Ergonomics for beginners Industrial design Perspective

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Module No. # 09

Performance support and design intervention

Lecture No. # 38

Vertical arm reach and relevant design application possibility- workstation craft

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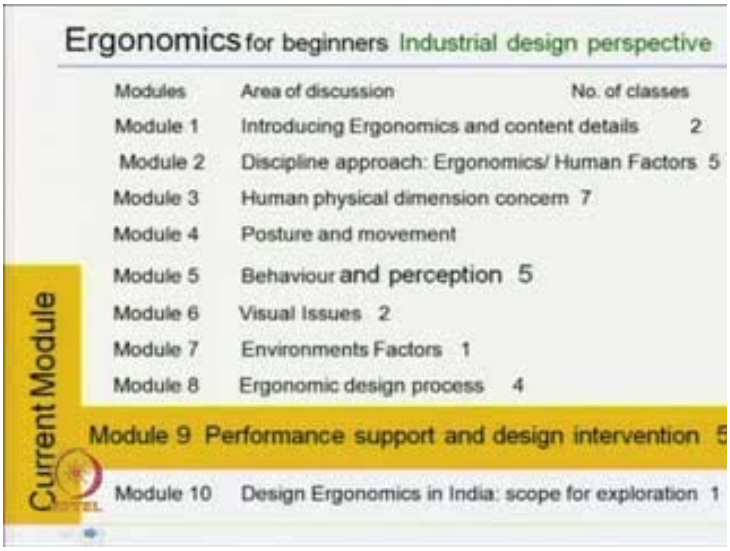

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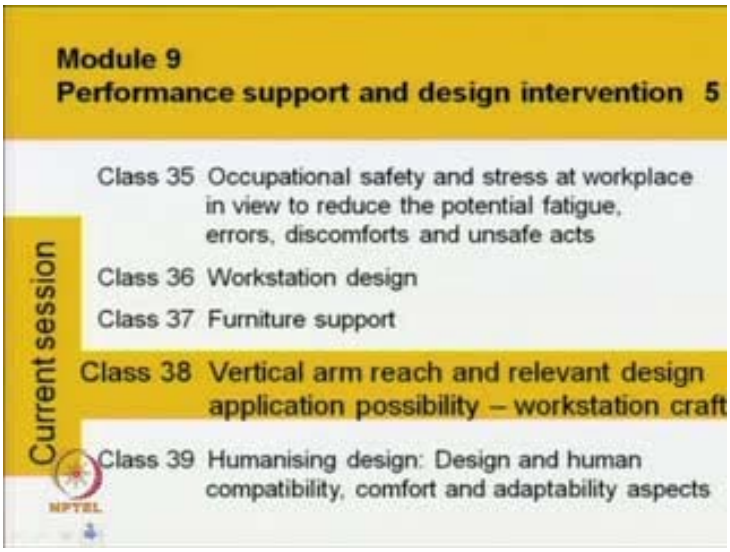

Welcome to the thirty eighth session of ergonomics for beginners industrial design perspective. The current module is module number 9, performance support and intervention or the fifth session or fifth class. In this total 5 classes, today, the current session is class number 38, the vertical arm reach and relevant design application possibility - workstation craft sector.

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Gist of last session in last class, we have discussed four design ideation exercises that satisfy specific requirements, and examples shown: as a multipurpose hostel table; a mobile lecture delivery assistive trolley; a student's classroom drawing table with sit-stand facility; a school classroom seat-desk furniture design. These were discussed in last classes and in summary, whatever we discussed can be said that, the design development attempt must have proper need identification, followed by design ideation exercise and incorporation of context specific human compatibility and comfort issues.

Similar to the above mentioned concepts that we have discussed in last class in class number 37, the relevant need based and anticipated need based design ideation exercises may be initiated to meet our varied nature requirements.

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So with this background, in today's session class number 38, we are going to discuss vertical arm reach and relevant design application possibilities, and ergonomic workstation for craft sector. We are going to discuss in this area that brass metal activity.

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In earlier sessions, we have discussed, body dimension match relevant issues and ergonomics criteria that influences design. The present deliberation focuses on some workstation application of vertical arm reach.

So, with this today's discussion, we are dividing it into two groups - the first part is that vertical arm reach related and second is workstation for a metal brass metal craft.

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So, in earlier sessions we have discussed these arm reach values and etcetera. And, now in this we are just giving some recollection of those issues like, in this figure in a machine work condition, it is said that the task should be within the arm reaching means, what happens normally is said that, if this is within 150 degree angle then one can perform skillful activity. So, it would be better to keep all the controls of the machine or wherever you need to touch; it may be upper shelf etcetera but it should be within that limit.

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Now, if you stretch, then in this figure it is said that the person taking books from the top shelf with a stretching body, he will be using maximum upper arm reach. Here, it is very difficult to select specific books and handle very carefully while taking out since that book may fall or something like that.

So, then what can be done here? Either to provide some support so that the person can be raise up or design something. So that these books, etcetera will be within the easy reach.

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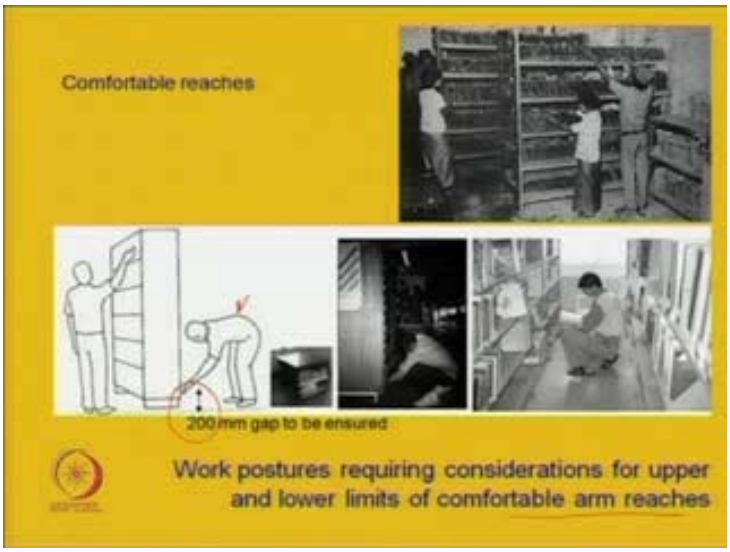

Now, this comfortable arm zone; here, it is also said that the same thing; not only that upper arm reach, lower arm reach is also required that around 20 millimeter gap to be ensured at below so that stretch will be less. This part have already discussed earlier but now, here we are stressing on that work posture requiring considerations for upper and lower limits of comfortable arm reaches have to be ensured where, we need to perform some skillful activities.

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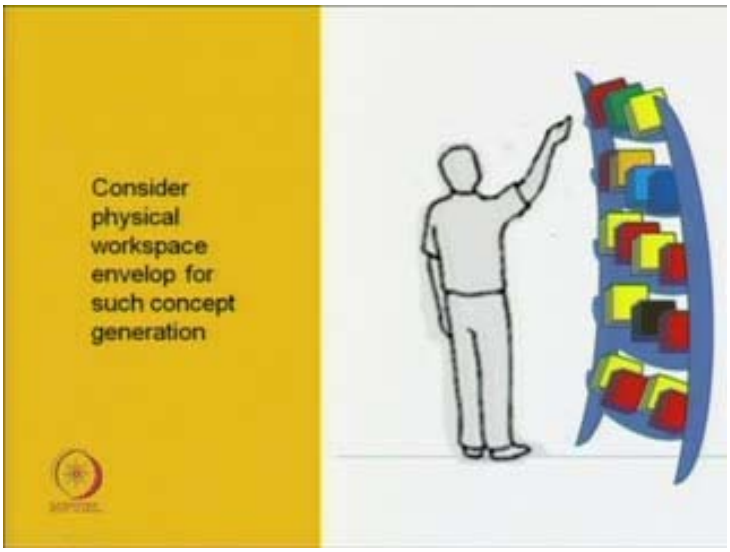

Earlier, we have discussed that arm space envelop and the total arm arc and the vision arc. So with that, this type of some rack design is possible where the total surface area may be as a card appearance and the topmost will be within arm reach. So, consider physical workspace envelop for such concept generation.

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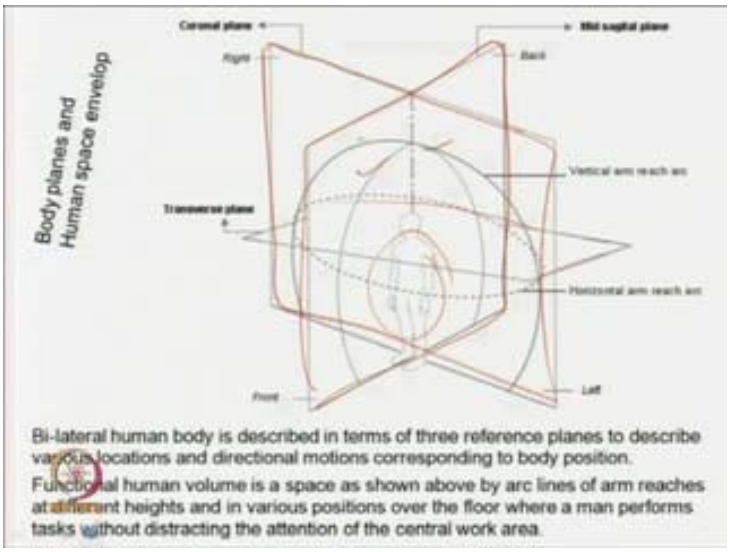

Then, what is the human body envelop, workspace envelop? if a person stands here and from that, if this is the vertebral main axis, central axis and so, the different parts. If you make in three different plane; like that, if this is the plane we are mentioning so then, right side and left side will be there and then, if we see this direction then back and front and if we have a transfer section then it becomes upper and lower portion and then all these arcs are the arm arcs means what happens is, when we raise our arm, extend our arm and then this is like this, this is a total arm arc at different height heights.

So, the bilateral human body is described in terms of three reference planes to describe various locations and directional motions corresponding to body position. Functional human volume is a space as shown above by arc lines of arm reaches at different heights and the various positions over the floor where, a man performs tasks without distracting the attention of the central work area.

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Some examples: height fixing the top platforms requiring easy reach height and here, it should not be the full vertical arm reach. Now, the total workspace if you see for this purpose then the bending space, height reach, lower reach etcetera has to be considered.

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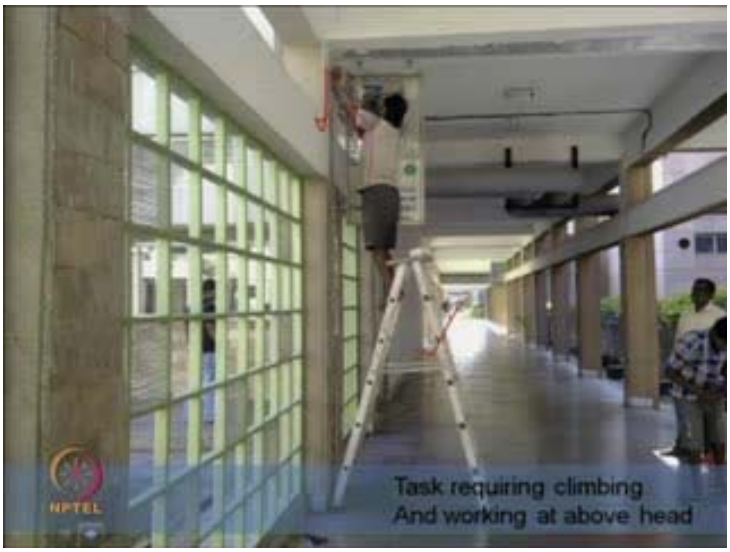

In this case, not only all the tasks are performed on a ground level sometimes what happens, the task requiring climbing. Now in this climbing, after climbing and working at the above head level so, at this position what will be the controllable upper arm reach? If this arm is extended beyond around 150 degree angle normally, then additional stress appears. So, it should be like so, then with that either you increase the support system, or you decrease the working point, or have a design in such a way that the task can be performed nicely.

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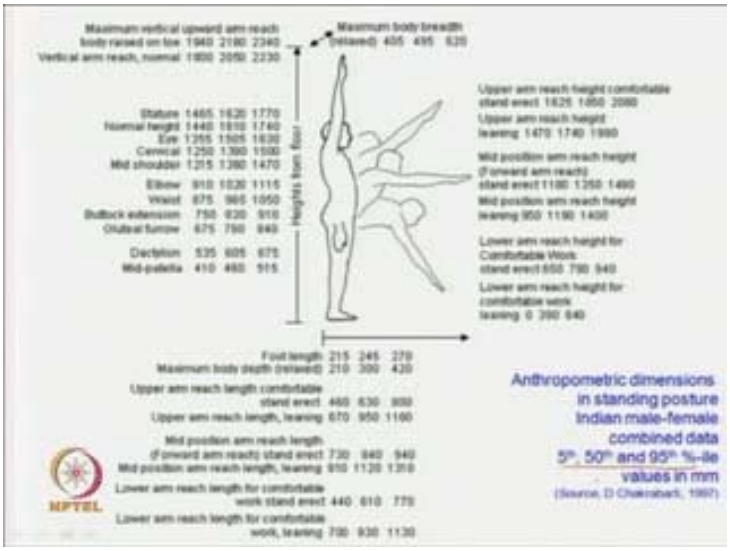

So, for general dimensions now what we were discussing is it requires some dimension then where these dimensions are available? So, in this slide some specific anthropometric dimensions are provided here for male and female combined data source. Here fifth, fiftieth and ninety fifth percentile values are provided and all the terms are given in this slide here. So, all measurements or values are in millimeter and this source here, some of the data are presented here but for a full range of Indian anthropometric data source, you can have from anthropometry dimensions in standing posture; Indian male and female combined data; fifth, fiftieth and ninety fifth percentile values in millimeter; the source is that Indian anthropometric dimensions for ergonomic design practice by D Chakrabarti published by nation institute of design, Ahmedabad at 1997.

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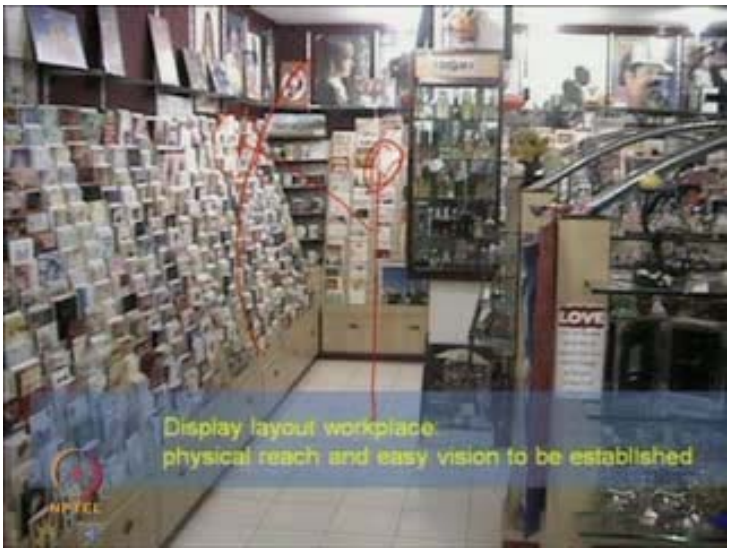

So from that data, one can use for new design development. This is a display layout workplace: physical reach and easy vision to be established. Suppose, in this case if a person's height is this much, then for him to lean here and to select some material will be little difficult. In that case, a concern comes whether we can have a curved surface like this. So that, it will be easier to reach and as well as vision control will also be there.

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So with this, the vertical arm related issues; now, we are shifting to ergonomic polishing workstation that is design of user-friendly new brassware polish machine.

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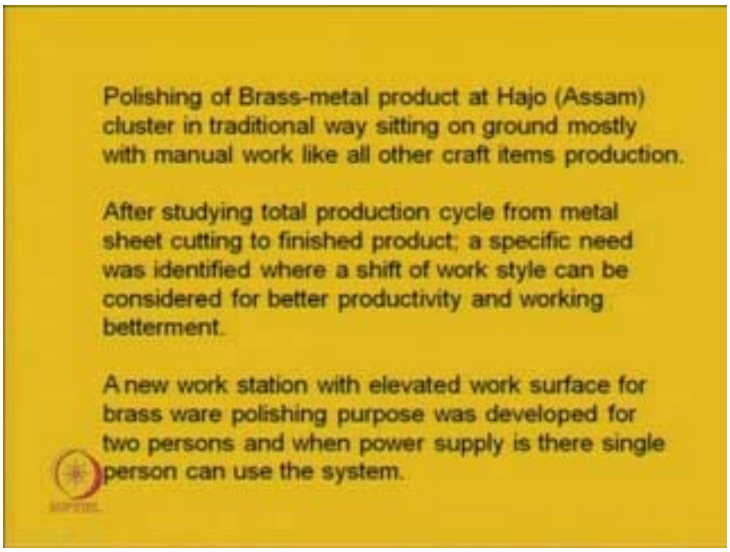

So, some background, background is that the polishing of brass metal product at Hajo that in Assam, near Guwahati. The cluster in traditional way, sitting on ground mostly manual work like all other craft items production is done.

So, after studying the total production cycle from metal sheet cutting to finished product; a specific need was identified where a shift of work style can be considered for better

productivity and working betterment. A new workstation with elevated work surface for brassware polishing purpose was developed for two persons and when power supply is there, single person can use the system. What does it mean the content of this slide?

In Hajo area in Assam near Guwahati, a cluster is there where they make these brasswares. Normally, they collect the material, raw material from market and then they do all the necessary steps towards making a final product like bowl, vessels, plates, pots, etcetera may be any sizes and shapes.

Now, it is found that all the activities are being done in a sitting position on the floor. So, a concern comes how their productivity can be increased and their work can be smooth enough. So, their each and every activities were studied from ergonomics point of view and after that one concern came that, all other activities concerning this brassware making are performed by single person but for the brassware polish it requires two persons. Brassware polish means, after making the pot or whatever [FL] it has to be put in a shaft; it rotates, one person pulls the thread to rotate that thing and another person sitting opposite hold a knife in hand and they chisel out the layer. So that, it becomes a polished metal means, when the brassware is moving and then he is touching with this blade, that knife, cutting knife. So, it is chiseled out one layer and by that, it is polished.

So, here what happens? they are interdependent, if some person stops this pulling the shaft of rotation then the person who is using the knife his activity also stops. So, it is interdependent; so, a situation comes while discussing with them. A suggestion came that if we can elevate the workstation so that, they do not require to squat or sit on the floor; a good workstation can be developed. So, this workstation was developed and it was found good with the field trials and etcetera.

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So now, we are going to see this in development process. Task performed by single person: all the tasks are shown here everywhere all the task pertaining to the brass metal production all the task are being done singlehanded and finally the product appears here.

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Now, this product needs to be polished. Then, here the bottleneck comes because two persons are necessary for that and among all the activities it becomes time taking. This is the typical figure showing how the polishing is done. So, one person is pulling this shaft and this is the brassware fitted here and with a knife, it is being polished.

So, polishing by two person's task: like that, way one is pulling the thread and another person sitting opposite side with a polishing.

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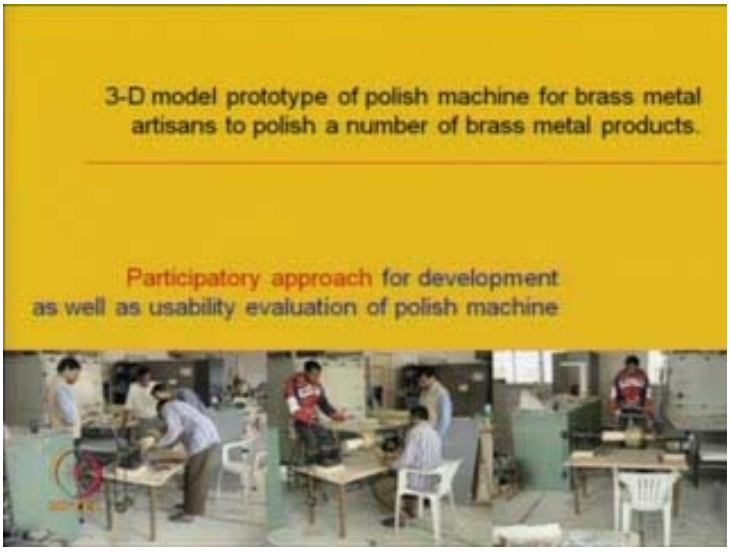

So whatever idea came, first a 3-D prototype of polish machine for brass metal artisans to polish a number of brass metal products were developed. Means, first what we made a 3-D model in computer and after getting a certain feedback from the users and after showing that thing we made it a full prototype, and while making this direct prototype, we asked those people to come there and to assist in the making so that all the modifications and their suggestions can be incorporated in modifications.

Now, participatory approach for development as well as usability evaluation of polish machine was done. Like here, this figure says that while making this model they are the actual artisans; they were called or invited to the laboratory and to assist in this process. Now, after fixing then their trials were also given.

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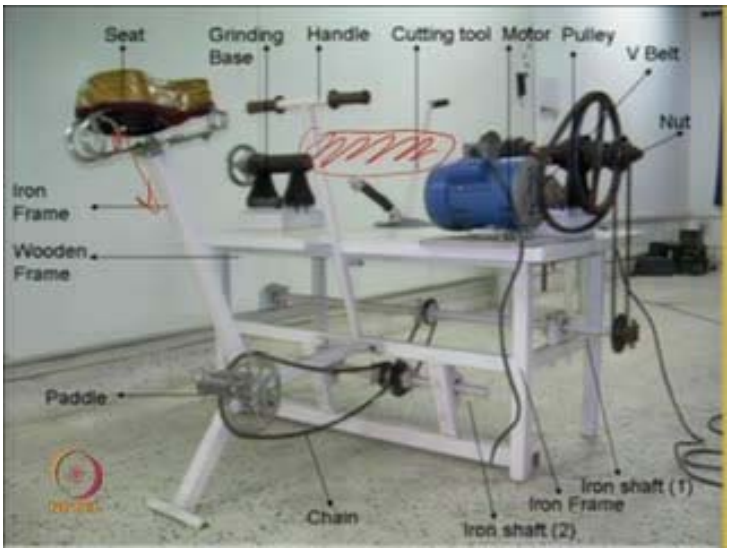

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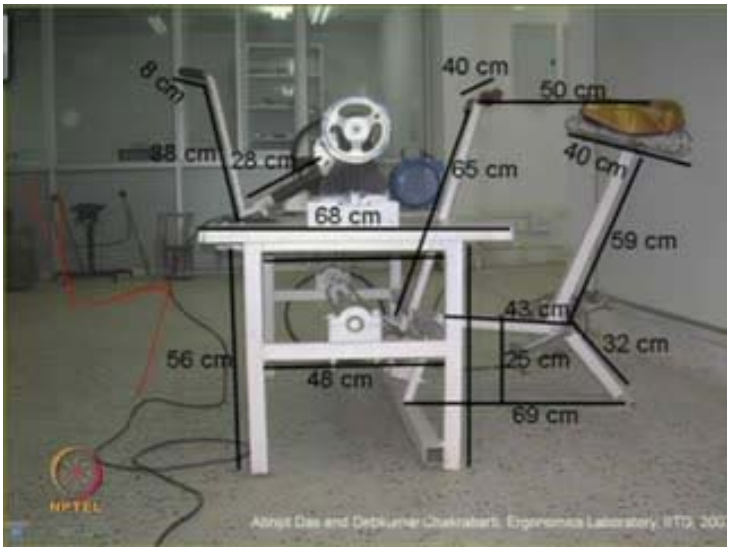

Now the thing is that this is the actual product where the workstation was developed. It has a higher platform; one side is a cycling facility where one can adjust height and then angle, this is the handle. So, here the main brass metal may be placed here and a motor was provided here. If power is there, then through motor this shaft can rotate and only one person can polish the machine from this side. When power is not available mostly what happens, why this thing was done because the craft areas are normally outskirts of the city area so, there the electricity availability is not always good. So, in that case it is manual as well as electrical, both the facilities are provided. So from opposite side we

can say that, in this case, in here, the person can use a chair kind of thing, any kind of chair he can use, sit and work. We do not need to squat always and here if special guided knife holder is given here, this cutter holder so that after holding here, he can operate it with this.

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Now, in earlier session while working on the floor, at that moment while cutting it, the arm remains in a suspended position so, it forces preset load on body here what happens with this a holder is provided so arm support is there and with arm support to one hand he can move like this wherever the cutter is necessary and then it can be cut. So, a holder-like support system is being used here.

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Now, this new workstation, the features are: the elevated work surface, automatic and manual power; both increases productivity and comfort free, postural facility. We gave this product to the artisans, they kept it for six months almost and then we got their feedback and it says that, it increases around 75 percent of productivity means by counting the products polished and free postural facility means, they can sit, they can stand though if the person who is holding the knife and when power is there single

person can work. So, we do not need to cycle for to move that shaft so, it is a free postural change for facilities are there.

The cycling to rotate shaft and polishing person can use sit-stand posture and a tool holder using optional that motor single man can do the polishing task so the subjective and productive performance by counting the number of polished material and ergonomic evaluation was carried out while working with newly adopted polish machine and with traditional one that is sitting on the floor result shows benefits of the new workstation design

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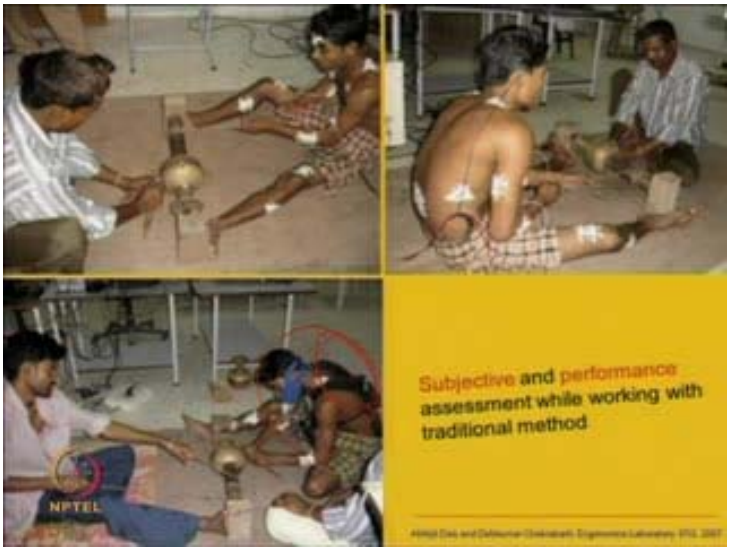

Now subjective means by asking them the questionnaires and productive performance by counting how many products they can polish now ergonomic evaluation ergonomic evaluation was done here two specific items like that the physiological parameters that electromyography records now while working after selecting the major muscles relevant to perform this task from that electromyography records were taken from this puller as well as here the other person who is using the cutter and also we have taken how much energy is being spent for this task using the oxygen consumption oxygen consumption what happens with a mask the air goes to a digital equipment placed on the back so it gives result of burnt in the air oxygen quantity or the oxygen available in the normal air and with the exhaled air what is the oxygen in that air so from that the total oxygen being used for this task from that the energy expenditure are even calculated

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So by this the energy expenditure and the muscle electromyography was taken of this traditional style of working and then while using this new machine like this the person here with a cutter he can hold it and with this the knife holder here he can modify wherever he needs to touch this so here also the major muscles required for this task electromyography record was taken and for the cycling person for him also the electromyography records were taken and oxygen consumption also was taken as it is shown here

So the result energy expenditure for a specific time of working on this machine and in the traditional method of working sitting on the floor the difference is that this machine gives a better performance

So design of user friendly new polish machine developed by ergonomics laboratory IIT Guwahati as a part of PhD research project

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So till now whatever we discussed in this workstation development both persons need to work but some special facilities have been developed here if power is there then we do not require this person only this person can perform the task when power is not there then this person may be added here now question comes why we require two persons can we develop a system for a single person's use the further work was carried out this was the development done then we got the influence from the sewing machine so from the sewing machine operation the idea came and this product is developed with further development for a single person's use that machine

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Here what happens the both sides are there so here we do not require any holder kind of thing like this any holder kind of thing because here with this area from this side or from opposite side in this he can put the elbow and then he can hold the knife and can polish it here so that was reduced that component

Now one motor was given here with a special power and with a special speed controller here so that with a speed control he can polish as desired pressure and desired speed is necessary here one cloth cover is given here so what happens while polishing whatever the brass particle falls it may be easy to collect it here when this power is not available power failure then using simple sewing machine type facility with leg movement this work can also be continued so this type of development was done considering at a single person's use

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Now another viewpoint it is seen that this is the motor area how the motor is fixed with a chain and the person sitting here any kind of tool or chair can be used with this machine so after this development it was discussed to the expert group while demonstrating live the feedback was taken and then the final modifications was done

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So these are the issues where not only to develop a product design developed must be evaluated if the desired effect has been achieved so that laboratory facility is necessary

In earlier exercises of that workstation design we mentioned that oxygen consumption and electromyography records and others just i mentioned only two but some others were also considered here

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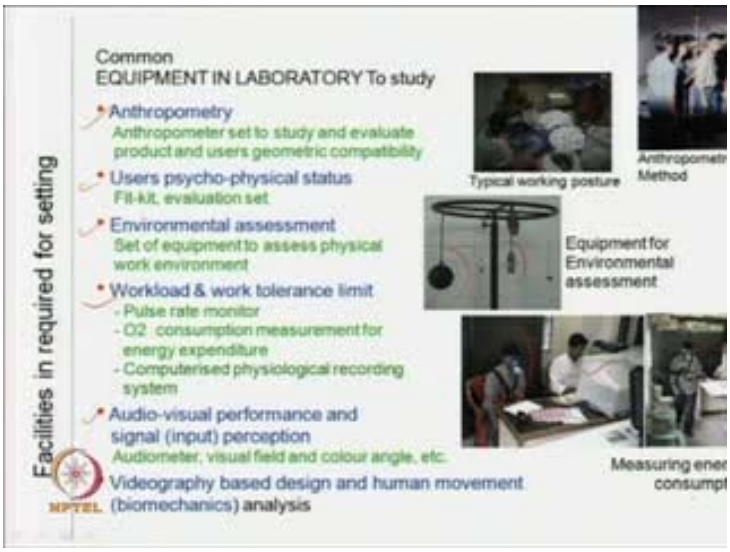

So now what facilities are necessary normally for such type of product evaluation there are many things but for typical ergonomics laboratory these facilities are necessary to be

there like facilities is in required for setting of laboratory facility for this evaluation procedure for common equipment in laboratory to study and anthropometry body dimensions anthropometer set to study and evaluate product and users geometric compatibility there are also some other greaves and etcetera may also be used

Users psychophysical status fit-kit and evaluation set means to understand or to assess the physical status of that person using heart rate body temperature and others like environmental assessment where the person is working what is the environmental load on him for that a set of equipment to assess physical work environment like heat humidity ventilation illumination etcetera and vibration and their effect to the physiological parameter to assess it is that workload and work tolerance limit like pulse rate monitor oxygen consumption measurement for energy expenditure computerized physiological recording system is necessary we may require to now that different blood flow pressure torque force etcetera pull-push force like that and then angle measurements of different body while working and then audio visual performance and signal output perception like audiometer to know the hearing visual field and colour angle measuring devices etcetera

Videography based design and human movement that is biomechanics analysis etcetera are needed to be performed there are many ergonomic software where the video after recording videography the total movement angle and etcetera can be analyzed

So now normally the typical work posture anthropometric measuring methods these are some of the equipment for environmental assessment like globe thermometer and other environmental meter etcetera then this is the oxygen consumption meter because while sitting or doing some task what is the energy expended that can be used measured while sitting or standing walking

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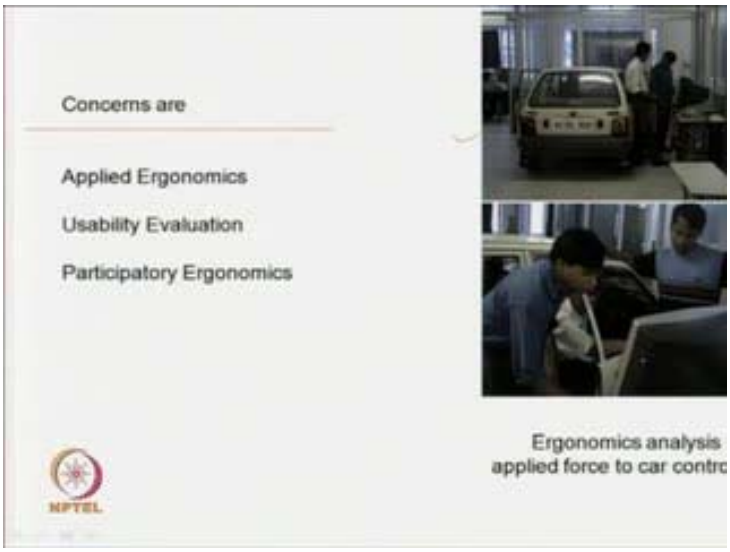

Now the concerns are applied ergonomics aspects usability evaluation and participatory ergonomics aspect means for whom we are doing to get their input in this it is shown that a car is being analyzed while using it what facilities and what problems they face and what facilities are required to be there for that some study is going on in laboratory this figure showing that ergonomics analysis of applied force to car controls

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Where with different pressure gauge and etcetera through computer that will record can be done like while developing this type of design usability evaluation using videography

means a person when they are doing from different corners if we take the videography and we present on a gridded line gridded box that directly one can recognize the work posture and etcetera also this video recording can be analyzed through computer using various software

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Now computerized physiological parameters recording like when you are holding in this right hand this left hand top corner this figure so it is a computer monitor figure shows that while holding a specific newly developed handle while holding it the pressures and etcetera and how it is really fit or not that part can be there and some of the equipment are showing here that being that one can use for electromyography recording electrocardiography recording electromyography recording even eye oculography eye movement etcetera and then heat and other resistance of the body like that everything all these things are necessary to carry out for evaluating a design

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Here they are showing that one figure that students are using or being taught how to use the anthropometric rod set and for that different physiological recording using computerized method here that EMG recording was being demonstrated to the student

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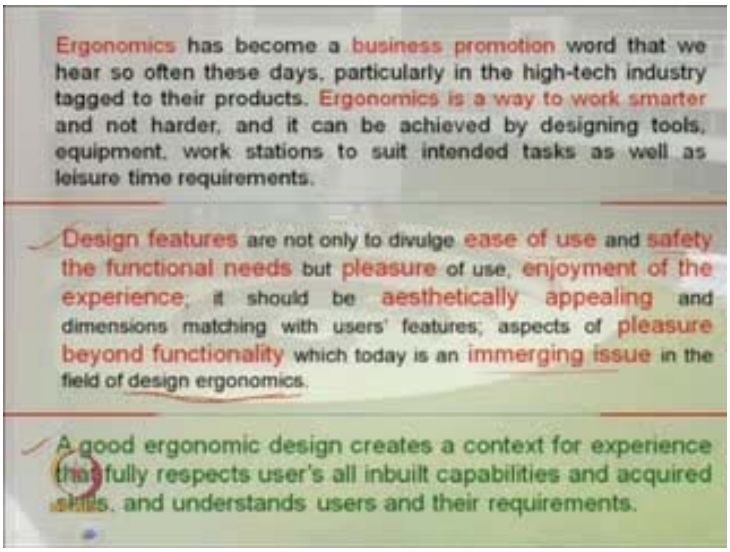

Now with this we can say that ergonomics has become a business promotion word that we hear so often these days particularly in the high-tech industry tagged to their products to increase their sale because users without knowing if the after seeing that ergonomic tag they feel that it is good one but ergonomics is a way to work smarter and not harder and it can be achieved by designing tools equipment workstations to suit intended tasks as well as leisure time requirements

The design features are not only to divulge ease of use and safety the functional needs but pleasure of use enjoyment of the experience it should be aesthetically appealing and dimensions matching with users features aspects of pleasure beyond functionality which today is an immerging issue in the field of design ergonomics

A good ergonomic design creates a context for experience that fully respects users all inbuilt capabilities and acquired skills and understands users and their requirements

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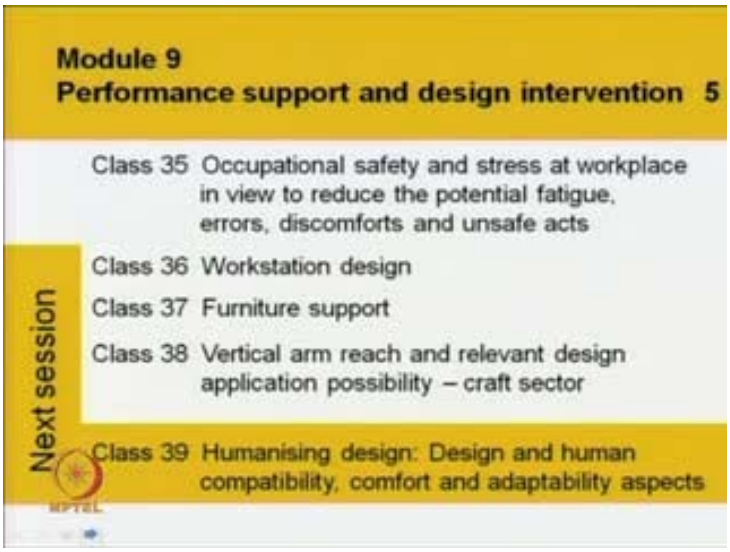

So with this we are concluding today's session vertical arm reach as issues and the workstation development possibilities in a normal craft sector where people used to work following the tradition sitting on the floor level now a trial was given if the work surface can be elevated up with some other facilities so that a workstation can be provided for certain purpose and that was achieved

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So now with this we are concluding this today's session so thank you