Ergonomics Research Techniques

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Week – 01
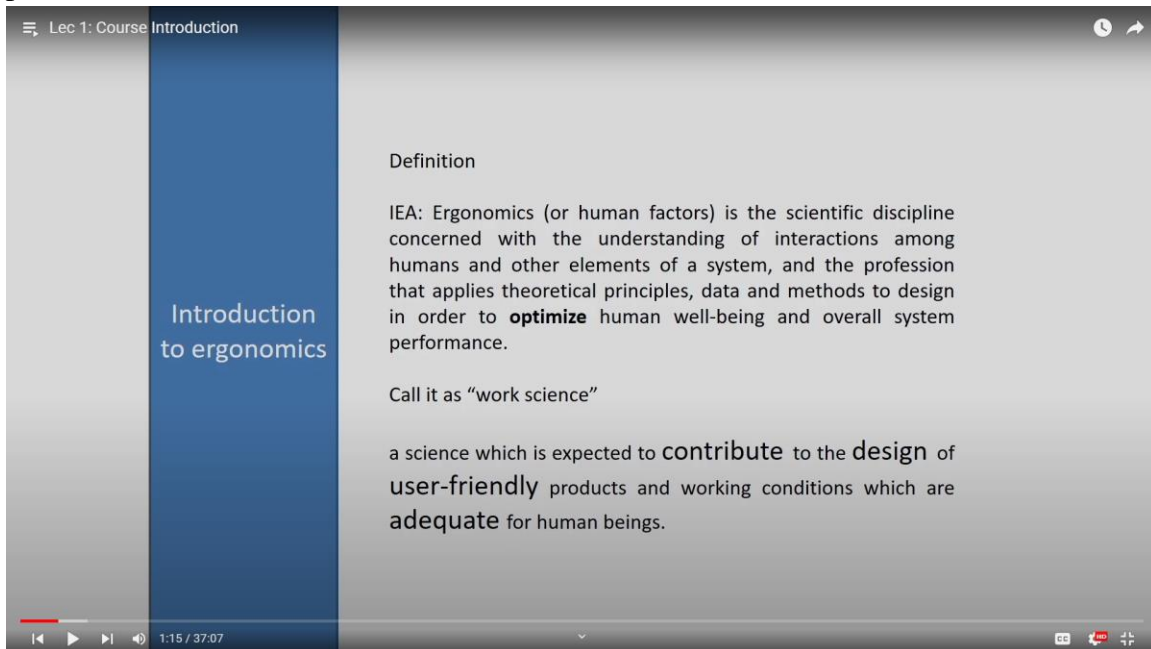
Lecture - 01

Lec 1: Course Introduction

Welcome to the new course, Ergonomics Research Technique. I am Dr. Urmi R. Salve. I am an Associate Professor at the Department of Design, IIT Guwahati. Today, in this lecture, I will be telling you how this course will run, what content we are going to cover during this particular course, and what the modalities of conducting this particular course will be.

So, let us begin with the terminology that is going to be used frequently because the main agenda of this course is ergonomics. So, let us define it. There are different definitions available in the literature, and various researchers have tried to define this particular term

over a period of time. However, in 2000, the International Ergonomics Association tried to compile various major aspects of ergonomics and try to define them.

So, we will be following that particular definition. IEA says that ergonomics, or human factors, is a scientific discipline. So, it is a scientific discipline concerned with the understanding of interaction among humans and other elements of the system. So, when we talk about ergonomics, the system is a major concern. So, whenever we are talking about human factors, we are not talking about individual human factors; we are talking about human factors that are present in a particular system. So, ergonomics is a scientific discipline concerned with the understanding of interactions among humans and the other elements of the system and also the professions that apply the theoretical principle, data, and method to design in order to optimize human well-being and overall system performance.


So, whenever we are talking about ergonomics, specifically the kind of applied research we normally practice in our day-to-day activity, that is, you know, optimization between human well-being and the overall system performance. So, whenever we talk about ergonomics, it is not about humans; it is also about the performance of the system. So, we will be talking about productivity; we will be talking about the efficacy of the system, the Efficiency of the system, as well as the capacity and capability of the human being or operator who is operating the system. So, in both cases, we need to understand how we are giving maximal output from the system With proper consideration of the well-being of the human being. So, normally, I suggest that my students practice using ergonomics as a work   science.

So, whenever we talk about work, there is a science behind it, and if you can work on that

particular science, you will be able to discover a lot of ergonomic principles and the methods that are involved in that particular system. This is a science that is expected to contribute to the design of user-friendly products. So, here it is very important; we are talking about a product; the product can be tangible, the product can be intangible; whatever we are developing should be user-friendly and have working conditions that are adequate for human beings. So, this will be our main motto when doing any kind of ergonomic study or ergonomics intervention. So, in this particular course, whatever tools, techniques, methods that we are going to learn, ultimately, with those results, we are going to improve the human performance, or we are going to improve the system performance, and we are going to enhance the human well being, So, that should be our objective.
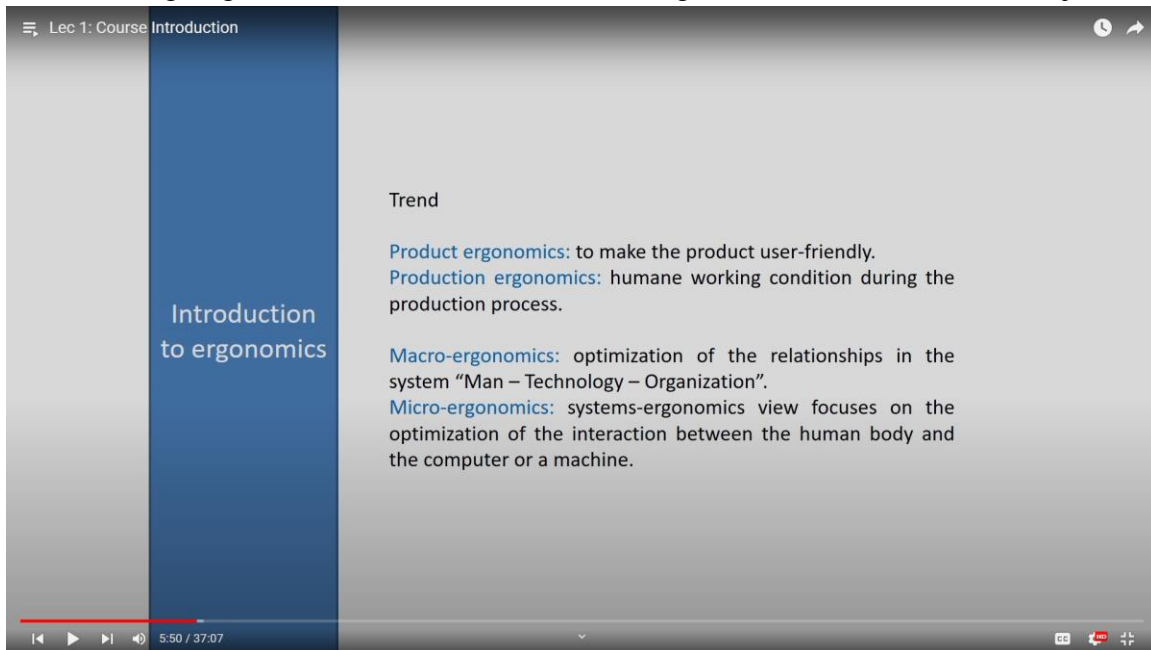

Moving to the next part of this presentation, I would like to mention the current trend in this particular field. If you look at the trends and try to categorize them, they are divided into four major categories. The first two components are product ergonomics and production ergonomics, and the second component is macro ergonomics and micro ergonomics. From the two perspectives, these broad divisions are. So, what is product ergonomics? So, we are talking about manufacturing or developing a kind of product. Developing a kind of product that is user-friendly following the ergonomics principle. At the same time, production ergonomics talks about human working conditions during the production   process.

So, we are going to cover these two major aspects. Also, we understand trends and talk about macro ergonomics and micro ergonomics. So, let us understand what is the definition of it. Macro ergonomics is the optimization of the relationship in the system, which talks about man, technology, and organization. How can we optimize it?

We cannot think that we will always talk about human beings, human well-being, and human benefit. We need to talk about optimization between man, technology, best use of technology, and the organization where it is being used. So, we have to think from all perspectives. So, 360-degree evaluation. What about micro ergonomics? It talks about the system ergonomics view and focuses on the optimization of the interaction between the human body and the computer or any kind of machine that is micro ergonomics.

So, macro ergonomics talks about the whole system, whereas micro ergonomics talks about its small elements. So, we will be talking about different tools and techniques from both perspectives: product ergonomics, production ergonomics, macro ergonomics, and micro ergonomics. So, we will be talking about different varieties of tools, techniques, and methods from all these perspectives. Now, the concern is that you need to identify which is the most suitable tool for you to introduce or evaluate for the data collection. So, you need to identify what you know and are trained in or what the category of your research is.

Once you identify that, then accordingly, you can choose any one of the tools or methods. So, while describing all the tools or all the methods during this particular course, what will I do? I will give the assumptions of what is required for that specific tool. Also, I will be talking about the limitations of each tool. So, before you use any tool, you know whether that particular tool is useful for your condition or not. So, that will be the flow of the course.
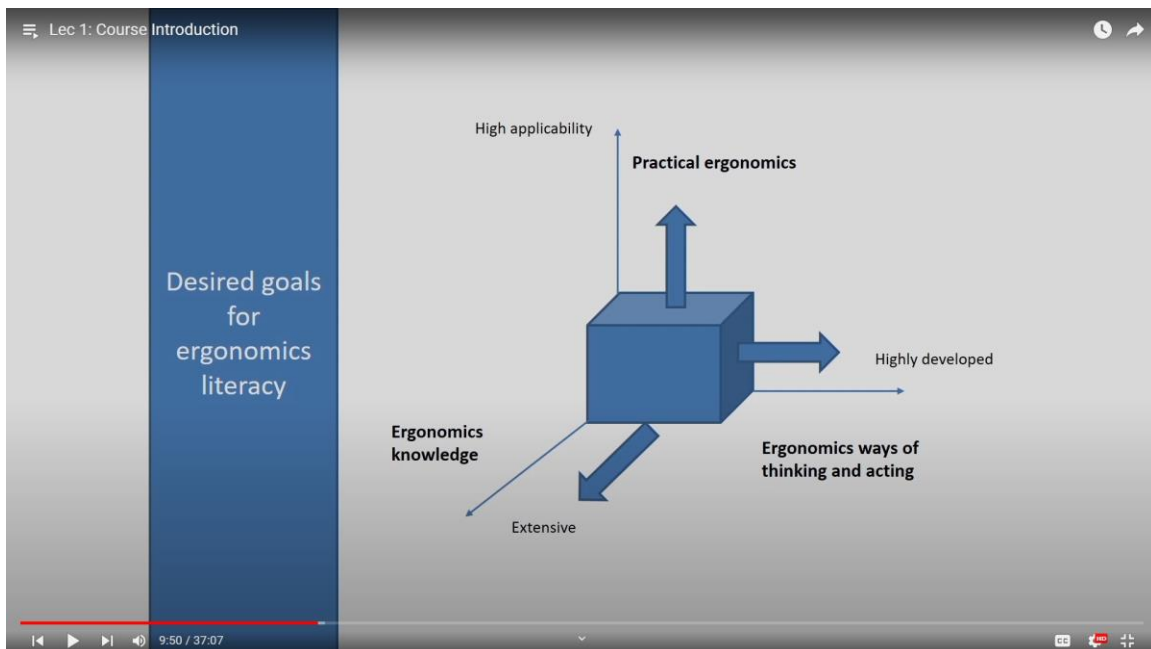
So, when we talk about ergonomics, we are going to achieve something, right? We are going to deliver something. If we take this in three directions, x, y, and z, you can see major practical ergonomics, which is applicable to ergonomics knowledge or databases, or you know some basic fundamental work and the ergonomics way of thinking and acting.

So, if we are talking about practical ergonomics, it is highly applicable. Applicable in the sense of applied ergonomics.

So, we will be talking about the direct implementation of intervention in any kind of situation. So, that is practical. On the other hand, ergonomics knowledge, when we talk about it, is more of a research orientation that is very extensive in detail. So, vertically, on a particular topic, you are going deep and deep and deep. So, you are trying to understand more detail about that particular topic, which will ultimately give you some basic or fundamental results or fundamental knowledge that can be applied further in other research.

So, this is the second domain. The third domain is ergonomics, which is the way of thinking and acting. So, training, modification, implementation, and all those things will come into the picture if we talk about ergonomics, which is a highly developed way of thinking and acting. So, you need to develop products you need to develop services you need to develop the system, and so on. So, these are the three major directions your ergonomics research can go on.

So, you need to decide, and it is not like you go in only one direction. Maybe you can combine one or two directions, or maybe for your research work, three components are present in different percentages. So, you need to have a proper understanding of which varieties of tools and techniques are lying where and how you pick them up. So, during this course, you will learn that particular process of choosing an idea. So, you will have a basket of tools or a basket of methods, and based on your research objective, you can pick and set it accordingly.

So, in this particular course, you will be getting all varieties of ergonomics methods. So, I cannot promise you that I will be able to tell you everything. However, we are going to cover the maximum possible available tools, techniques, and methods. So, we are concentrating on the perspective of commonly used tools and techniques. There are many tools and techniques that are very niche.

Role of
ergonomists

- Human capabilities and limitations
- Human–machine interaction
- Teamwork
- Tools, machines, and material design
- Environmental factors
- Work and organizational design

13:25 / 37:07

So, we may not discuss those because of time constraints, but we are going to discuss them as much as possible. If we talk about the role of ergonomics, these are the major roles of ergonomics. So, human capabilities and limitations. So, we need to find out what human capabilities and limitations are. Accordingly, we are going to use that capability and that capacity in a particular situation.
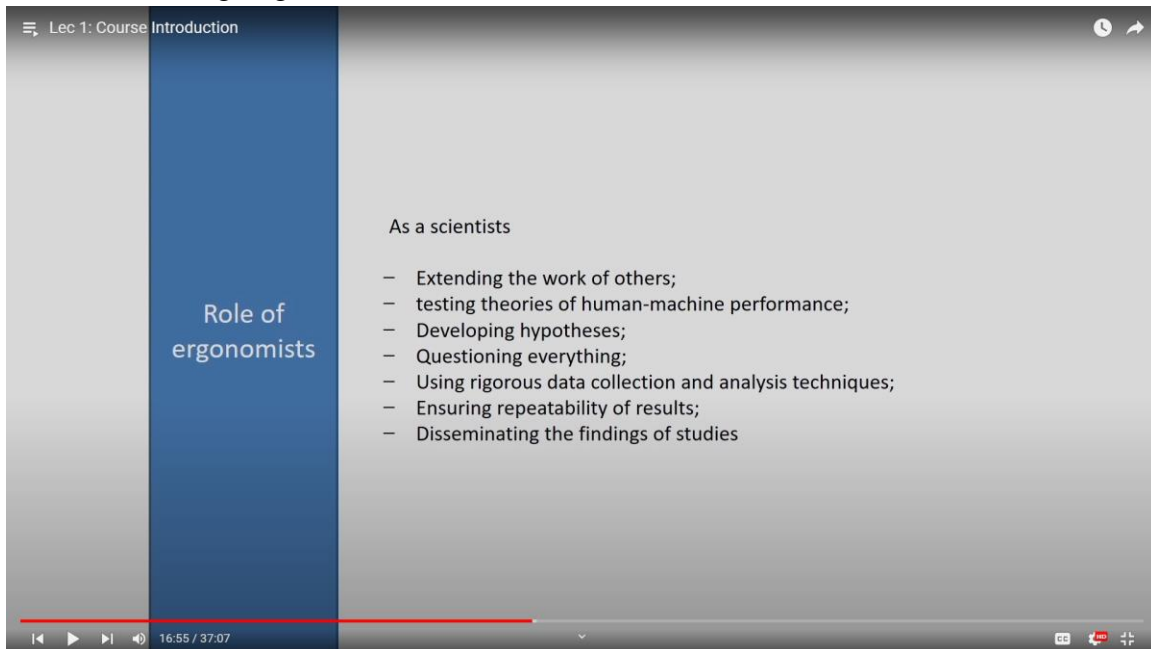
So, if we can do that, then only we will get the optimum utilization of the capacity to get the maximum productivity from that particular system. Human-machine interaction. So, how nicely or flawlessly are human machines interacting? So, if we can ensure that human-machine interactions are flawless or less difficult, we cannot say. So, in ergonomics, there is nothing 0.

There is always some value. Our objective or our agenda for any research is how to minimize that risk at the maximum possible reduced level. So, we are going to use these tools. When we talk about ergonomics, we talk about teamwork. So, information processing, teamwork, psychosocial factors, all these things are also, you know, connected. So, ergonomics talks about teamwork.

So, you know, interaction between each worker, interaction between the superior and the person who is working under the leadership of a particular person. So, how the information is happening, workload, work demand, work autonomy, all these things will come into the picture. Tools, machines, material design, environmental factors. This is, again, a very important factor because if we are talking about human capacity and human performance, it is pretty much connected with your environmental factor.

So, if now I am reading some slides. I need to look at the slides; I need to deliver my lecture. If the illumination level is not up to where I can read the slides, this is definitely going to hamper my capacity or capability. So, the environmental factors. If the temperature is very high or the temperature is very cold, I will feel so uncomfortable delivering   the   lecture.

So, depending on the situation, how the environmental factors are, and how they interact with human performance, that is also a kind of goal of any ergonomic study. Of course, the last is work and organizational design. So, how are you designing the work and the organizational structure? So, these are all major concerns for ergonomics when we are talking about any ergonomic study. Now, I am going to tell you based on aspects like if you are a scientist, how you are going to perform, and if you are a professional, how you are   going   to   take   it   ahead.


So, as a scientist, the role of ergonomics will be extending the work of others. So there is some fundamental work that has been done, or some application has been made, and you have to take it further to the other level. Testing theories of human-machine performance. So if there are some kinds of theories, suppose there are n number of theories available, you can test them. Is it really applicable or not? You can develop hypotheses, you can develop various kinds of models, and you can question whatever earlier theories are, and you   can   have   your   own   agenda   to   prove.

Using rigorous data collection and analysis techniques, you can have a different set of databases that is also a part of work or part of a job as a scientist or ergonomic scientist. Ensuring the repeatability of results. So, when you are doing research, you should ensure you are not doing a repetitive job or repetitive task. So, suppose the same work is being

done by somebody who is, you know, methodically done and published, proved. But again, you are doing the same, so that is not a valid work. So, if there are some challenges, then you can definitely work on them, but the same work you should not repeat them.

And disseminating the findings to the study. How do you do that? You can publish your research results through journal publication, conference proceedings, or patenting your study; if it is a product or a service, or if it is a process, you can patent it and publish it to the public forum. Also, through seminars, and conferences, you can disseminate that particular knowledge. So, these are the ways you, being a scientist, use ergonomics or the role of ergonomics comes.
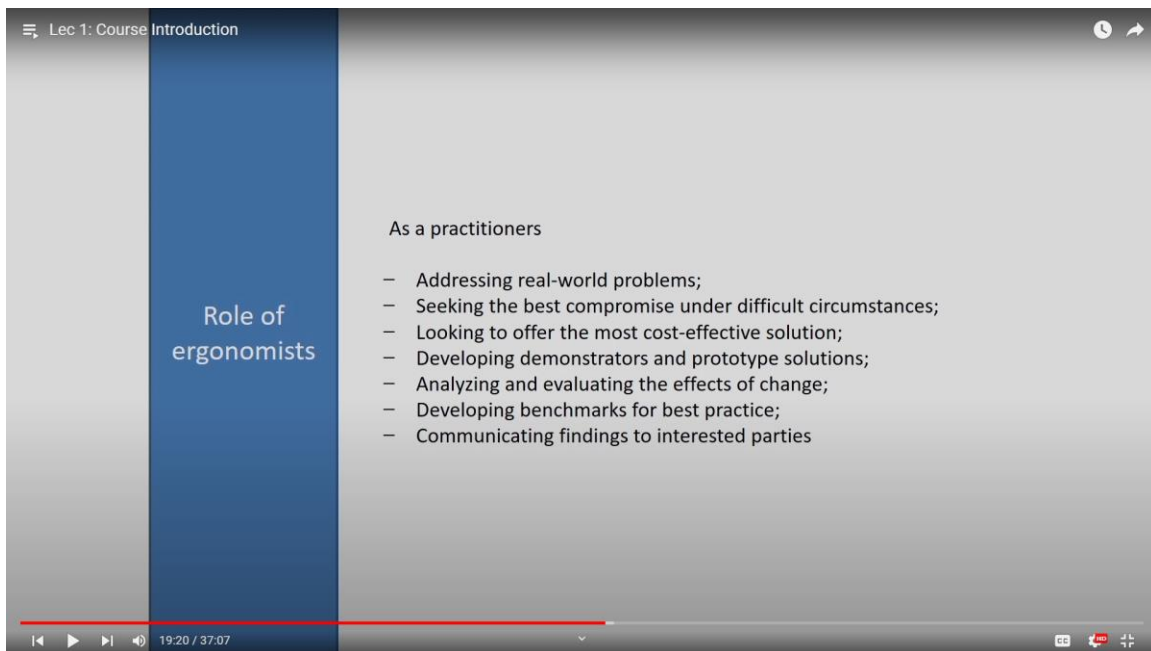
Now, as a practitioner, what are you supposed to do? You are supposed to address all real-world problems.

Here, all the tools and techniques that we are going to learn in this particular course are going to help you. So, you are going to address all real-world problems. Whatever you can see, you are addressing it. So, it is coming under application. So, it is very much related to the application of ergonomics theories and principles in a particular real-world condition.

Seating the best is comprised under difficult circumstances, okay? So, if you have a very difficult circumstance where you need to compromise with one or two elements, now you have to judge an ergonomist that compromising is going to give the best cost-effective analysis. So that understanding, that decision-making, and which you are going to get or will be able to make through only these use of tools and techniques. Looking to offer the

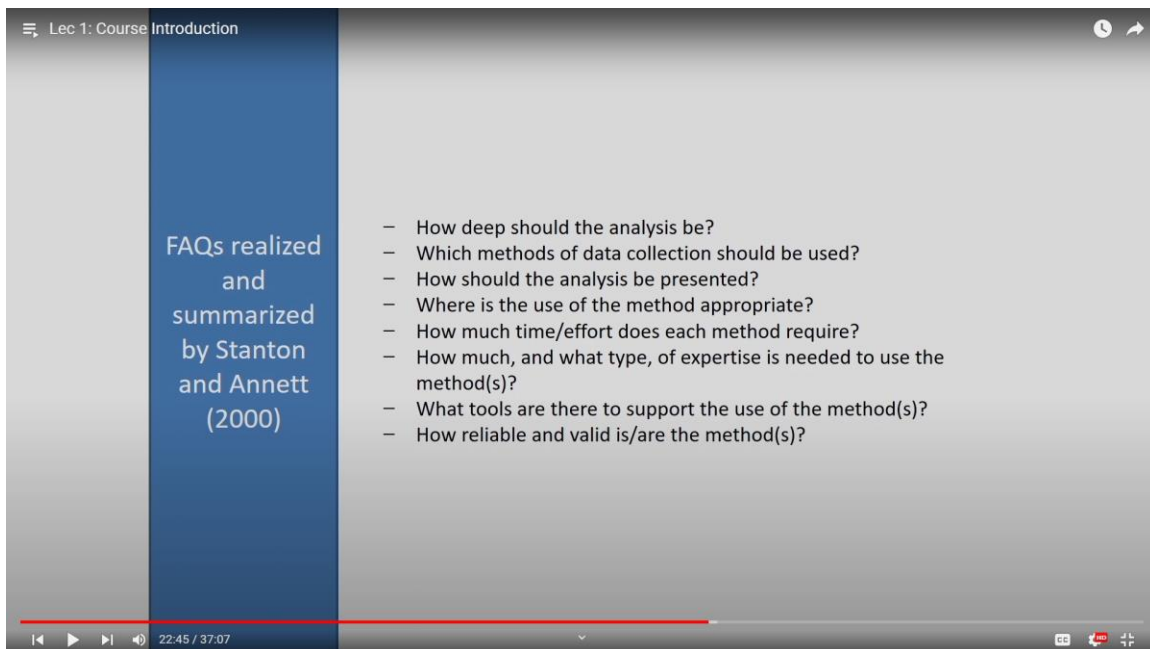most   cost-effective   solution.

  This is very important. You are going to industry, you are going to give some kind of
ergonomic solution. However, you need to remember that any employer will only attend
to you if it is beneficial to the employer or to the industry. If it is not, specifically when
we are in India, we will not be able to implement any kind of ergonomics intervention
because profit you need to maintain. If you do not have the organization, the institution,
or the industry, and if they do not have money, then no intervention program will be
sustained. So, how cost-effective is it? You have to develop, demonstrate, and prototype
the   solution,   which   is   one   aspect.

  Analyzing and evaluating the effects of changes. So you have done the intervention; now
you have to evaluate that, yes, it is done. Then what, what is happening? I identified that
there was a problem, and to find the solution to the problem, I gave this particular
intervention. Now, is it reduced, or is it aggravated? What? So, for each and every
intervention, what do you need to do? We have to make a comparison before and after.
So that you need to do. You have to develop the benchmark for the best practices and
communicate   the   findings   to   the   interested   parties.

  So here comes about the awareness program, you know, workshops and all those things.
So, as a practitioner, I know that the role of ergonomics is major in these areas. So, which
area you are working in, you need to see which one you need to pick up for your situation
and your context.

Basic realization. This is given by Stanton and Annette in one of the books, which I am going to refer to many times during this particular course.

If we are talking about ergonomics, what should we look for? What should we question? So, there are some basic questions that they want every ergonomics researcher or practitioner to ask. I will read one by one. First, they ask someone how deep the analysis should be. Why? Now, the question is if I want to know, just for example I am telling, okay, if I know what the kind of prevalence of musculoskeletal disorders among bank operators and bank employees is. I know, okay, I am going to give some kind of questionnaire or some kind of techniques or simple focus interview or maybe some kind of observation or something, and then I have a kind of prevalence data.

Now, do I need to understand the causal factors? Do I need to go for any kind of intervention to improve it? At what level should I give the intervention? Do I need to check after intervention if it has been improved or not? So for, before we start any kind of study in the field of ergonomics, we should know how deep we want to go. If we do not have that understanding, we will not be able to choose the right tool for that particular case. So understanding at the very beginning is very important. So, we are talking about setting the objectives of your research. Which method of data collection should be used? Of course, if we have a proper understanding of our research or study objective, we will be able to set the methods correctly.

If the objectives are not set correctly, we will be going to get some random methods or random tools, which are not really going to answer the objective that I am supposed to fulfill. So, each is connected with the other. So first, set the objectives correctly, and then next, choose a very specific method to fulfill that objective. So, if you go through this particular course, you will see many varieties of techniques and tools available for different situations. So, based on your situation, you should choose that particular tool.

How should the analysis be presented? For a specific tool, you may have a variety of analyses. Now, based on your objective, you need to decide which analysis is going to give you the best results. Where is the appropriate use of the method? How much time or effort does each method require? So, I tried to give the application time and learning time for each tool and technique separately during this particular course. For every technique, you will see there will be one slide where I am talking about the learning time of that particular tool and the implementation time of the particular tool. So, approximately, you have an idea of the total time span you have for your study and, for this method, how long you are going to take for data collection or analysis.

So this is going to help you to calculate all these. How much and what type of expertise

is needed to use that particular method? So that is your training period. What is the level of expertise required? So, I tried to explain everything to approximately every tool. Okay, still, if you have any questions, you can ask us what tools are there to support the use of that particular method. So, if you need any kind of hardware or software to apply that, we are also going to discuss how reliable and valid that particular method is. Of course, we also try to explain or explore reliability and validity in this particular course for each technique   and   tool.

So, we try to follow this set of questions before we start any kind of study. So, all these tools and techniques that we are discussing or that we are going to teach you during this course will follow a similar pattern. Okay, so you will be able to get all the answers if you follow this particular course. Now, here I would like to mention something that is very important: how we distribute or categorize our methods, tools, or data collection process.

|		Analytic	Evaluative
	Primary purpose	Understand a system	Measure a parameter
Annett's Dichotomy of Ergonomics Methods (adapted from Annett, 2002)	Examples	Task analysis, training needs analysis, etc.	Measures of workload, usability, comfort, fatigue, etc.
	Construct validity	Based on an acceptable model of the system and how it performs.	Is consistent with theory and other measures of parameter.
	Predictive validity	Provides answers to questions, e.g., structure of tasks.	Predicts performance.
	Reliability	Data collection conforms to an underlying model.	Results from independent samples agree.

So, according to Annette 2022, there are two specific divisions. One is analytical division; some tools, techniques, or methods are specifically analytical in nature, and some are evaluative. So, whatever ergonomics tools and techniques are available, we tried to distribute them into two major categories. A few tools are from the analytical. So, it is going to give you a lot of analytics from the result, and some are evaluative in nature. So, the primary purpose of analytical tools is to understand a particular system. So, there will be   some   tools   that   will   give   you   a   basic   understanding   of   the   system.

Whereas when you are talking about an evaluative tool, it is going to give some kind of measurement of the parameter that you are looking for. So, for example, task analysis and training need analysis are all analytical tools. On the other hand, workload assessment, usability assessment, and comfort assessment are all evaluative. So you are assessing it,

you are evaluating it. Now, we are talking about construct validity based on an acceptable model of a system and how it performs with any analytical tools. Constructive validity can be   determined.

   Whereas the evaluative tool is consistent with theory and another measure of the parameters. So you have a theoretical value, and you have similar variables that you can measure using some measurement instrument. If both are giving similar results, then only constructive validity can be determined. Predictive validity, if we talk about an analytical tool, provides the answers to the questions, for example, the structure of a particular task.

   So that can be given. At the same time, it talks about evaluative tools and performance prediction. So, if there is a particular system through the evaluative tool,   you can predict what the performance could be in another particular situation where you are modulating different other variables. Data collection conforms to an underlying model in terms of reliability. Whereas we are talking about evaluative tools and techniques results from the independent samples. So, you can do a pilot study, and from there, you can confirm the reliability   of   that   particular   tool.
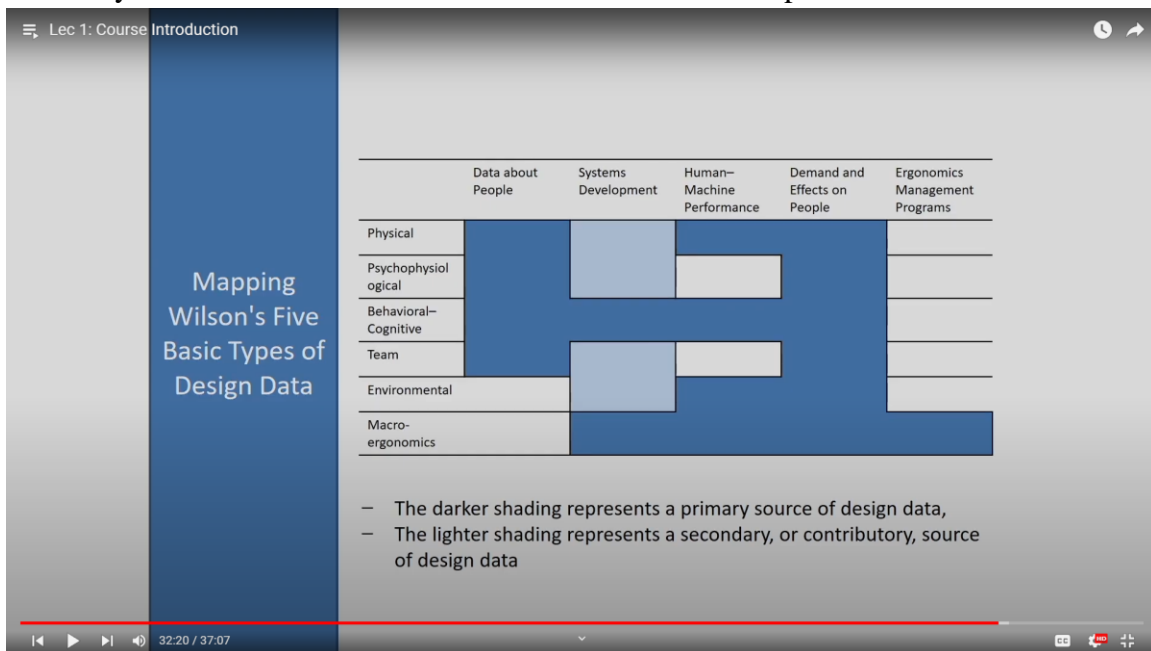
   So this is the kind of dichotomy of whatever tools are available to us, and we are going to follow this particular categorization or classification. Now, if we talk about mapping the varieties of tools because you have physical tools, psychophysical tools, behavioral tools or cognitive tools,   some kind of team handling, environmental, macro ergonomics, and varieties of tools in different categories. So, how do we use or choose tools when we are in a situation? So, this is a basic mapping provided by Wilson. Here, they followed five components.   One is data about people, system development, human-machine performance,   Demand and effects on people, and ergonomics management programs.

So, if your study objectives are categorized in any one of these categories, Then how do we choose tools, techniques, or methods to evaluate or get the results? They also have categories here about the tools available: physical, psychophysiological, cognitive or behavioral team, environmental, and macro ergonomics. Here, you can see that there are two major colors: one is darker blue, and the other is light blue. So darker blue shading represents the primary source of design data. So, if you want to have some kind of design solution   from   this   area,   you   should   have   primary   data.

So, you need to identify a method or tool to gather information or data from the field study or field observation. So that is the darker shade. Whereas the lighter shade, you can have secondary data that means from the literature. So this is the broad classification or broad mapping; I would say mapping that if you have a scenario, then how do you decide which tool to use, and is it a primary data collection, or can I have some kind of secondary data? So this is how you can use this map, and you can choose which tool to use for your data collection   or   for   your   study.
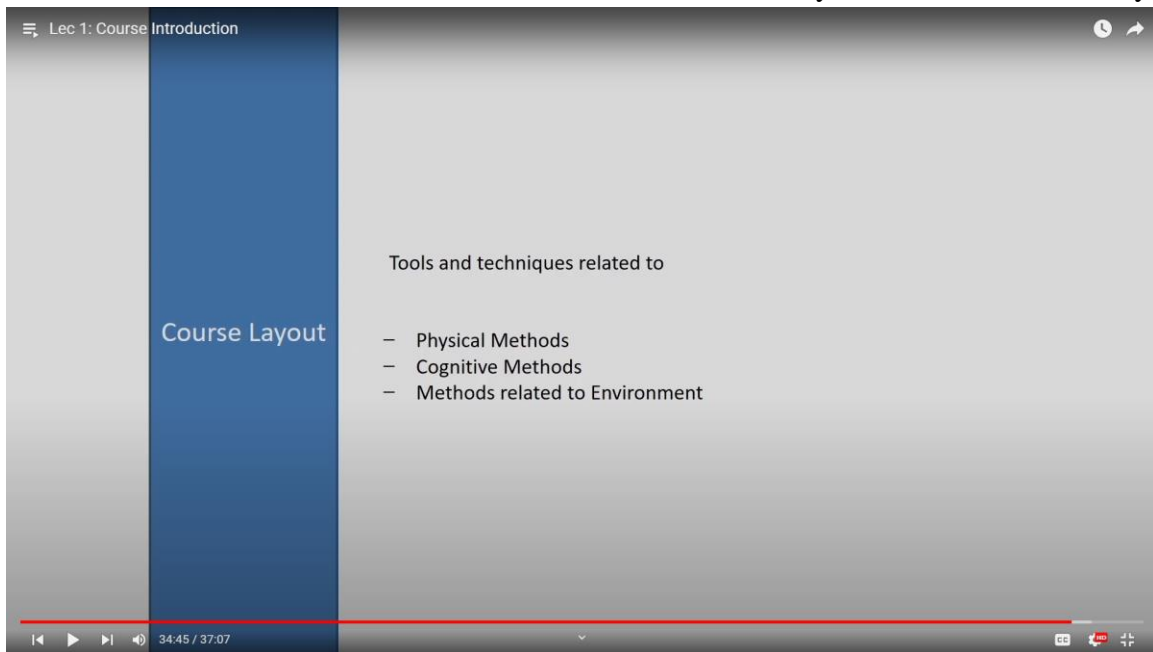
So, this is a broad mapping, as Professor Wilson gives it. So, during this particular course, we will be talking about three major domains and related tools, techniques, and methods. First is physical, second is cognitive, and third, whatever methods are available for the environment.   Now, this environment is a physical environment, okay, light like illumination, thermal, and all so on. So, we will mainly be talking about physical methods and cognitive methods. In cognitive methods, we will talk about cognitive and behavioral together and the methods that are related to the environment. So these are the three major

domains that we are going to cover during this particular course.
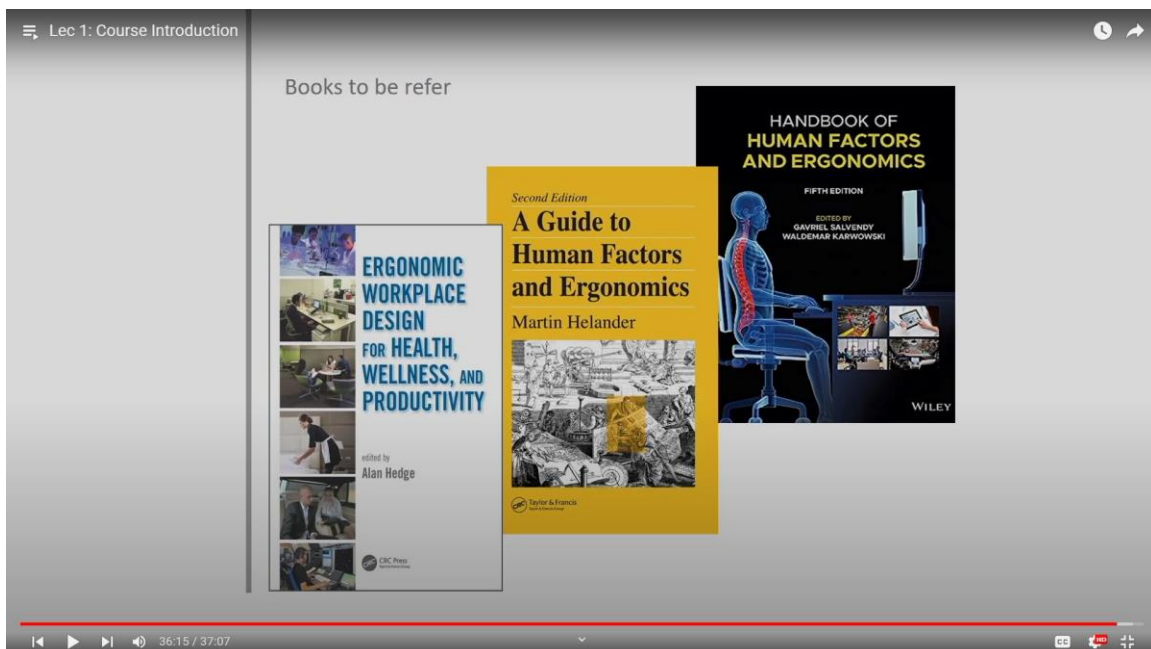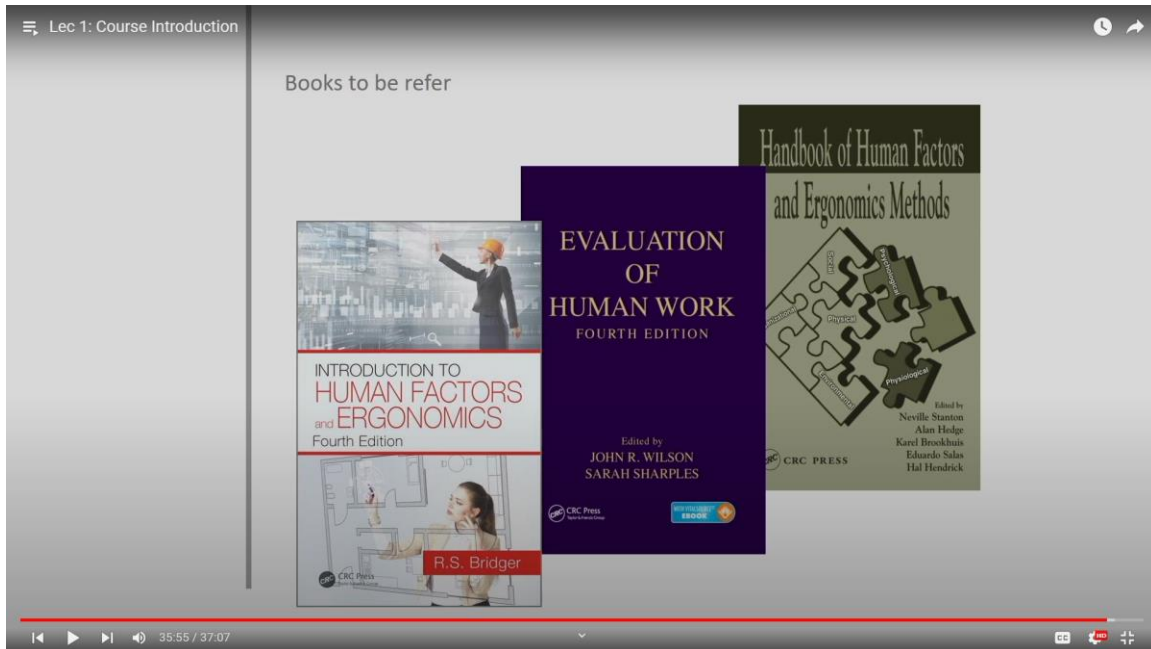
Now, I would like to introduce you to the books that you are going to follow. So, these books are available online, or you can purchase them as a hard copy. So you can follow these books during this particular course or some other research material like a published paper or, you know, some kind of research document that is available through different internet sources. So that also you can follow. So I suggest before we go ahead further in our actual study or, you know, course discussion, method discussion, you should follow this book, and if you want to know more about this book, you can come back to the discussion forum, you can ask us, we will be able to guide you.

So, let us begin our course, which is the ergonomics research technique. Thank you. 1