Ergonomics Workplace Analysis
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Lecture – 06
Assessment of Physical Job Demand

Welcome back to this course Ergonomic Workplace Evaluation. Today, we will be talking about Assessment of Physical Job Demand.

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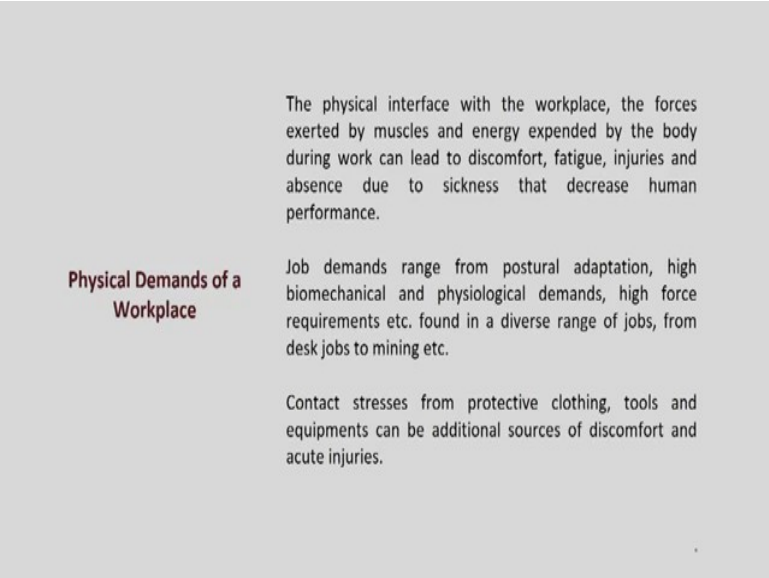

So, let us understand what is physical job demand? When we are in the workplace we are interacting with different physical elements. How we are going to analyze or understand the interaction between human being and those components and the demands of the posture or the physical aspects of those components that we will be coming, or we will be discussing under physical job demands.

So, the physical interface with the workplace like force exerted by particular group of muscle, kind of energy we are using, body posture that we are going to adopt, throughout all these things what kind of discomfort, fatigue, injuries, we are getting or adapting those assessments and how it is going to help for further intervention we will be discussing those aspects here.

So, job demand range from postural adaptation because when suppose I am using a particular instrument how I am adapting my posture to operate that particular instrument; high

biomechanical stress – like you know when we are talking about posture we are definitely talking about different biomechanical aspects of it; then physiological demand, high force requirement. You know it is absolutely present in the kind of environment we are discussing, or we are interacting.

So, contact stresses from protective clothing. You know sometimes it happens we are wearing some protective clothing, but we are getting lot of you know reverse information from that like. Just take an example; we are wearing goggles to protect from glare. So, the demand of the instrument is it should fit with our eyes. Now, when wearing that what is the contact stress is generating? So, we do not know. So, how I am going to analyze it. So, these are kind of things always happen when we are wearing different types of protective clothing. So, sometimes it is not there, sometimes it is there then we need to understand how we are going to evaluate it. So, we will be discussing them.

Various types of tools, equipment that we are going to use always. Suppose I am using a computer mouse. How that computer mouse is interacting with my wrist or with my this particular portion of my hand. So, how I am going to analyze those stress or force exerted while working. So, these are we will be considering in the physical job demand evaluation.

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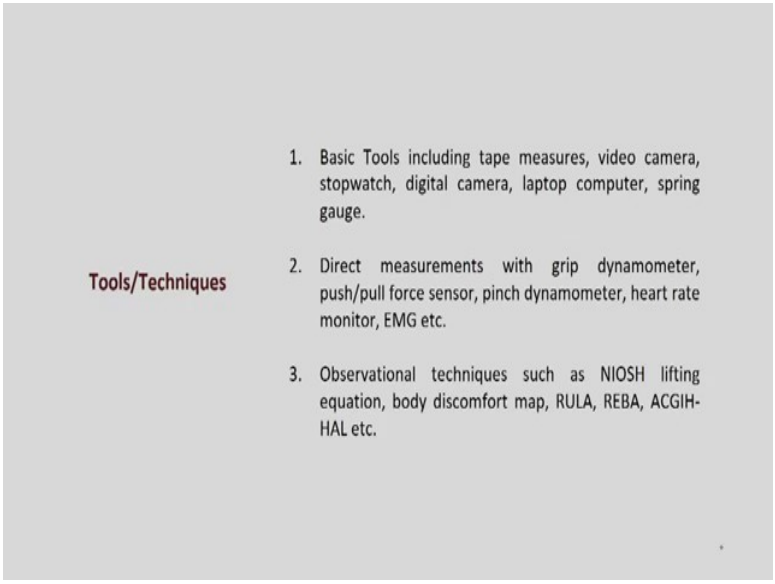

So, basic tool if we talk about physical job demand evaluation or assessment basic tool mainly includes tape measures like you know you have measuring tape, video camera, stopwatch, digital camera, laptop computer, spring gauge and many other something like this. Also, we can do some kind of direct measurements like; grip dynamometer, push-pull force sensor, pinch dynamometer, heart rate monitor, EMG, etc. So, we can measure those also.

So, there are varieties of instruments and varieties of variables are present, which we are going to use during our evaluation or assessment process. It is not possible to explain each one of them, but we will be trying to cover what are majorly used instrument, or majorly used variables in ergonomic workplace assessment.

Further, with the direct measurement we have some techniques that comes under observational techniques such as; RULA, REBA very commonly used names right, then lifting equation, discomfort map we will be talking few of them about the use, their process and the context where we are going to use all these things in this particular day of lecture.

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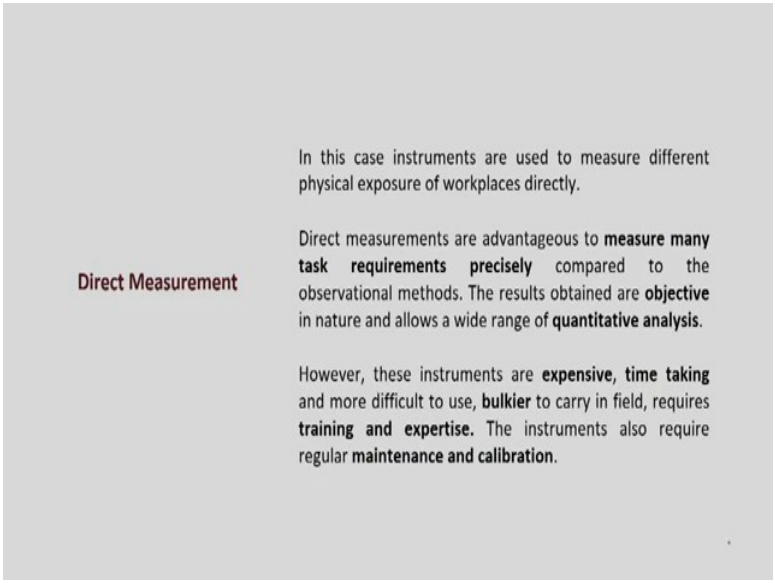

So, let us start with the direct measurement, what it is? In this particular case instruments are used because we are talking about direct. So, we are going to use some kind of instrument to measure different physical exposure of workplace. So, there are varieties of physical exposures we have. So, we are going to measure directly using some kind of instruments.

So, direct measurements have some kind of advantage. What are these? These are like whenever we are using direct measurement these are very precise because we are using instrument to measure some variables from the physical components. Also, the result whatever we are getting from these instruments, or these techniques are objective in nature, and it allows us to varieties of quantitative analysis which is very important many times in our research area.

However, these instruments are very expensive. So, individual researchers when we are doing research individually may be at our own laboratory; it needs real funding very important. So, big laboratories only can afford to have this type of instrument. So, it is a that is major constraint to use this type of direct measurement techniques because the kind of instrument we will be using it is very costly in nature; also it needs time.

So, whenever we start using these kinds of instrument; we need proper time, we need proper experiment set-up to use this, also sometimes we need that each variable, or each instrument how to use it, how to collect that data and analyze that data that needs little training as well as you should be well you know accustomed with the whole system then only you will be able

to collect and analyze the data properly. So, these it needs elaborate setup. So, that also very important aspect.

Also, when we are talking about instrument definitely it needs periodic maintenance and calibration which is very important aspect because, if the instrument is not calibrated properly, you will not get sufficient good data. Also, it needs proper maintenance because you know there are lot of sensors we will be using in the instrument. So, the sensor needs to be maintained and well like stored in the right way. So, those are the important aspect when we are talking about direct measurement.

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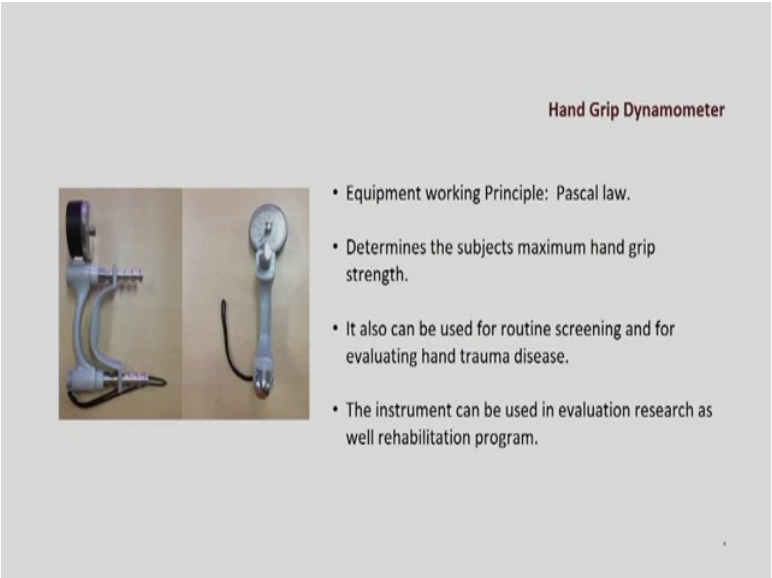

So, now let us start with small and then little we will take you further. Of course, when we are talking about instrument over here we will be in our laboratory experiment, we will be showing few of them not all because the whole course timing is minimum. So, we will not be able to describe all. So, we will be describing few of them. Of course, if you have query for particular instrument you can write back to us, or call back. So that we can explain those specific queries of your question.

So, first, I will talk about very frequently used instrument that is the “hand gripped dynamometer”. This particular instrument is working in the “Pascal law of principle”, what it does? It determines the subjects maximum hand-grip strength, only the hand-grip strength. Now, this handgrip strength dynamo or handgrip dynamometer can be used for your research as well as this is frequently used in clinical field like rehabilitation program.

So, when somebody has some problem, or injury, or any kind of disorder, in their grip strength or grip what we supposed to do? We take measurement using a particular methodology, and we record the data and keep it with us. So, when we are talking about handgrip dynamometer first we need to understand where we are going to use it. So, suppose we are designing an instrument where we need to understand what kind of grip strength we need, or we are going to use for this particular instrument. So, there also we need to understand what kind of strength is possible by that particular population. There we can measure this type of instrument.

Also, in clinical field, this is very useful instrument clinical research where we are talking about you know rehabilitation program. When a person is having any injury or any kind of disorders in the wrists or the hand we what we do is we measure the strength handgrip strength using this particular dynamometer and then we start the rehabilitation program. And periodically we check how this is being increasing the strength is being increasing or not.

So, this is the major use of hands in the dynamometer. So, you can you know use for your routine screening also. Suppose, there is a set of worker who are working in a particular job with their repeated hand movement or hand motion. So, you can have a periodic check or throughout the day also sometimes periodic check that is there any impact of that particular repetitive motion or the forceful exertion on the hand strength or grip strength or not. So, for that also we can use. So, based on your research area, based on your study area you can find out where you are going to use this particular data.

Also, there are some set of normative value like you know standard value with that we can compare and tell is how my data looks like. Now, the constraint is there are very limited set of data available in Indian context. So, there is an opportunity to you know gather data, and you know we can publish for our future reference.

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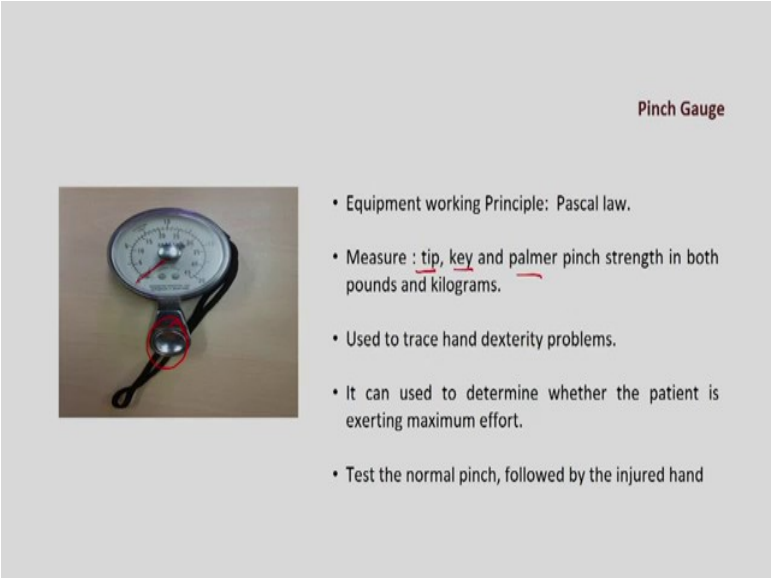

Same as for your pinch gauge. So, this is again is being used based on “Pascal law” and what we do is? We measure tip pinch, key pinch, and palmer pinch. These are the three varieties of pinch we use. So, what is where the sensor is? Here we have the sensor, and we asked them to hold the instrument with their particular position based on tip pinch, key pinch, or palmer pinch.

What we do is this particular dial we set at 0. This particular the key we set it at 0 and ask them to hold it or keep continue the pressure for 1 to 2 seconds, then we ask them to release it. Once the pressure is being released that pointer comes back to the normal and another pointer stays back there. So, then we can measure, or we can record that value. So, that way we use pinch gauge.

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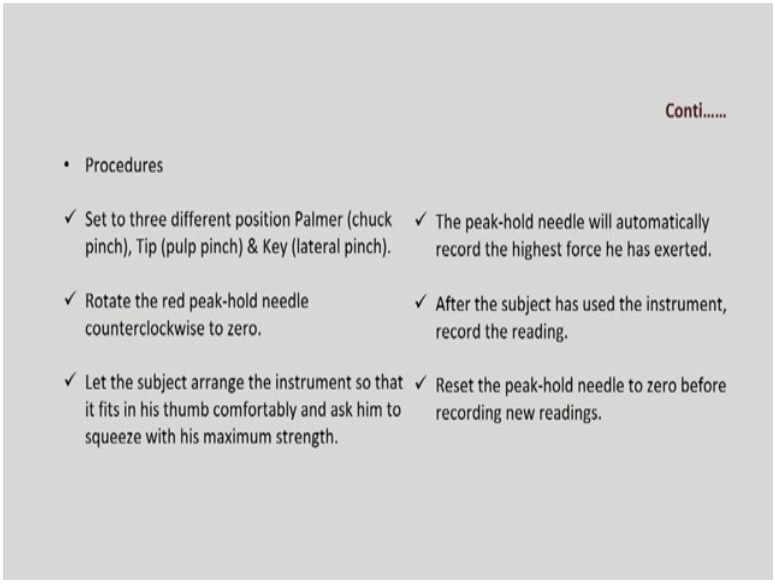

Now, this is the procedure what I have tried to jot it down for you.

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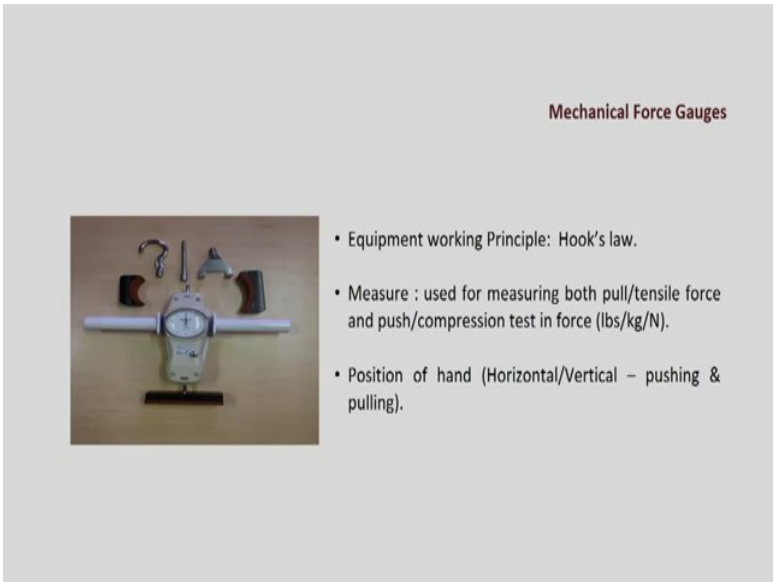

Now, another very important instrument that we normally use is the mechanical force gauges. This particular instrument is being used for pull or push that is the major use of this particular instrument, and the reading is being recorded by the pound, kg, or Newton. This instrument is based on "Hook's law". So, now I am not going to tell in detail of all these instruments. So, if you find this particular instrument is useful or this particular variable is useful for your

research or your study then you can study in detail and then if you have any query, you can call back us.

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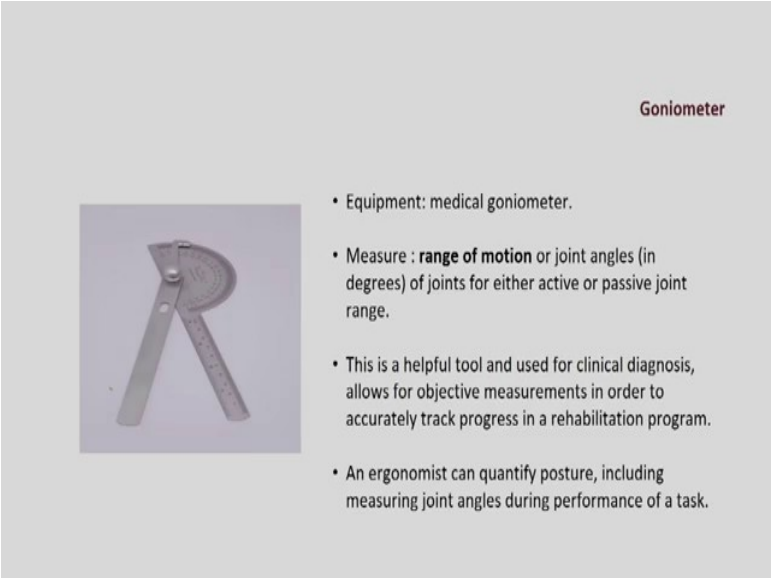

This is very one of the important instrument when we are talking about the posture or angular movement. So, that this particular instrument named as goniometer. So, this is a medical goniometer, and it is normally is being used for the range of motion. Range of motion means if you have a joint movement, so, from which range to which range it is going to move, that particular range we are going to measure ok.

Now, this is also being used in the clinical or medical field, and mainly for the rehabilitation program to understand the periodic development of the patient. Also, we can use for our research purpose like; physically measurement of the particular workplace.

So, suppose I am going to design a particular workspace envelope. Now, if I am talking about only sitting posture and my right-hand movement, then how my arm is going to move and how I am going to accommodate all the required elements of my job within that particular envelope. So, when I am going to discuss that or when I am going to arrange that, we need this type of instrument for our purpose.

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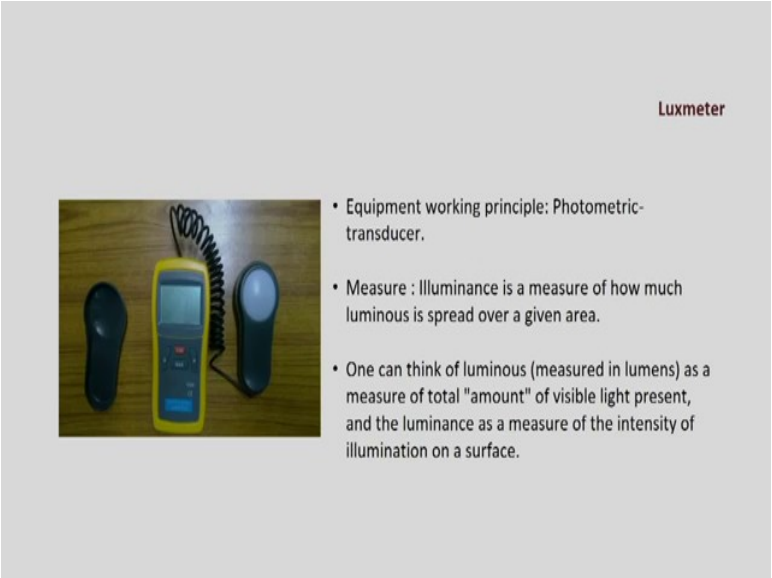

Now, once we do this, also I should tell little bit about the physical environment like; illumination, ventilation, and all. So, first I will talk about luxmeter. This particular instrument is being used to understand the illuminicity of the particular workplace, it is based on the photometric transducer this particular principle they follow and what it does it try to measure the luminous of a particular workplace. Now, here the question is where I should measure? The measurement of luminance is should be on the work surface.

Now, we cannot determine this is the place, or that is the place, based on my requirement based on the kind of or nature of workspace or workplace we have we need to decide where we are going to measure the luminous ok. So, suppose my main job is desk-based and I am going to work, or I am going to do some kind of assembly job at my desk. So, I need illumination to measure on that particular desk.

Now, when I am talking about the classroom environment, and someone teacher is teaching then I should understand what kind of visual clarity I have on the blackboard maybe if my objective is one of them, then I should may understand. Then I should again go and check back the level of illumination we have at the on the blackboard or the screen of your projector.

So, based on my requirement, the positions will be changing. So, it cannot be fixed, but still there are varieties of standards available which says based on the work what amount of illuminates we meet for a particular job. So, once you collect your data then you can refer

back to those standards BIS is available, ISO is available. So, you can go back and check with them, and compare, and recommend or change your design in such a way so that you reach the required standard or benchmark.

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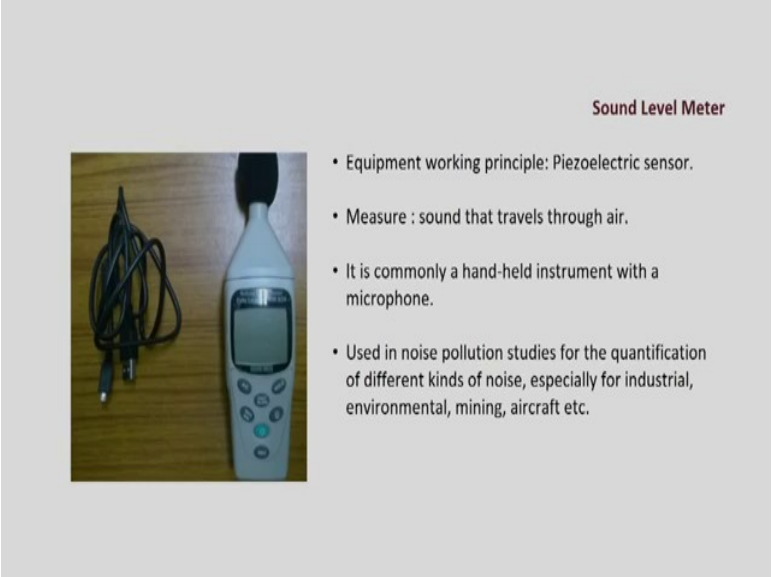

Same as for noise the name of this instrument is sound level meter. This is only one make; there are varieties of make. So, even this thing is applicable for other instruments whatever I showed the picture these are the things what we have in our laboratory. So, I can show you those pictures only, but there are other makes also. So, you can use any one of them based on your requirement. So, it is this particular instrument is being used or is working on the principle of piezoelectric sensor.

So, what it does? It measures the sound that travels through the air. So, this particular instrument again it can be used for any industry, it can be used for you know environmental or you know noise-level measurement. So, here though both can be possible – one is your personal noise, another is for you area noise. So, based on your study area, based on your requirement you can decide, and you can start collecting data this is not only the. This is not the only one instrument we have varieties sizes of instrument available as per as the sound level meter is concerned.

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Now, this is a very interesting instrument. This is apart from that we have many other we call a "thermal environment meter". So, let us talk about the thermal environment. So, this is one instrument which measures air temperature, relative humidity, and air-speed. We have some instrument which can measure you know air temperature separately, dry and wet.

Some instruments are there which can measure the air-speed separately. But, what we need actually is the different measurement of these variables because, when we are talking about thermal environment as we discussed in the earlier presentation or earlier classes that when we are talking about thermal environment we have varieties of indices; WBGT index, ET, and all those. So, for that we need this type of instrument.

Where, we are going to use them? We can use wherever we need to understand the impact of thermal environment on the physical aspect of the worker like productivity or the comfort or you know kind of workflow they are doing. So, if we need to understand those we can use any one of these instruments. This is just only one. We have other instruments also to understand the air temperature, relative humidity and air speed.

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Now, let us talk little bit about vibration. I think you must be knowing there are two types of major vibration that is the hand-arm vibration and whole-body vibration and we have one instrument that we call as vibration analyzer. There are varieties of make available. Based on your the finance and the availability of the instrument you can use any one of them.

What exactly we do over here is the vibration we measure the kind of vibration we have in the source, as well as how much it is getting transmitted towards your body, as well as we need to understand what kind of acceleration is happening that we do with this particular instrument. If we get a chance to explore, then we will be discussing this one in the laboratory experiment part. Now, these are what we discussed earlier these are all direct measurement.

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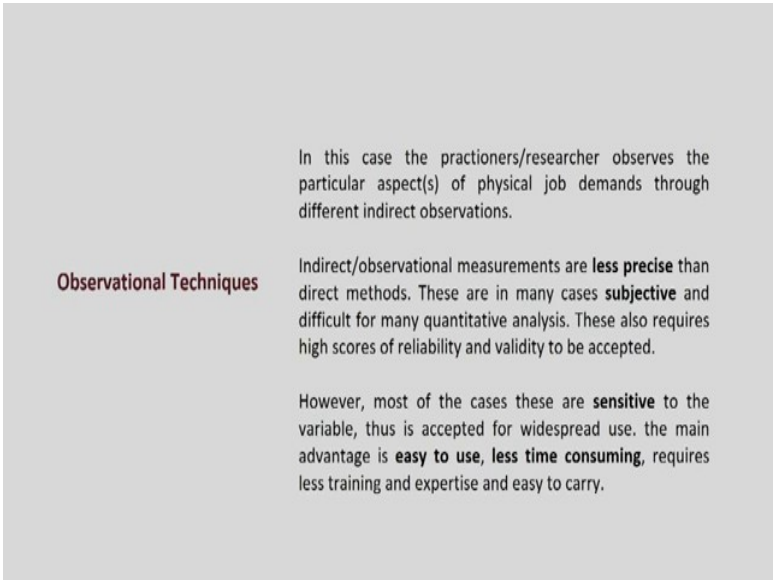

Apart from that, EMG, ECG, eye-tracking system, there are varieties of direct measurement system available right. So, I just gave the few of them to let you know that, what type of them are available and how you can use it.

So, now, once direct measurement, you understood, let me tell a little bit about the observational technique or indirect measurements. So, by nomenclature itself you can understand what it is. It through your observation, through your discussion you are going to analyze few of the variables which is important when you are talking about ergonomic workplace assessment.

So, when we do not have such kind of instrument direct measurement tools, then are we are dependent on this type of observational technique. Also, in many cases we have instrument, but we do not have scope to use it. So, those cases also we need to use observational techniques.

So, what is the advantage of this? It is not that precision like the precision rate is not that high as the direct observation direct measurement has, but it is less exhaustive like you do not need to have elaborate experimental setup. As this particular type of instrument or tool is you know has subjective responses we take care of subjective responses then lot of participatory methods also is being taken care. So, it is very important that we interact with the human who is actually working in the workplace. So, understanding about their perception, it is less time consuming, very important. Most of the cases these are sensitive to the variables.

Now, just take an example. We are talking about the thermal environment; physical thermal environment. We have instrument; we measured air temperature, air velocity, then humidity and we found out the kind of impact we have on the temperature on the human body or kind of indexes we have. So, is it good bad or whatever.

Now, let us understand with that particular environment how a human being is giving or is perceiving that particular environment. Now, if you talk about a thermal environment where heat is little high and through measurement, we found it is not really conducive to work, but if you go and ask those people who are working on the field they may not really give the exact similar you know responses how we found through the instrument.

Why that happens? It happens because of acclimatization right because the person is already adopted because our physiology setup is already being modified according to that particular temperature. So, when we are going to do the design intervention or any ergonomic intervention we really cannot only dependent on the instrumental measurement. We really also know to know what kind of responses we have from those subject who are working or who are actually been there in that particular environment. Therefore, subjective responses or these type of observational techniques are very important in certain cases.

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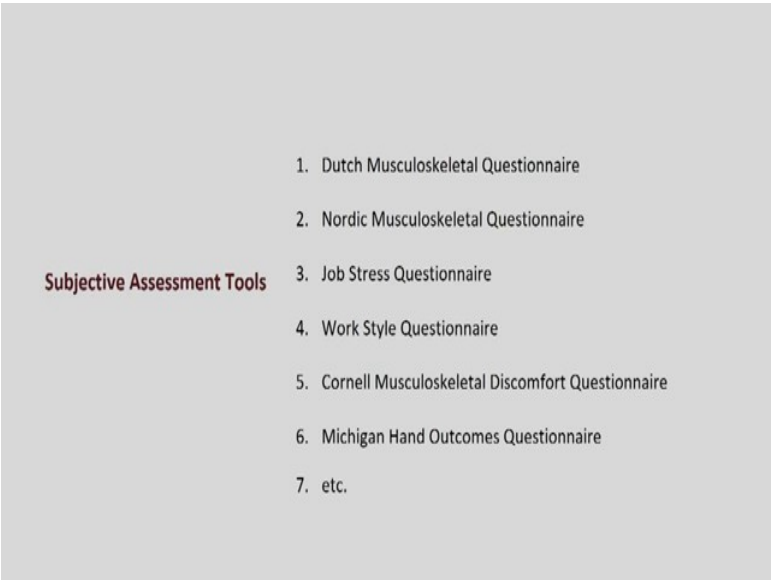

So, let us understand a few of them. Whenever we are talking about ergonomic workplace evaluation very important aspect is musculoskeletal disorder right. So, to understand that, we have varieties of questionnaire: I am naming here few of them: mainly Dutch musculoskeletal questionnaire, Nordic musculoskeletal questionnaire. There are many others even there are some questionnaire; which is very much body parts specific like low back, or shoulder, or hand wrist. So, there are varieties. So, again I am telling the same thing that based on your requirement you should choose where and which tool to be used.

There are job stress questionnaire which evaluates kind of job stress we have in the environment. Work style questionnaire; again one more instrument for musculoskeletal disorder is Cornell musculoskeletal discomfort questionnaire very important; Michigan hand outcomes questionnaire and many others. I am going to only mention few of them and also some elaboration only in Dutch and Nordic musculoskeletal questionnaire.

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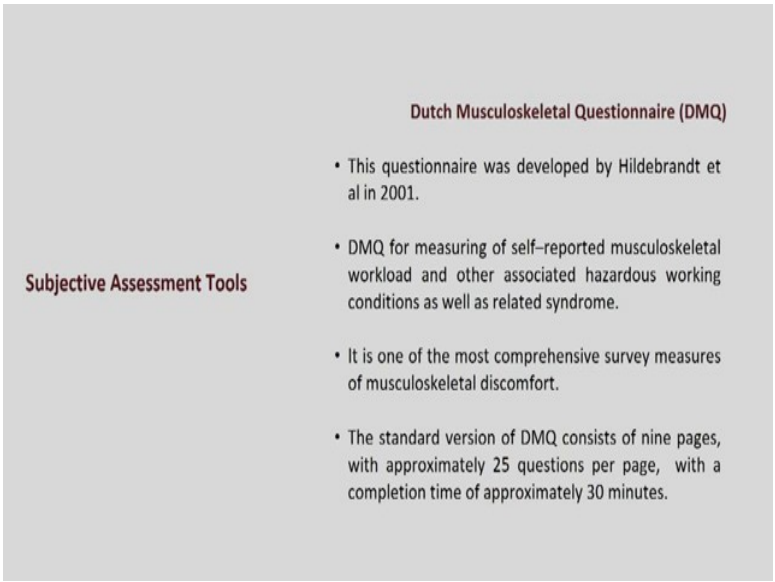

So, subjective assessment tool under that let us understand Dutch musculoskeletal questionnaire. It is developed in 2001, is not a very old questionnaire. So, what it does? It talks about self-report. So, in the environment, in the workplace there are people working and you found we need to understand the status of the musculoskeletal health or the kind of prevalence we have in that particular area.

So, we are going to ask people who are working. So, it is, and we are going to take those responses. So, it talks about the self-reported musculoskeletal workload and other associated hazardous working condition. Also, it helps to understand the related syndrome. So, syndromes maybe, you know there are some reports of particular disorder or particular phenomena or symptoms, then we are going to collect those data as well as we are going to use Dutch musculoskeletal questionnaire and we are going to associate them or we are going to relate them. Then we are going to go back to their cause root cause analysis and maybe once we find out we analyze that and we interpret that we may go for intervention.

So, it helps us to navigate the source of problem. It is one of the most comprehensive survey measured. So, very important, it is very comprehensive. This particular Dutch musculoskeletal questionnaire is total the whole one is consists of 9 pages, and each page has 25 questions. So, if we are going to conduct or if we are going to get survey from this particular questionnaire it takes around 30 minutes to complete one set of questionnaire. Yes, it is time-consuming, but it gives lot of details. So, depending on your case you can choose this or you can choose any others.

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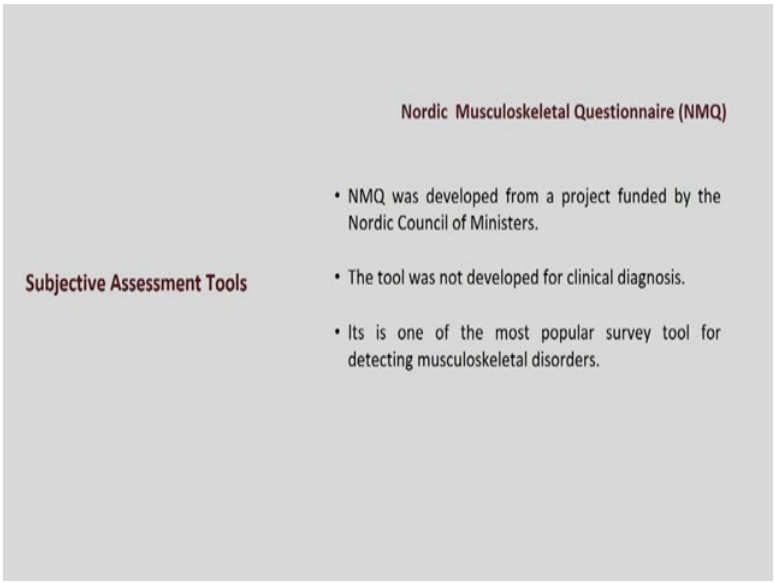

Nordic musculoskeletal questionnaire, it is a very common name, and I think whoever is working in the field of ergonomics in the place of workplace evaluation they are definitely going to use this particular Nordic musculoskeletal questionnaire. This particular

questionnaire was developed by Nordic council of minister. It was actually a funded project and from that this particular questionnaire came out as an outcome.

Here the important thing is this particular questionnaire is not being developed for clinical diagnosis, it is just subjective responses. So, we cannot use it just for a clinical diagnosis. So, very important point what I would like to mention for you because many times it happens that we are going to use this particular questionnaire, we are getting a data, and we found yes, this is a clinically diagnosed problem. No, this is not. This is just a response collected from the subject.

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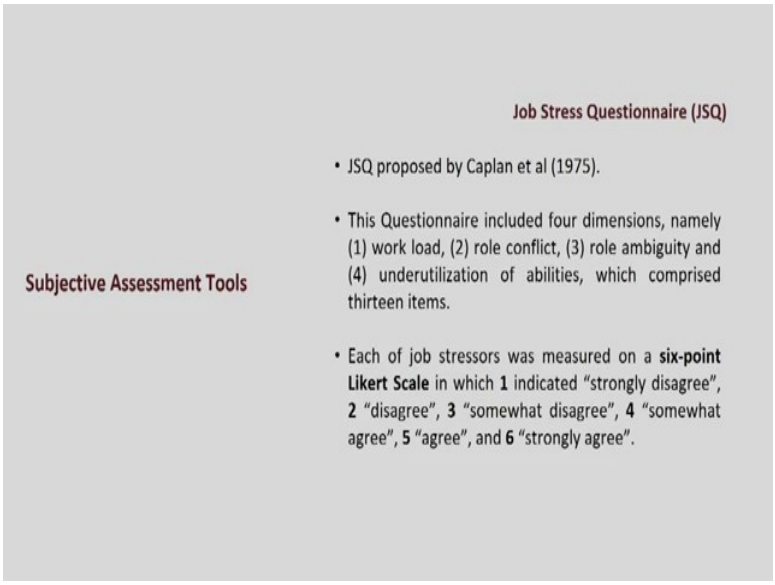

Job stress questionnaire – this is being developed in 1975 by Caplan. What it does? It is very important when we are talking about job stress; we need to know about the workload, work conflict, and all those things. So, this particular questionnaire has major four components; first one is workload role, conflict role, ambiguity and underutilization of your ability.

So, when we are talking about all these four factors or four components, all these things are being analyzed or interpreted based on total six-point Likert Scale. First one is like the 1, it represent that I am agree, the strongly disagree with that particular question. Second number 2, it is only disagree; 3, somewhat disagree, then somewhat agree, agree and strongly disagree.

So, like that, we have the intensity rating of those particular 13 items. So, based on that we are going to understand the value of workload, work role, conflict role, ambiguity and underutilization of your ability. So, with these maybe we can have some objective data, and again we can correlate we can go for a final result. So, these are not only the questionnaire. There are many others I am just giving some example.

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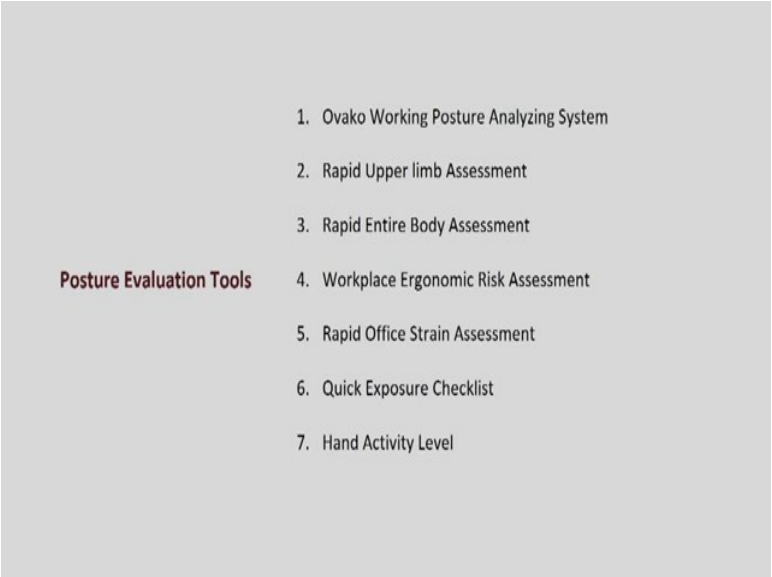

Now, when we do that, let us understand little bit about the posture evaluation because posture evaluation also sometimes it is subjective. Like we are talking about observation grading them and rating this posture is not good, this posture is ok, this posture is bad something like that.

So, there are varieties of method available. Let me name them few of them; one is OWAS, RULA, REBA, Workplace Ergonomic Risk Assessment, ROSA, QEC, Hand Activity Level, and many others. I will explain few of them. Those are very commonly used I will name them and rest you can find out these all are available in any textbook and you can refer them, you can use them, and if you find any difficulties please contact back.

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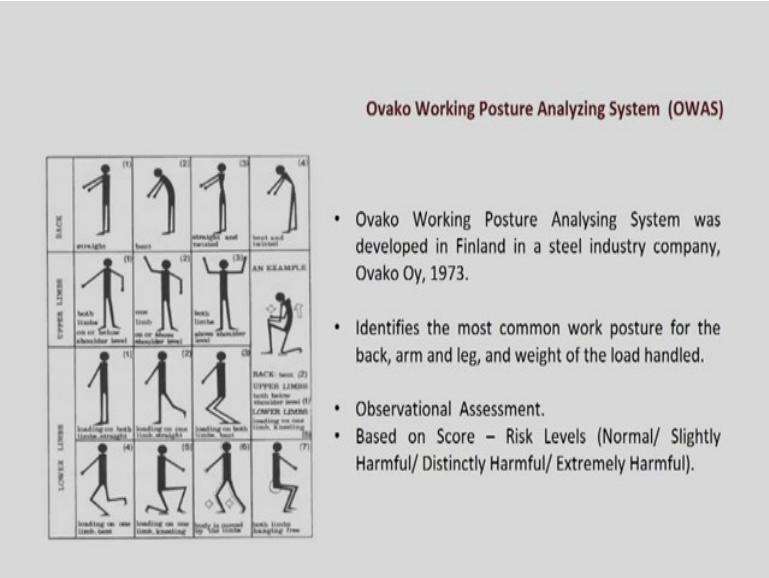

So, the first important work posture evaluation tool that is being used and is being modified further is the Ovako Working Posture Analyzing System (OWAS). This is being developed in 1973. Yes, there was a company that is a steel company, and the name of the company was Ovako and based on their name this analysis tool named as Ovako Work Posture Analysis tool.

What it does? It identify the most common work posture for the back, arm, leg, and the weight we are going to use, or we are going to expose to that. So, these are the major components of this particular working posture and based on that we have the intensity rating, the risk level basically we call it for posture analysis. So, normal means we are with the posture, slightly harmful, distinctly harmful and extremely harmful.

So, whenever we understand yes if the working posture is normal then we will say we may continue the posture; but if you find a harmful, yes, there is some problem. So, we need to find out that like that if we go and go then we will get distinctly harmful or extremely harmful. So, if it is extremely harmful; that means, he says that we need to do any kind of intervention or any kind of changes in the work pattern immediately.

So, this is just an indication tool that helps us to understand there is a requirement of posture modification. So, posture modification is again associated with the workplace equipment modification right so, how we are going to do that. So, it helps us to understand what kind of like which way we should go ahead.

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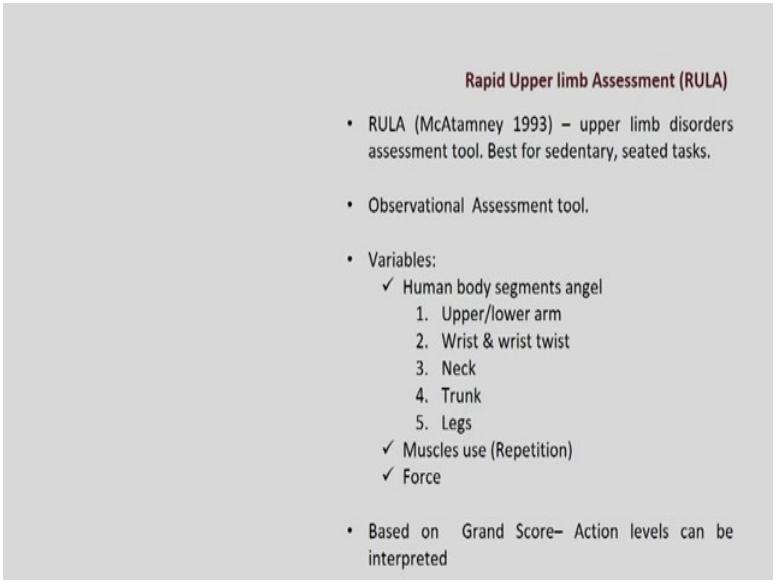

Similarly, we have RULA, which is only for sitting posture. When somebody is sitting further, we are in a sedentary job. There only we are going to use this particular tool. So, sedentary sitting posture job we are going to use it.

So, again here we have upper and lower arm, wrist and wrist twist, neck, trunk, legs. Further we have muscle use code that is that helps to understand the repetition and force. So, using all these things we are going to get similar kind of result as OWAS. This particular tool is developed in 1993 by McAtamney et al.

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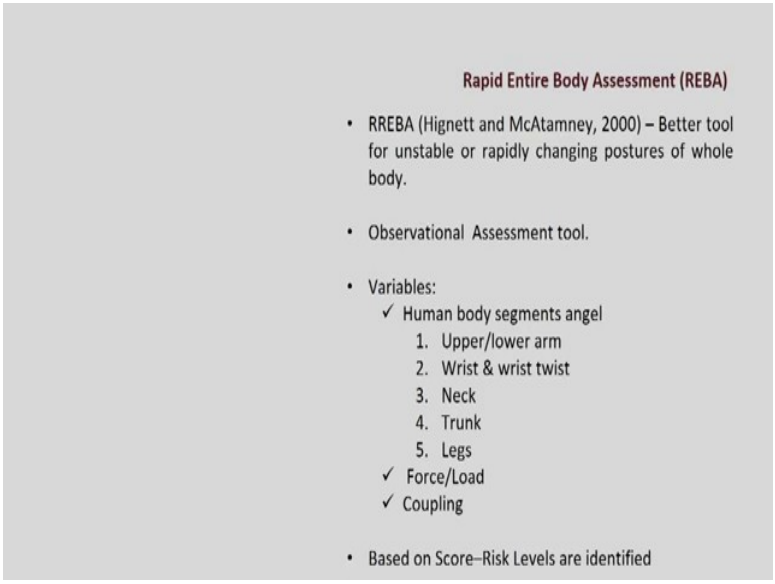

One more important tool for posture evaluation is REBA that is Rapid Entire Body Assessment system. It is very new tool, and it is you know developed in 2000, again similar type of assessment. So, for all these assessments of posture, we have pre-computed table; we can go back to the literature, find out those table, you can get those value and finally, you can check your the grading of your final risk code. So, once you understand what is the level of your final risk score, you tell that, yes, there is a problem or there is no problem. So, that is the way you should use any posture evaluation tool here I named only three.

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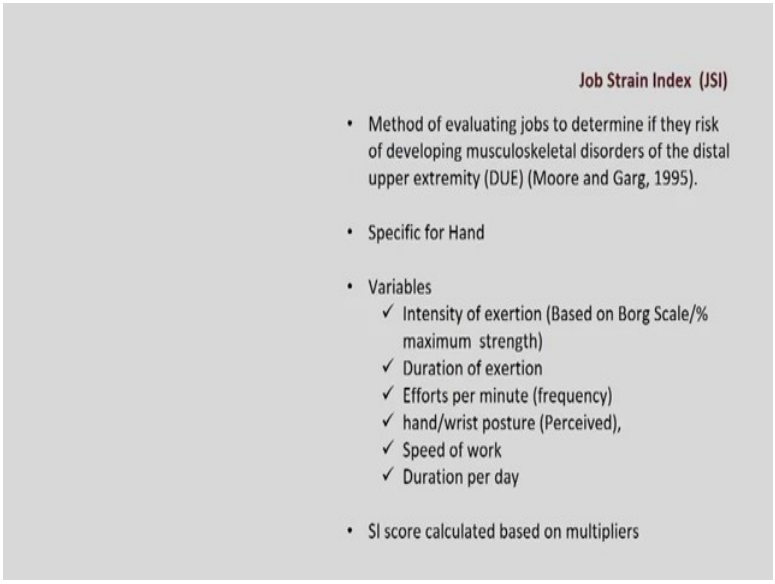

Now, let us talk a little bit about job strain index. It is again developed by the by Moore and Garg. It talks only about the distal upper extremity. If you have found in the from various sources or various problem that you know there is an issue with the distal upper extremity, you need to know how intensive that is. There you can use the job strain index, and you can find that level of intensity.

Here we use total six variables. First one is intensity of exertion, duration of exertion, efforts per minute, hand-wrist posture, speed of work and duration per day. Using all these variables, we have multipliers, and from the multiplier we calculate the size score that is the strain index. So, it is all the multiplication of these multipliers. And we have the intensity rating, pre-computed intensity rating. You compare your SI score with the referred SI score, and then you tell that where your strain index is and how you are going to design it or modify it.

So, for the detailed paper, you can refer Moore and Garg's 1995, that development paper you will get all the method how to calculate or how to execute to that.

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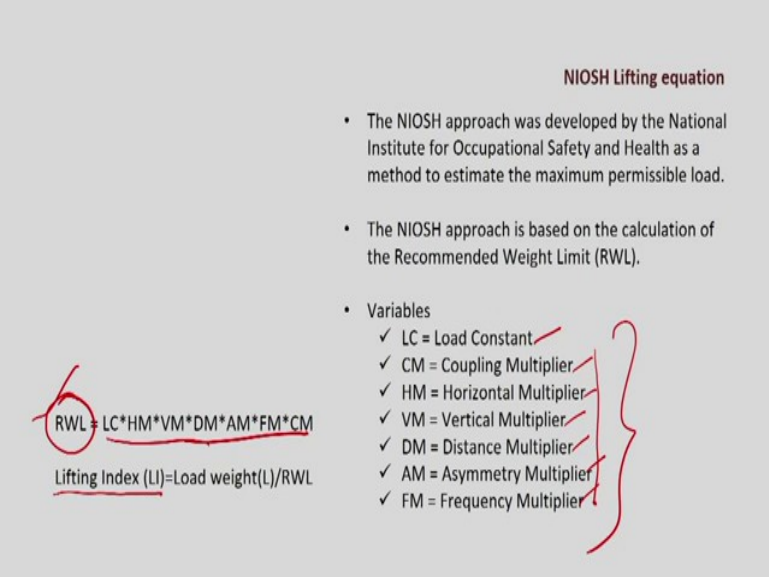

Once we are talking about strain index, definitely I should mention one important component or one important tool that is the NIOSH lifting equation. This is basically a revised equation. From this particular equation, what we get is recommended weight limit; that means when we are doing a lifting job or a lowering job, how much weight I should lift or lower for a particular situation. So, that is the use of this particular tool.

Here again, these are the variables, load constant, coupling multiplier, horizontal multiplier, vertical multiplier, distance multiplier, asymmetry multiplier, frequency multiplier. All these components you have various specific definitions. So, if you are interested you can refer those definition and based on those definition you can measure your measurement. And then you can use this particular formula, and you can find out what is recommended weight limit for that particular context.

So, once you understand your recommended work limit, you need to know that is it good or is it bad. So, for that, you have a variable that is called lifting index. So, lifting index is actual weight what you are lifting or lowering right now divided by your recommended weight limit. So, if it is high, then it will be more than 1. So, then if it is more than 1; that means, you are actually lifting more than what is recommended.

So, what you should do? Either you should modify or any one of these factors so that your recommended weight limit goes on the higher side. And you can accommodate the kind of load right now you are lifting is matching to that. If not possible then you reduce the amount of load that you are lifting or lowering. So, this is the way how you should use the NIOSH lifting equation.

But, here if you see the current situation there are because of lot of mechanical instrumentation or mechanical tool we are not really using lot of mechanical you know manual lifting or manual lowering, still many places that is available. So, we need to use those only those cases not everywhere.

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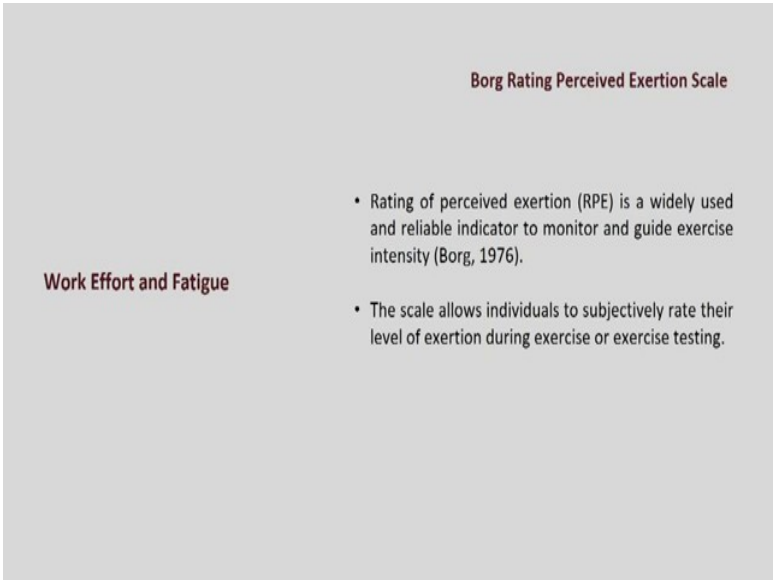

When we are talking about working in the particular environment definitely we are getting a fatigue response. So, how much I am getting exerted in a particular situation or particular context we have some kind of scale which helps us to understand that is the perceived exertion. So, rating of perceived exertion; mean in the beginning it has been developed by Professor Borg in 1976 and further it has been modified in subsequent year.

So, the first scale what we have that starts with 6, and ends at 20; the other scale which is being modified from this it starts with 0.2 like 0.2 and then ends at 11 and finally, like extreme point of exertion. So, based on that, you can use any one of them. Majorly when we have physical exertion we use this 6 to 20 scale when we are sedentary, then we use this category the second one that is the category ratio scale.

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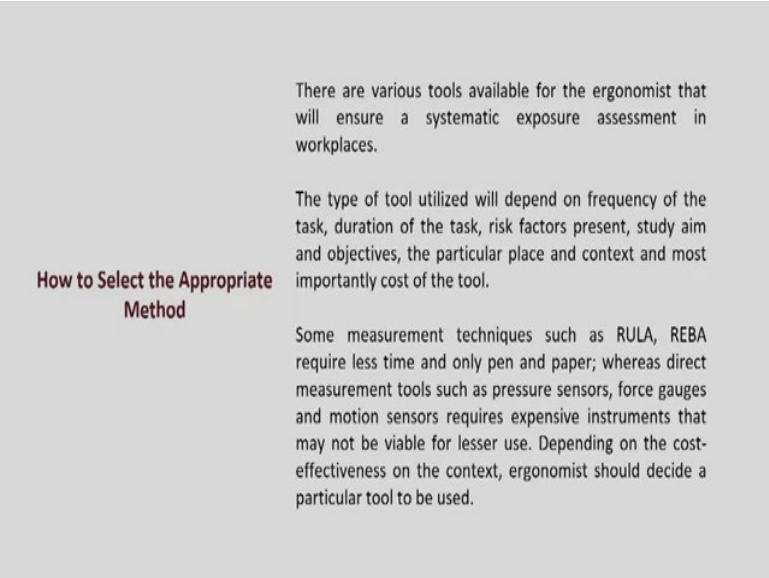

So, once we understood all these varieties of scale so, whatever I named these are not only the limit you have 'n' number of tools, or techniques in terms of physical you know direct and indirect measurement available. Now, question is where you are going to use it and how you are going to use it. Again, same point what I mentioned earlier, it absolutely based on your aim and objective of the study.

The kind of context you are using this particular tool. So, study objectives, study design, study context is very important that how you are going to choose those tool. It is recommended that once you choose any tool or any instrument for your particular study, first you do a small pilot experiment. You see that how data is behaving and how those data actually is representing or answering the kind of objective you are aiming to. So, once you finalize that part you understand the pilot data, then you go for final analysis or final data collection or final experiment.

So, it is always better you do all these important aspect or permutation combination of a different technique. One more important thing is each tool is not validated or useful for each context. So, whenever you are using them you please check the utility of those particular tools, maybe it is direct or indirect in your context. So, that is important aspect.

Again, I will be giving you some assignment. You can use you know through assignment and through your own understanding, you can take up all these tools and many others, and you

can find out how you are going to use it. So, once you finalize that if you find ok, then you can start using; if you have any difficulties you can write back, and you will get that answer.

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So, these are the books normally we follow. It has all varieties of description in detail. So, you can refer this book, and of course, in the examination we will be taking few of the questions from this as well.

Thank you.