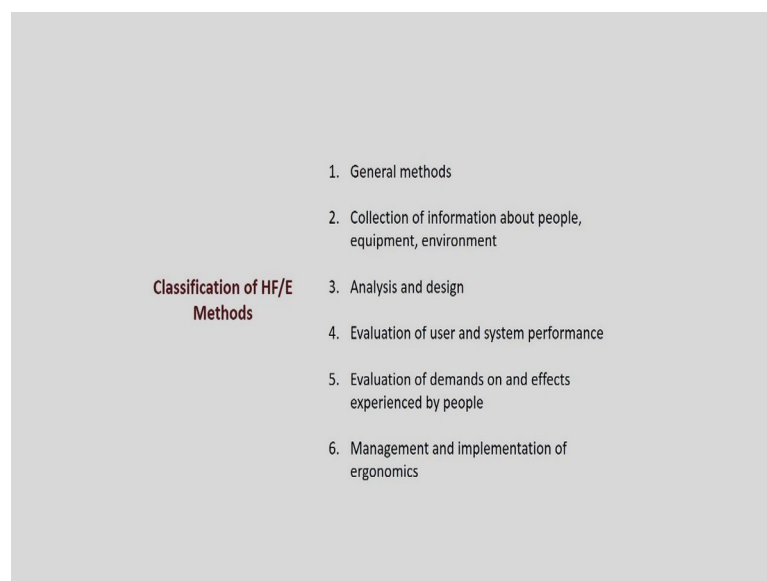
So, to move beyond the typical person technology dyad and analyzing the human interaction of natural and man-made system we need to understand what the focus of it is. So, once we understand that then we need to understand the context of behavior and performance, suppose a person is working in a particular office. So, if he or she likes that particular job or the way he is doing the job is relevant to that particular system, the performance maybe different. Or, if same setup, same kind of job if he is doing somewhere else where the context or requirement is little different the performance will be different.

So, before analyzing the whole system or ergonomic workplace analysis, we need to understand the context of that particular system. Once we understand the context then it will be very relevant for a person to implement or evaluate it. Third one what I would

like to mention over here is interacting parts of any system. So, it could be human, technical, information, social, political, economical and organizational components. Now, another relevant topic when we are evaluating any ergonomic workplace or any workplace is holistic system approach. So, acknowledging the people do not work in a social vacuum. So, you need to understand that and then you should implement ergonomic workplace analysis or any ergonomic intervention.

Emergent properties after implementation also you need to consider and this may have a positive impact or may have a negative impact. Also embedded ergonomic practices that include this success depends on the position of human factor engineering in the organization which is also we need to understand and study. Now, I will take you to the next step because this particular course is mainly on the method and processes. So, I will take you various methods available for this particular topic.

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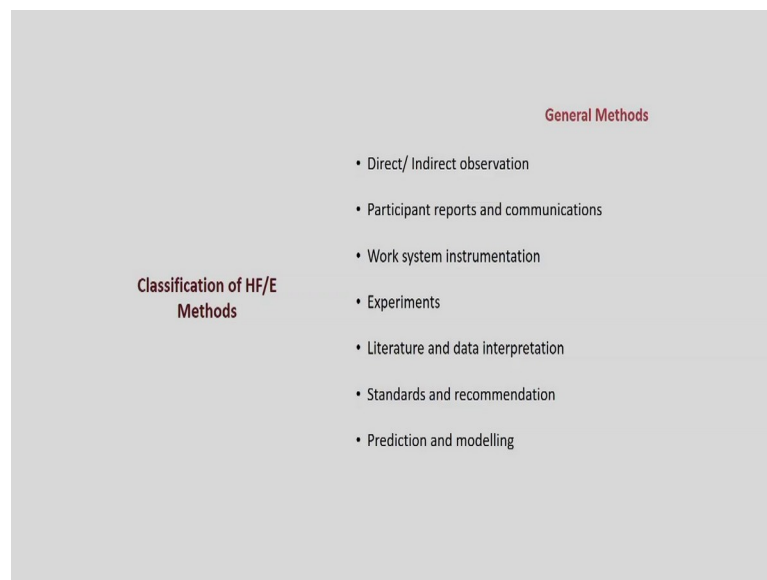
So, first we have general methods and then we will talk about the collection of information about people, equipment and environment. Then analysis and design, then evaluation of user and system performance and evaluation of demands on and effects its by experienced people, management and implementation of ergonomics.

When we are talking about general method we mainly talk about different approaches of data collection or analysis. It represents all approaches of data collection and analyses that can be used with a range of different design or evaluation goals across a work

system. Second when we are talking about collection of information about people, equipment and environment we are talking about basic description of it, measure of either an individual or environmental state or characteristics.

That means, we will be doing a lot of instrumental experiment where we will be collecting data to understand the behavior, understand the nature of the whole system. Third one as I mentioned earlier analysis and design that says tools that provide links between data collected and underlying influences actively supporting design process which is very crucial part of any ergonomic workplace analysis or various methods. Now, I will take you slowly for each step in detail.

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First let me explain general methods. In general methods we have direct and indirect observation. In direct observation we can say we have checklist, we have experts rating, photographs, we have video audio recording, data and logging etc. So, these parts when we are trying to do we need to be well equipped or we should have previously arranged whole thing and we need to start our collection. So, what we will be doing? We will be doing in the direct observation various checklist. What are these checklist? We have available number of checklists given by ILO, ISO and many other researchers based on the context, we will be choosing them and we will be using them.

Also we have indirect observations where what we can do? We can use archival data and to get those information artificial analysis and also data mining. So, we can use all these

information for general purpose. This will be the starting of your evaluation. Second is participants report and communication. What we do over here is the verbal protocol, survey, questionnaire, rating, ranking, scaling, entries, diaries and checklist. So, through this we are trying to gather information about the particular context or about that particular job or task which we will be analyzing using various methods later.

Then is work system instrumentation. What we can do is we have instruments like eye tracking system. Suppose somebody is doing a particular job, how the concentration is oriented in that particular whole system: maybe in the control panel or in the operating system -how it is segregated; to understand that we may use eye tracking system. Eye tracking system is just an instrument through which we can monitor how the gazing or concentration is distributed in different sectors. We can have a video recording and then we can analyze it later. We can use various data logs to analyze it. There are various methods. We will be explaining few of them definitely during the course.

Next one is very crucial and it is very important for us to understand the literature, for once we start collecting data or once we start analyzing our whole system, it is not that only we are doing. Maybe there are some different thoughts already available of this particular type of context by many other researchers. So, before starting we really need to understand the literature and interpretation of those data which is mentioned on the in this particular literature. So, once we understand that then we may correlate or we may associate or we may implement that information in our study. So, literature and data interpretation of those literatures is very important, crucial and critical for any ergonomic workplace analysis.

Also we need to understand standard and recommendation because ISO, BIS and many other relevant organizations have given relevant standards for each sector of our workplace. Those standard data has been developed by various empirical studies and lot of big number of data. Once we understand those data first and in try to implement them during our analysis it will be much easier and relevant. So, we need to understand standards and recommendation. Also one more important aspect of any ergonomic analysis of workplace in many cases is the prediction and modeling.

Because, if I can see some specific behavior of that particular zone or that particular workplace I need to predict how the performance will be or how the human health will

be affected or how this whole system will perform. So, prediction and modeling are used. Modeling is also one of the aspects when we are talking about the general methods.

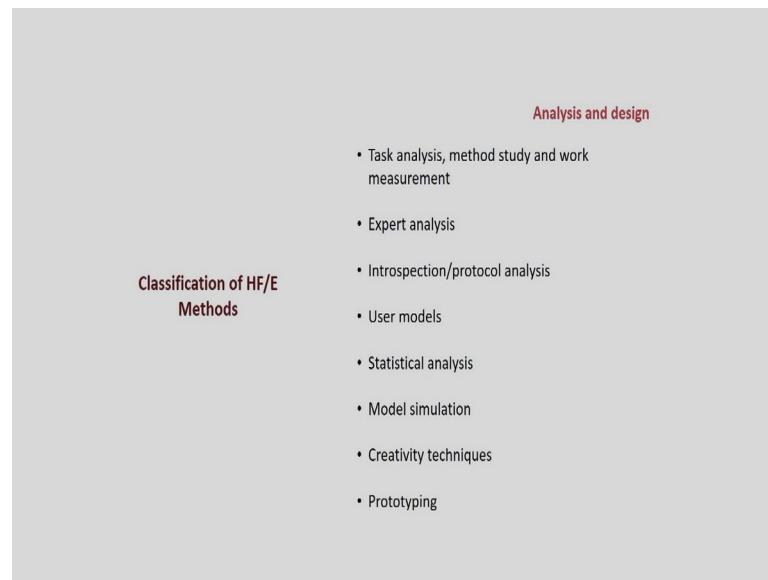
So, this is all about classic human factor and ergonomics methods which will be learning definitely for each and every section in the next few series of lectures. Also we should not forget that each method has some limitation, has some advantages. So, for a particular context we may need to use multiple combinations of method which I thought I should mention over here.

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Next level of or next varieties of method is collection of information about people, equipment and environment. How do we do that? Through physical measurement, through physiological measurement, through environmental measurement, perceptual and cognitive assessment, social and organizational measure and of course, knowledge. Knowledge means it is not only the researcher who is doing that its expert, it is literature, it is for that who is expert in that particular field or maybe some time the worker who is actually working that particular knowledge of that particular workplace and various model and task analysis. So, we will be learning all these separately; so, this is just to tell you what are the things we are going to cover.

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Now, next is analysis and design. Task analysis, method study, work measurement these all are the small-small process for which will give you an understanding about the whole ergonomic workplace analysis. Expert analysis, introspection and protocol analysis, users model, statistical analysis, model simulation, creativity techniques and prototyping. Now, I want to mention over here that all the steps, all the process, all the methods are not are not going to be implemented for a single workplace analysis. We will learn everything, then based on our requirement, based on the type of or context of my situation I will be selecting few of them and I will be doing my study.

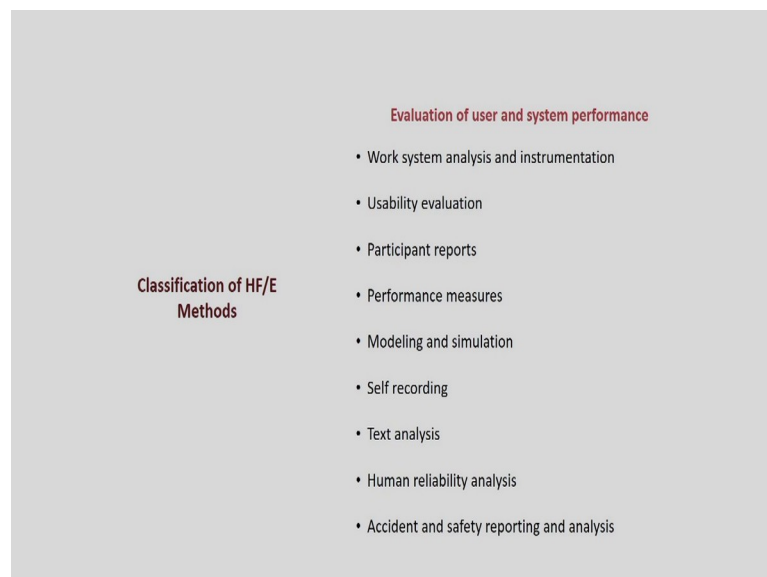
So, need to learn everything, but need not to implement everything. It is very important and you should remember this one because, I learned this one I should do; I learned this one I should do no, it's not. What do you have to do base on context you have to choose which one you should take and which one you should not take? So, that will definitely come from your experience with your expert knowledge and discussion, maybe sometimes from literature also. Once you learn all these process you have a basic understanding of limitation and advantages of these topics. So, once it is there then you are the person who needs to choose it.

It may happen many times I have chosen a wrong method for a particular workplace analysis. How do we I understand that? Once you collect data or once you see the pattern of that data or the result you yourself will understand that no this particular method is not

useful for my current situation, I need to use another one. So, once you complete this course you will be in a position to take that decision. So, everywhere posture analysis, everywhere anthropometric data, everywhere you know some kind of video recording may not be necessary. Because, that is our common understanding that you know ergonomics means I need to do posture, I need to do video recording, I need to do this and that. No, we need to understand which one is important and which one is not important.

Also, another important aspect is participatory method. What it is? Participatory method says that for whom we are doing this particular analysis or we are doing this particular evaluation, we need to understand or we may take the consideration what they are thinking or what they are their experience or their view. So, whenever we are doing the whole analysis or intervention program or anything we need to consider their perspective as well. It is not always, but many times. Again, I am saying here that based on the context, based on the requirement we have to decide shall I go for participatory as method or not.

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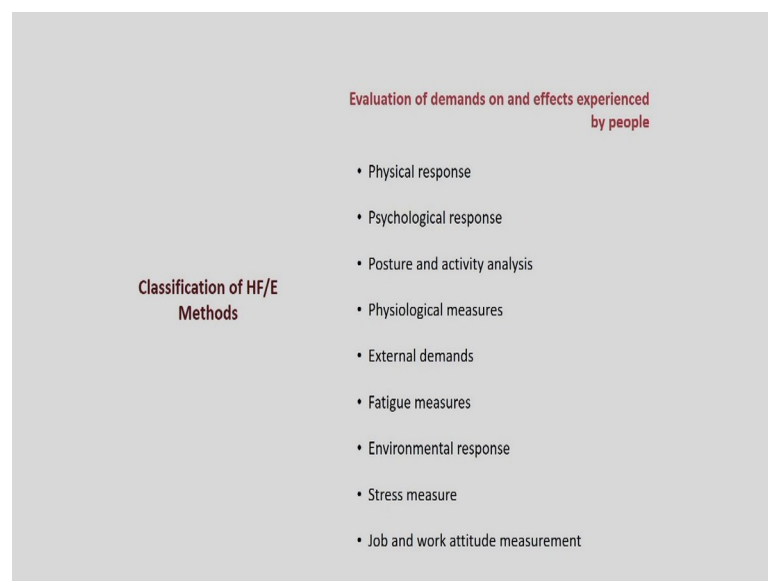


So, other method is evaluation of user and system performance, it includes work system analysis and instrumentation, usability evaluation, participants report, performance measures, modeling and simulation, self recording, text analysis. What does it mean by this self recording? Self recording means suppose a worker is working, you may ask the

person to record some kind of information which is relevant to your study by himself or herself.

Once he or she records that you may use those information for your evaluation- that is called self-recording. It is not that you are recording. It is recorded by the operator or it is recorded by the work. Then there are text analysis, human reliability analysis, accident and safety promoter reporting and analysis. So, about these few, definitely we are going to continue in next few series.

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The other one is evaluation of demands on an effects experienced by people. If the demand is something and the effect of that demand on the person is different we need to understand that. For that, we need to understand the physical responses, psychological responses, posture and activity analysis, physiological measures, external methods, fatigue measurements, environmental responses and many. One more thing is stress measurement. Also we do job and work attitude measurements.

So, all these process whatever I am mentioning here we will be taking one by one and we will be giving the examples. Also, you can refer all of them to various text books where you will come to know that how critical topics are they. Because, this particular course is only for 10 hours, we may not cover all these thing in great detail, but of course, we will try to answer if you have questions for all these topics. So, till now we understood what is ergonomics, what is the aim of ergonomics and what are the various methods available

for ergonomics workplace evaluation. In the next few classes we will be learning each of them.

And, we will be continuing with the actual experiment as well as small-small assignments. Also, I request that, it will be good for you to if you start to read all these topics by yourself and if you have some questions for these topics so, you can raise your query. So, we will be solving it in the next classes. So, for today this is all. Here I would like to close and we will continue in the next classes.