Ergonomics for Beginners Industrial Design Perspective

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Module No. # 02

Discipline approach: Ergonomics / Human Factors

Lecture No. # 06

Ergonomics/ Human Factors fundamentals

So, welcome to sixth session of ergonomics for beginners industrial design perspective.

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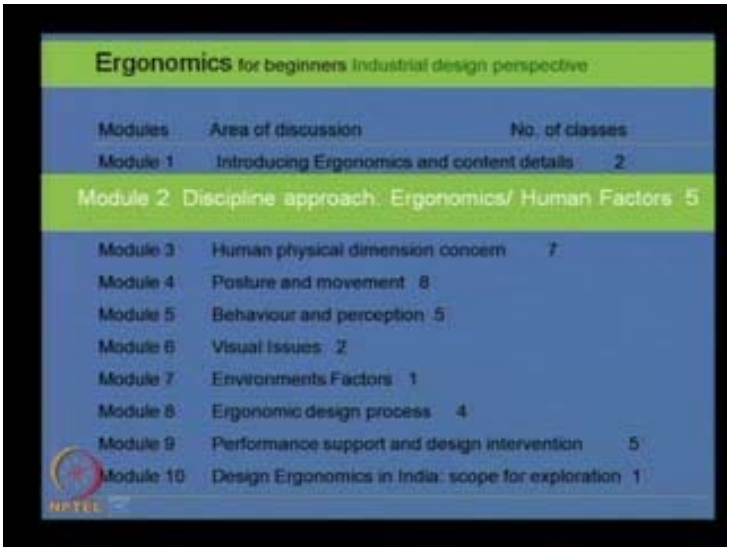

Now, under this module 2, is discipline approach: ergonomics and human factors.

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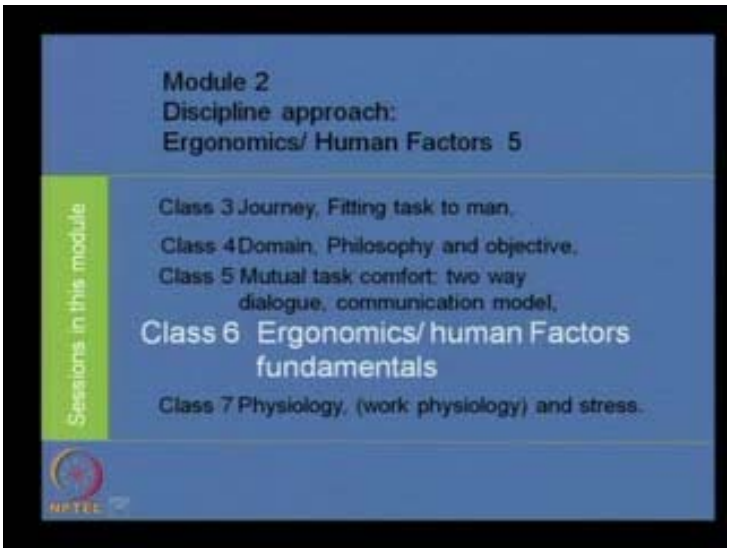

In this, there are totally 5 sessions and today is the session number 6; that is, ergonomics human factors fundamentals.

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So, if we see the last classes' gist, what we have discussed earlier, it can be said that for new design concept ideation and development, salient features conceived should facilitate easy-to-use human-machine; that is, relevant usable commodities, interfaces and all the ergonomics domain issues are involved to make the design appropriate. And this matter we have discussed with an example of mosquito repellent device.

The domain of specialization: Finally, now, people consider that is physical ergonomics - that is, hardware match with man and equipment or usable products and space also; cognitive ergonomics - there is a behavior in consideration, that is perception area and organizational ergonomics, that is, macro aspect of ergonomics; that is, men, his all other equipment whatever he is using, that you need and multiple units, relations, etcetera.

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And also we have discussed, that task and design should be based on Sense-Decide-Act and feel feedback and follow a communication model of message encode criteria in design and decode easiness, and influences of multiple transmission inhibitors and transmission facilitators in this process. And all these inhibitors and facilitators are to be considered with the human compatibility issues; that is a physical dimension, physiological tolerance limit and behavioral capabilities. And all the products or the commodities we use, it has context specificity, content and the user specifications.

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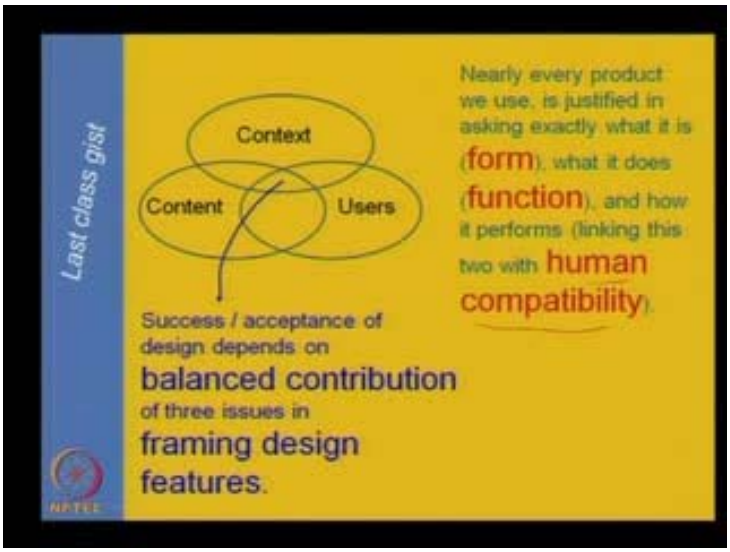

Now, nearly every product we use, is justified in asking exactly what it is - the form of the product. So, after seeing the form, we can understand, what is the product, how it can function. It must have some relation with our past knowledge and experience of handling similar type of products. After understanding the form, getting the image of the product what it does, that is the function. So, after seeing the product, the user should recognize its intended function and how it performs; that is, linking these two issues - common function with human compatibility factors.

If we can establish these links, then the product will be well accepted by the intended users. Now, the product success or acceptance of design depends on balanced contribution of three issues, that is the context, users and content in framing design features.

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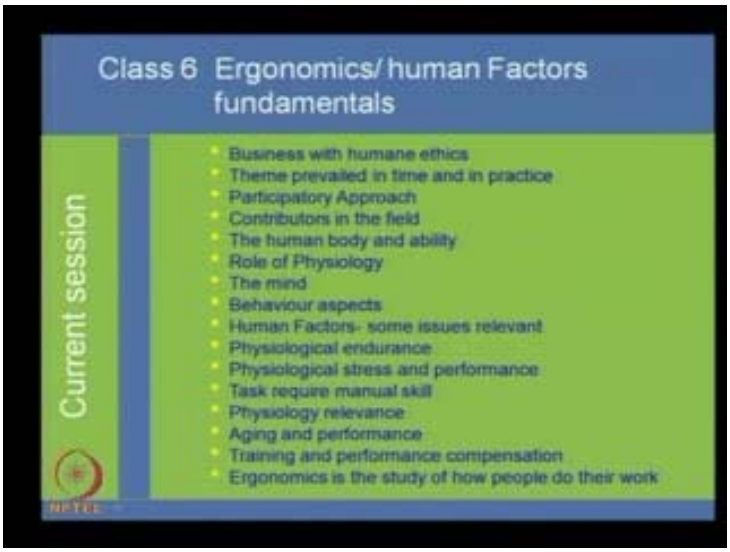

So, these we have discussed in last classes. Following this, today's discussion in the current session, we are going to discuss: Business with human ethics, that is the ergonomics base; Theme prevailed in time and in practice; Participatory approach - what does it mean; Contributors in the field in this design ergonomics area - what other fields specializes have contributed; The human body and ability - the basic matter of man-machine compatibility factors; Role of physiology; The mind; Behavior aspects; Human factors - some issues relevant in that; Physiological endurance capabilities; Physiological stress and performance; Task require manual skill; Physiologic relevances; Aging and performance; Training and performance compensation and finally we will discuss, Ergonomics is the study of how people do their work. So, this matter we will discuss today.

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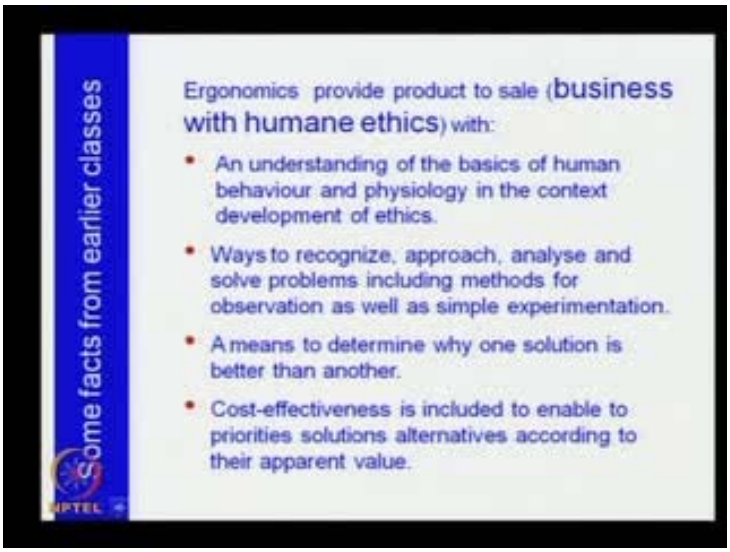

Now, some facts, if we recall from whatever the examples we have cited earlier, from there you can say that ergonomics provide product to sale, that is, business with human ethics with: an understanding of the basics of human behavior and physiology in the context development of ethics; ways to recognize, approach, analyze and solve problems, including methods for observation as well as simple experimentation; a means to determine why one solution is better than other, what are the issues it influences, while selecting a product over another similar type of products, the aspects behind that; cost-effectiveness is included to enable to prioritize solutions alternatives according to their apparent value.

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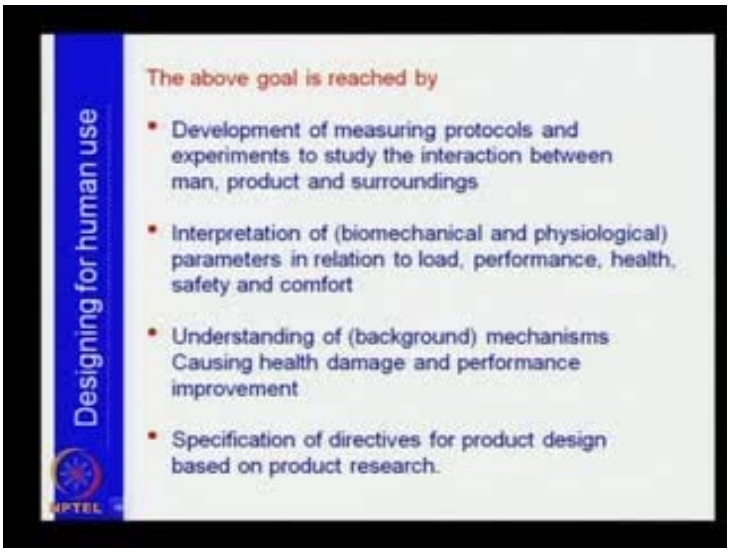

Now, to achieve the above goal, it could be reached by development of measuring protocols and experiments to study the interaction between man, product and surroundings; interpretation of (biomechanical and physiological) parameters in relation to load, performance, health, safety and comfort; understanding of (background) mechanism causing health damage and performance improvement; specification of directives, for product design, based on product research that is necessary to understand.

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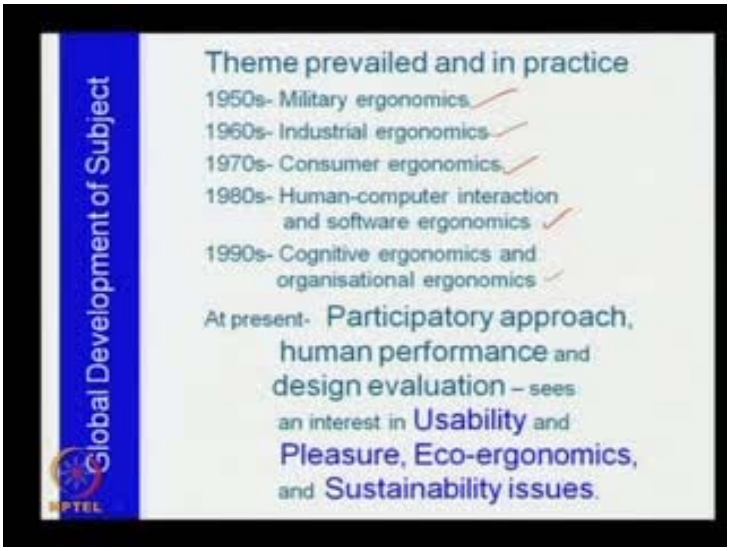

Now, in different timeframe, people have worked with a specific theme like, it can be said that the theme prevailed and now in practice is that in 1950s, mostly people have worked on military ergonomics requirements; so, the findings of that period we can term as a military ergonomics areas findings.

In 1960s, industrial ergonomics, that in industrial management and industrial design had just started; in 1970s, all the works were concentrating on consumer develop products development; so that knowledge base, generated at that time, it can be said that consumer ergonomics area. In 1980s, when computer came in market in full-fledged use, then the human-computer interaction and software ergonomics it took place.

So, the findings of those studies and etcetera, it has created a base, database. In 1990s, cognitive ergonomics and organizational ergonomics were in place. At present, based on all the earlier experiments and the findings, now the participatory approach, human performance and design evaluation sees an interest in usability, and pleasure, eco-ergonomics and sustainability issues. It means, the man and product, that relation, it should attain such a way that the outcome it would be sustainable; means, the users can make it, maintain it and if it is necessary, they can modify according to their context specific requirements.

Now, what is the participatory approach? Participatory approach is that when we develop some product or some system method of functioning, then if we take the intended users to be in confidence while developing the process, then we can understand the field reality and thus the outcome it will be sustainable.

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So, integrated developmental dynamics with sense of belongingness of the likely beneficiaries should be there, and importance of involving users or employees as part of the participatory approach to system design.

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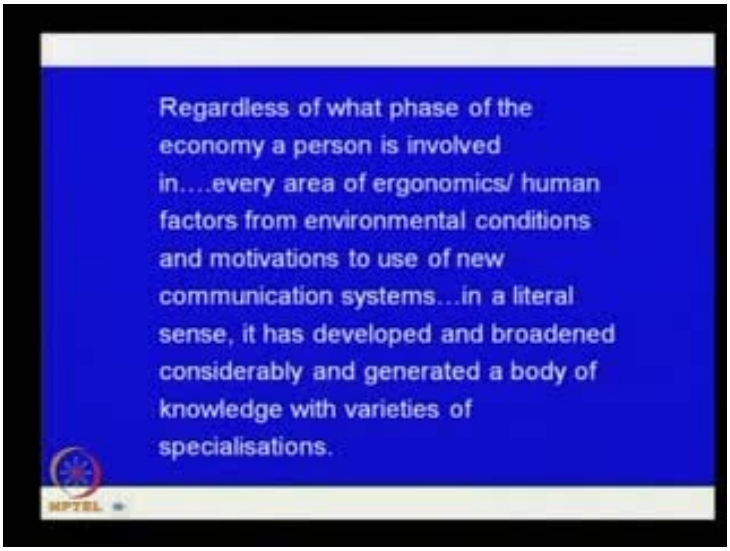

Now, with this, it can be said that regardless of what phase of the economy a person is involved in, every area of ergonomics and human factors from environmental conditions and motivations to use of new communication systems… in a literal sense, it has

developed and broadened considerably and generated a body of knowledge with varieties of specific specializations.

Now, how these specializations are formed and what type of influences have come from different or other subjects specialties that one can consider, so that the relevant information can be borrowed from those specializations and thus the application of design ergonomics while making a good design would be possible.

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Now, apart from physical body dimension, physiology and psychology, that is, behavior the other specific contributors in the field, among that we can say that the industrial engineering concerns the plant layout with its facilities and the arrangement of individual workspaces, work-studies, which aims to develop the work and performance links; so these area are linked with the industrial engineering discipline that is relevant to ergonomics.

Now, industrial hygiene and safety, and occupational health - these areas, concern the work environment and work methods to eliminate the cause of health problems and occupational safety hazards. Industrial relations, behavioral sciences and industrial psychology are concerned with improving the work organization and job design, with a view to enrich motivation, satisfaction and the job attitudes of the workers. Various expertise in different fields of other engineering, architecture, health sciences, human resource management, biology, environmental sciences, design, field of arts and crafts;

thus the list may go on, who have enriched with their specifications or with their contributions in enriching the ergonomics areas. Now, specifically in this course schedule, we will discuss the most influences are applicable to design development.

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Now, the human compatibility factors in terms of limitations and the specific natural facilities of humans and acquired needs to be looked into. Now, if we see the human body and ability, there are some factors, some issues are coming and that we will discuss in details. It can be said that our bodies assorted human body size, and the shape also. We need to know our anatomy, body dimensions, biomechanics, that is the mechanical issues of our body movement and growth pattern - how we grow, what are the stages of growth and how it affects in our design selection or working with varieties of designs and other facilities that we develop to support ourselves and related variables affecting the body dimensions.

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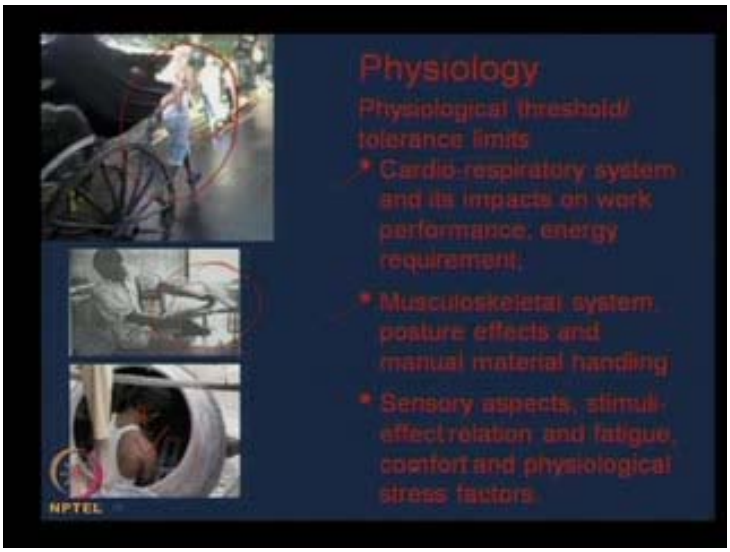

Now, if we see, the basic thing is that physiology, whatever we do or we feel, its reaction, the visible reaction comes through our body expressions. And that is the true physiology like blood pressure, then cardiovascular other things, respiration and all others, it get affected.

Now, physiology, here we can say that the person is pulling heavy load, that is, a rickshaw - hand pulled rickshaw; so, he is basically using his muscle power; so his workload can be evaluated with various physiological parameters. Now, if we can design a better product, that is a rickshaw, that can reduce his physiological values, physiological load, then we can say that the new design developed is a good one. Now, in this case, that due to this design matter, the person while taking out some material from this platform, he has to take an awkward posture.

So, now that design can be modified, so that the person can use it without adopting any awkward posture. Now, see while cleaning and maintenance, in a cement mixing machine, the person has to go in and work; so, here the total task can be designed in such a way and the design of the product in such a way that man need not to adopt such posture whatever we are seeing here; so, this is in a question mark.

So, then physiology, while doing some work or using any product, the physiological threshold and tolerance limit we must need to consider. These are in terms of cardio respiratory system and its impacts on work performance and energy requirement;

muscular skeletal system, posture affects and manual material handling; sensory of aspects, stimuli effect relation and fatigue value, comfort and physiological stress factors we need to understand and by that way, we can say that physiological threshold and tolerance limits in respect to this we need to know. And based on this one can evaluate a new design, a new work method and process, while that it is beneficial to the intended user.

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Now, the mind, that is behavior that is inbuilt and acquired skills of recognizing a purpose through decoding meanings of symbolic representation of what-to-do, how-to-do correctly and error perception; whether these things are easier; if it is made easier, then we can say that the product is will be well accepted.

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Now, the behavior aspect, specifically speaking, the cognitive capabilities of people; sensation and perception and impact on information process, perception and processing. So, whatever information we are receiving, how we can perceive, how much complexity it has and after perceiving its meaning, how I can react to that; so that is the matter.

An human error analysis and prediction and mental fatigue - when we use some product maybe in or a computer program something, if we do not feel easiness or comfortable then mental fatigue comes on it. Psychomotor skill, attention, learning and memory, language and communication, and problem solving and decision making - these are the items that we must consider under behavioral aspects of ergonomics and that is the design relevance. How these factors are related to design directly, that we will discuss with taking specific examples in next classes.

Now, in this we can say that why these people make such group - formal group, semi-formal or semi informal group and total informal group; what are the factors deals with this type of arrangement; those things come with behavior as well as physical space and physical interactions also.

Now, environmental factors of varied nature and intensity influences the above human compatibility factors. So, while approaching any design, we must consider the compatibility factors between man and that equipment or the usable product, this physical body dimension match; that is, human body geometry and the product

specification should match and while working, the workload, the using load, must would be below the physiological tolerance limit; and it must match with their psychological abilities; all these things have some relation or influence of a various environmental factors.

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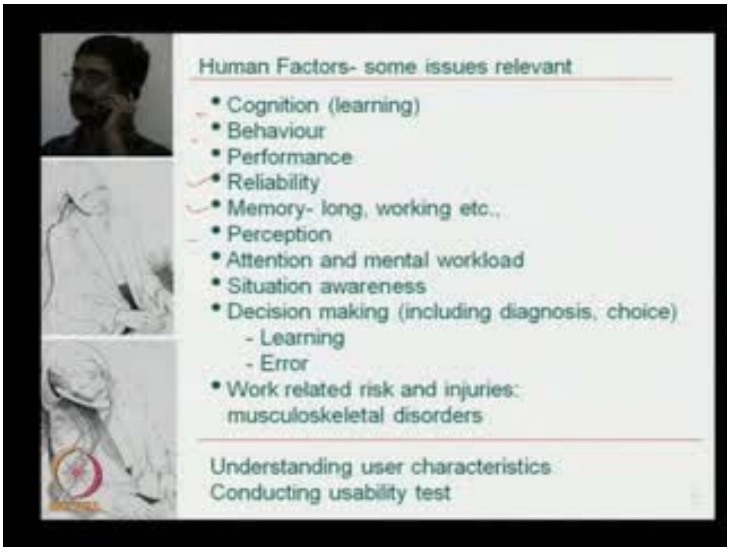

Now, human factors - some issues relevant is that cognition, behaviour, performance reliability - made up while operating some product, it should not give any misresult; memory - long term and working, perception, attention of mental workload, situation awareness - where I am using this, whether this product fits in that or in this context; decision making, that includes diagnosis and choice, that is learning and error. How fast I can learn to use the product and what are the factors responsible for that selection and error, why error comes? Is it due to some faulty design or there is some problem with the man itself; why error takes place? Then work related risk and injuries; musculoskeletal disorders. Understanding user characteristics conducting usability test is necessary to make a product good.

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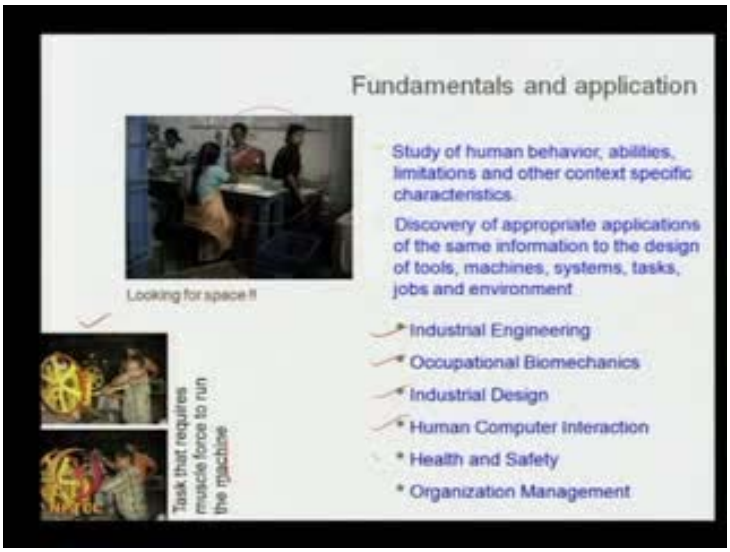

Now, fundamentals and applications - it can be said that now, in this case, the people are working here, whether individual work space is proper, whether privacy is there, whether for that working they have enough space, surrounding, the furniture is ok. So, for this we can say that and in this figure, it can be said that the task, the person is doing here that requires muscle force to run the machine. So, here, if we can develop a design that can reduce the muscle force requirement would be better; no question comes - why not to make a mechanized product? Then it comes that human affordability and a context in tradition, culture; so many things are coming play to play with their individual role.

Now, specifically ergonomics fundamentals and application is that study of human behavior abilities, limitations and other context specific characteristics. Discovery of appropriate applications of the same information to the design of tools, machines systems, tasks, jobs and environment where it can be applied - industrial engineering, occupational biomechanics, industrial design, human computer interaction, health, safety and occupational and organizational management.

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Now, some facts regarding the physiological parameter issues. Now, here we can say that both the tasks are apparently same, mostly using the leg muscles; here it is to develop endurance here, it is not, here the endurance; here the load will be increased, so that she can get motivated towards this exercise. In this case, considering the age of this person, etcetera, here, our aim would be how we can reduce most of the load while operating this equipment, that is, the rickshaw. With this it can be said that physiological endurance level differs from individual to individual and the performance with or without any specific design item or a work system support also differs.

So, that design development for specific purpose we cannot say what any that always. Suppose, we can say that while making a staircase, the staircase up and down, that is an exercise, for young person. We can gradually increase the staircase height, so that gradually their workload can be increased, but when it is a normal staircase to climb up, at that time, we do not know who will be the intended user of that staircase; it maybe an young person, maybe an old person or it may be a little physically disabled person - permanent or temporary nature. In that case, various considerations to be taken and the stair height, it should be above or we can say below the one-third of lower leg limit; means, from foot to perpendicular height, that is, the back side of the knee, that point, if we take that length, then it will be around one-third of that. Normally, we can say that while climbing that, it will remain within the physiological tolerance limit.

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Now, physiological stress and performance another we can say that, while applying some force, how we can apply and with what posture we can apply force at which, what height we can apply force. While optimum stress enhances performance, excessive stress has disastrous consequences; maintain a steady level within physiological tolerance limit; various physiological performance indicators are to be considered while engaging a person in a task, let it be productivity relevant working or spending pleasure oriented leisure time.

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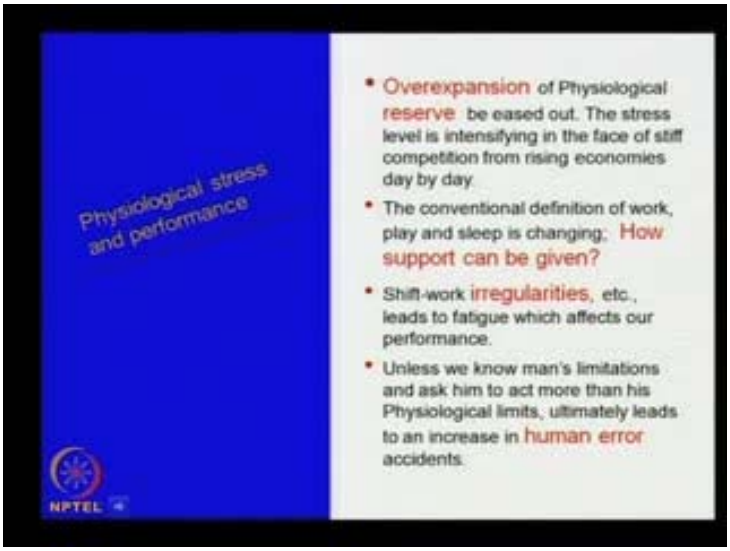

Now, overexpansion of physiological reserve to be eased out. The stress level is intensifying, the stress level is intensifying in the face of stiff competition from rising economics day-by-day. The conventional definition of work, play and sleep is changing. Now, we keep ourselves awake in little late evening, till midnight or more; so for that we use varieties of designs to support us, to make ourselves awake. So, with this changed our life pattern, with the or what type of products or facilities we can support.

Now, how the support can be given? In certain cases, this type of support is necessary; sometimes, we must develop some process or method or some check that restricts us from doing this practice. A certain design that maybe good for adult may not be equally good for a young child. So, what are the difference is to be maintained, shift-work irregularities, in industries etcetera, leads to fatigue, which affects our performance. Unless we know the man's limitations and ask him to act more than his physiological limits, ultimately leads to an increase of human error and accidents.

So, if we can maintain our working level within the physiological tolerance limiting, then obviously, it can be said that chances of human error and that related accident would be less. Now, let us see a task requiring force frequency repetition and skill and what comes to our mind. So, from this, if we see this small filmlet, then we can say that the person is beating a rod on the heap of this cotton, to make it cleaner and fluffy.

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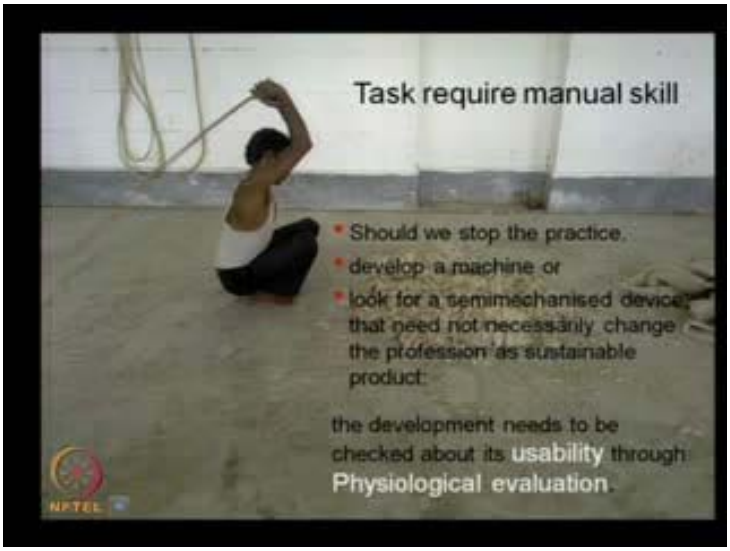

Now, see the movement pattern he is following here, it is mostly the muscle power oriented task. Now, this task mainly requires manual skill; now, after this view can we say, that to reduce his muscle force requirement and his activity, should we stop the practice, develop a machine that can replace this manual work or look for a semi mechanized device, that need not be necessarily change the progression as sustainable product. The development needs to be checked about its usability, through physiological evaluation. It means, if we develop a product, maybe a semi mechanized device or whatever, where the man also needs to be involved while operating that machine, the usability of that product, we can evaluate from the physiological evaluation; means, before or without using that device, when the person is working as it is today's condition, then what is his requirement? What is his physiological cost like oxygen consumption that the energy, heart rate, etcetera and other physiological parameters like electromyography and etcetera of these various muscles involved for these activities?

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If we measure and after that if we develop a product and if we ask him to operate, then take again all the measurements and then see what is the benefit? Obviously, we have to see that why that productivity is increased. Now, task requires manual skill and precision. Frequency of performing such activities, duration and the force required aggravates the physiological stress level; any design attempted to ease out the situation must be evaluated accordingly.

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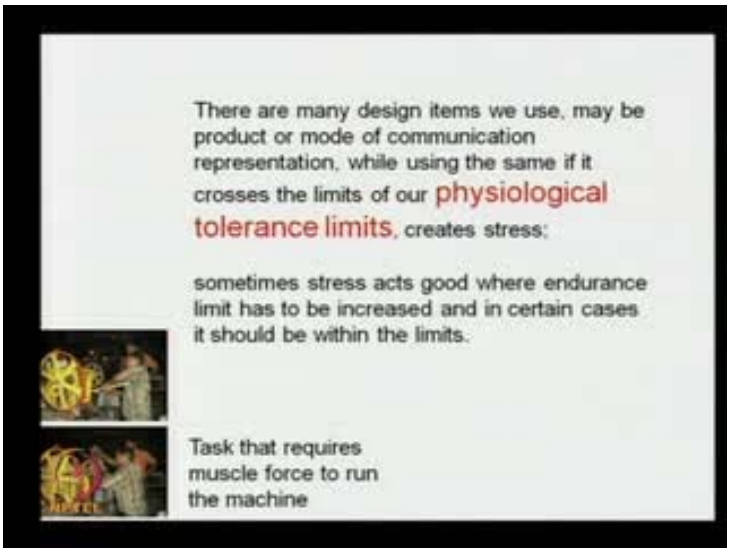

There are many design items we use, may be product or mode of communication representation, while using the same if it crosses the limits of our physiological tolerance limit, creates stress; sometimes stress acts good, where endurance limit has to be increased and in certain cases it should be within limits. This is the reference again, we can cite the task that requires muscle force to run the machine, which one to be given importance to design the machine, to replace the men or should design a machine, where man can operate it from his own easiness or own will as he requires to get the function done from that machine.

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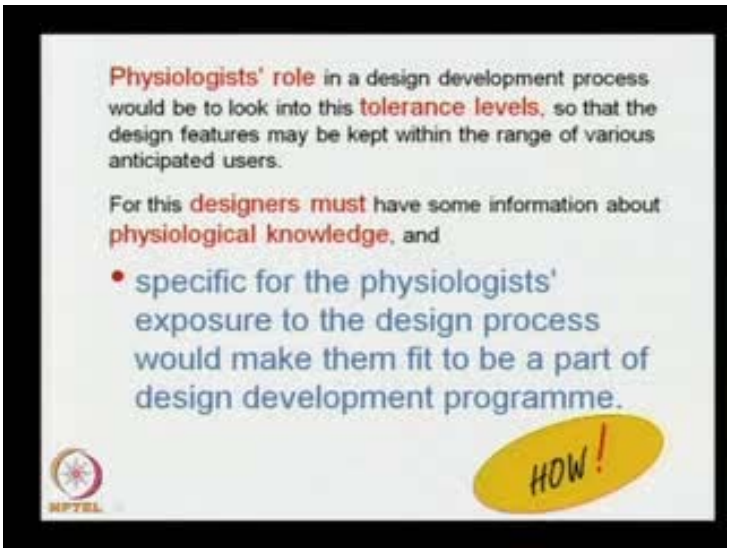

Now, we can say that in this design development and etcetera, what is the role of a physiologist? Why we need to understand or know that physiological parameters etcetera? Why every designer should know the basics of physiology or he should take help of physiologist? Now, the physiologist's role in a design development process would be to look into the tolerance levels, so that the design features maybe kept within the range of various anticipated users. For these the designers must have some information about physiological knowledge and specific for the physiologist's exposure to the design process, would make them fit to be a part of design development program. It means certain physiologists should know basics of design development process, so that they can develop relevant information that a design field requires; but how to develop, how to make a bridge between design requirement and physiologist information this bridge, design ergonomics also looks into this aspect.

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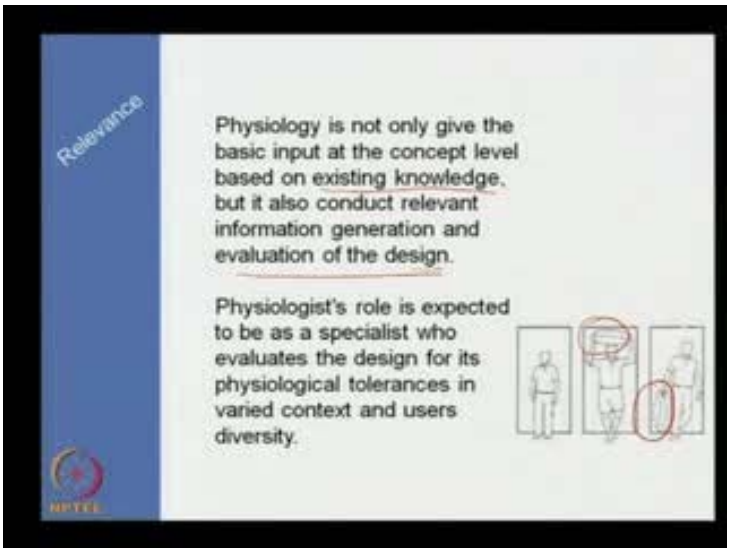

Now, some relevance physiology not only gives the basic input at the concept level based on existing knowledge, but it also conducts relevant information generation and evaluation of the design and for this specific design evaluation here, role of physiology would be useful. Physiologist's role is expected to be as a specialist who evaluates the design for its physiological tolerances in varied context and user's diversity.

So, by this, we can specifically say that the roles of designers to conceive the design idea and to give the design form and physiologists are supposed to support the design

decision with specific human information, while and to keep a check on the design development process, whether it is for the human body requirement. After the design is developed fully or in different stage of developments its evaluation, whether it is actually doing the desired effect.

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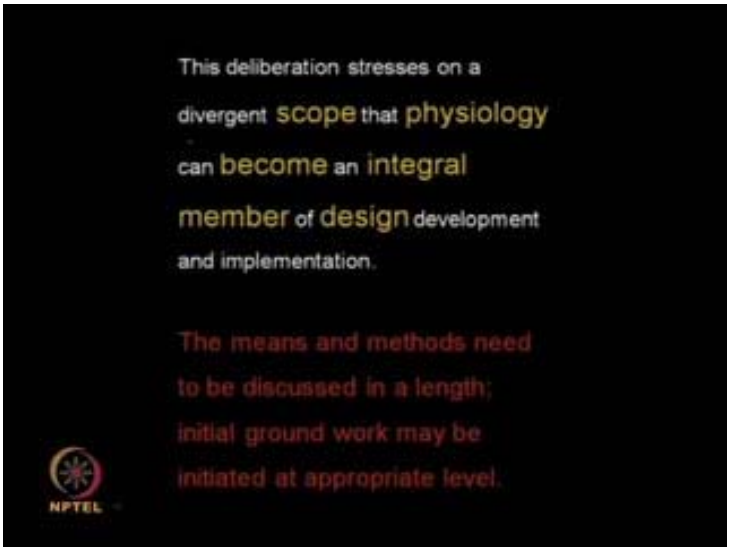

Now, in this case, it can be said that simply while designing a load bag, the considerations come both from design as well as physiology is necessary and thus the total area of discussion is under design ergonomics. This deliberation stresses on a different scope that physiological can become an integral member of design development and implementation process. The means and methods need to be discussed in a length; initial groundwork maybe initiated at appropriate levels is that design initiation stage, design execution stage and after design the evaluation stage.

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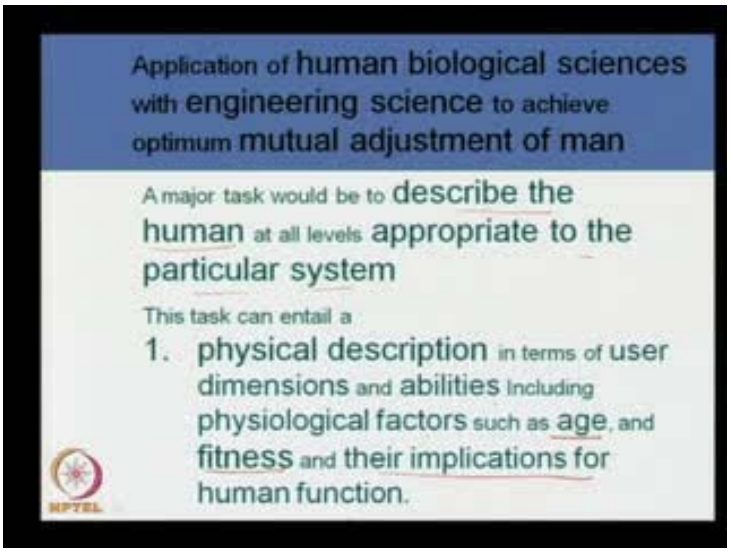

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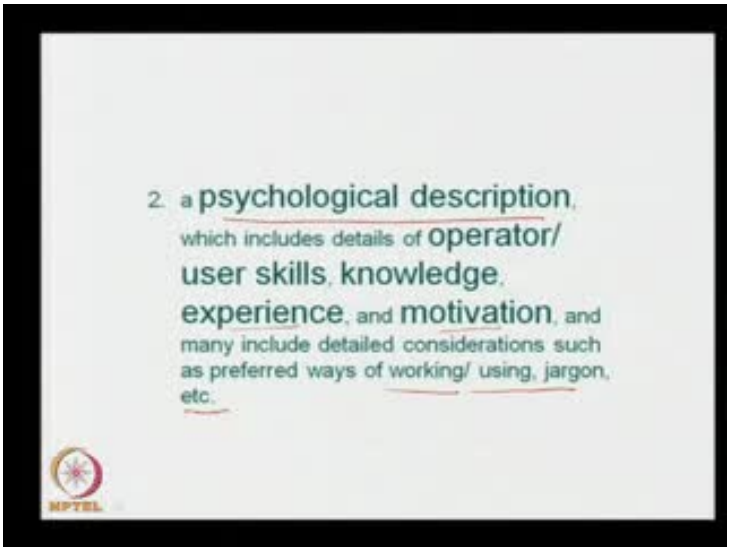

Application of human biological sciences with engineering science to achieve optimum mutual adjustment of man; a major task would be to describe the human at all levels appropriate to the particular system. This task can entail a number 1. physical description in terms of user dimensions and abilities including physiological factors such as age, and fitness and their implications for human functions. Number 2. a psychological description, which includes details of operator and user skill, knowledge, experience, and motivation, and many include detailed considerations such as preferred ways of working and using jargon, etcetera.

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Now, aging and performance; the same design product, the way young person uses and aged elderly person use differs. The process of ageing is associated with a variety of deficits, ranging from physical body parts coordinated movement, range of body movements, reaction time to any sensual information - that is vision, auditory, olfactory, taste and tactile; selective skill development, young people they use maximum muscle force to do certain task, whereas the aged person with his experience, he can do the similar activities with a skillful movement with a selective use of muscle groups. Physiological endurance capacity is different from sensory impairments and response slowing to deficit in working memory and the performance of demanding attentional tasks.

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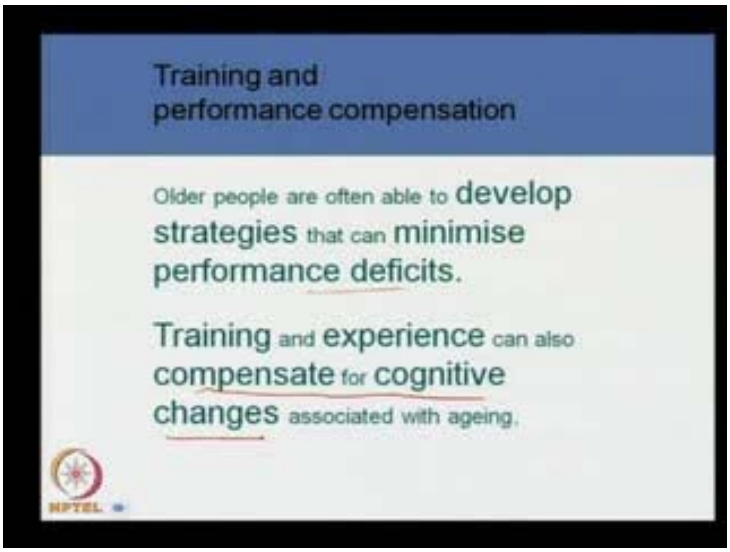

So, these are the little differences of aging one needs to consider, when developing design training and performance compensation. Older people are often able to develop strategies that can minimize performance deficits. Just now, I said that the older person with their experience and training or earlier learning, they can use specific group of muscle to do certain skillful activities, but the young person they use the major muscles group to do the similar task is found sometimes.

So, the older men can develop certain strategy of their own, how to minimize their own performance deficits training and experience can also compensate for cognitive changes associated with the ageing. Just one example can be said here, that how training can repair some cognitive, some skill; the one case can be said here, it is also said in many forums and many discussions that in a circus, a monkey - a skilled monkey, who can walk on a rope - his specifics grey cells responsible for that skillful walking were damaged. And then it was found that the monkey could not walk properly, but after specific training he could walk again and then what happened? With the impulse given on that specific muscles of leg, it seems response was found in the neighboring cells; means what happens?

If the one cell is inactive in a brain, cell becomes inactive, then neighboring cells can take charge of certain activities, if a specific training or exercise towards regaining that

capability is given; so, in the aging process if that training is maintained properly or exercise is maintained properly, then it can serve good result.

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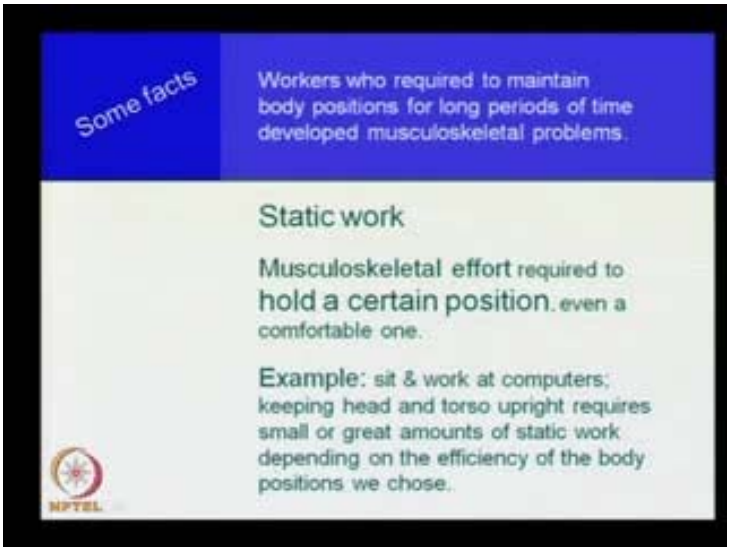

So, these factors we must understand and apply, while in our design development like some facts, that is, workers who required to maintain body positions for long periods of time, developed musculoskeletal problems. A static work musculoskeletal effort required to hold a certain position, even a comfortable one. Example, sit and work at computers; keeping head and torso upright, requires small or great amounts of static work depending on the efficiency of the body positions we choose.

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Now, from this small movie, if we see that specific postures for beating the cotton with this rod. Here we can say that muscle overuse, results in tiny tears in the muscles and the scarring; this contribute to inflammation and muscle stiffness. Work activity should permit the worker to adapt several different healthy and safe postures. Muscle forces should be done by the largest appropriate muscle groups available to exert measured force.

So, these considerations are to be used while developing any design specific to ease this type of activities or to develop a specific method and process of working, where the men can feel easy, comfort while operating we need to consider this.

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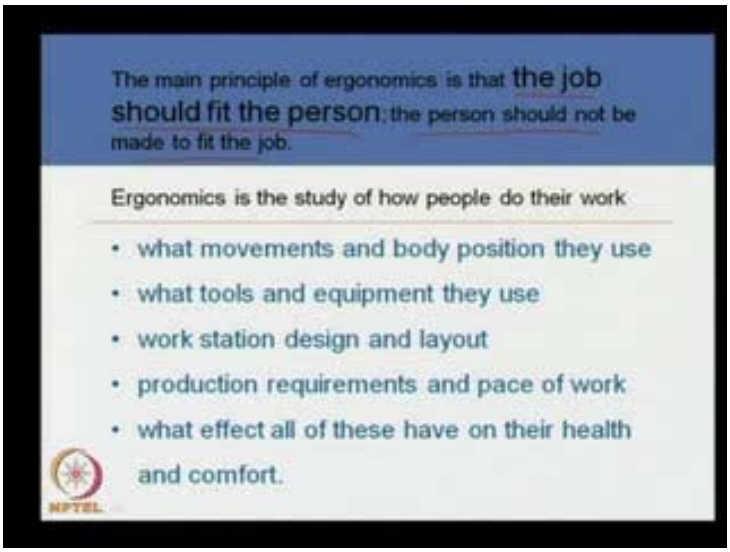

Now, the main principle of ergonomics is that, that job should fit the person; the person should not be made to fit the job. It means man is the prime system component, consider his requirement first and accordingly divides others. Ergonomics is the study of how people do their work - what movements and body positions they use, what tools and equipment they use, what station design and layout, products and requirements and pace of work, what effect all of these have on their health and comfort.

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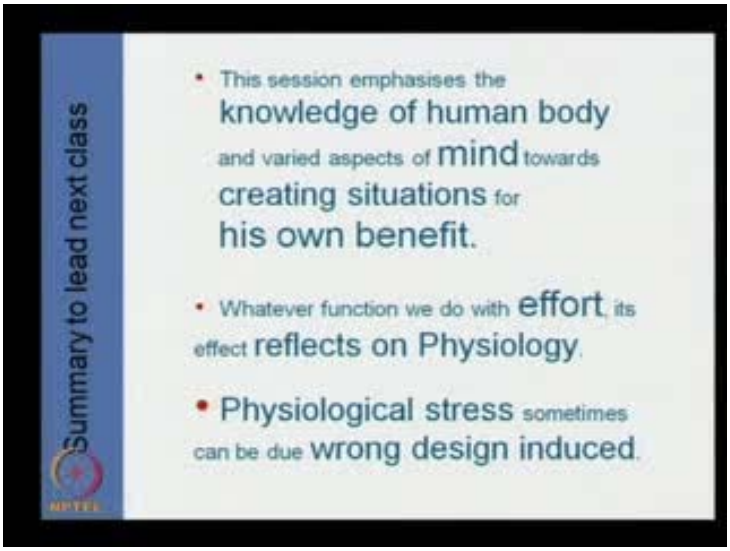

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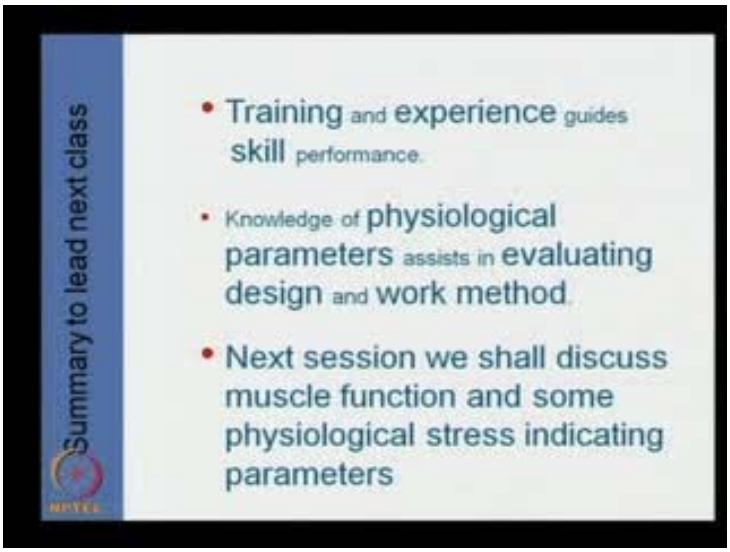

Now, with this, what we understood today, let us summarize it, this will lead our discussion to the next class. So, this session emphasizes the knowledge of human body and varied aspects of mind towards creating situations for his own benefit; whatever function we do with effort, its effect reflects on physiology; physiological stress sometimes can be can be due to wrong design induced; training and experience guides skill performance; knowledge of physiological parameters assists in evaluating design and work method.

Next session we shall discuss muscle function and some physiological stress indicating parameters. So, with this we are concluding today's session and next class, we will discuss some of the physiological aspects specific to the muscles.

Thank you very much.