Ergonomics for beginners Industrial design Perspective

Prof. D. Chakrabarti

Department of Design

Indian Institute of Technology, Guwahati

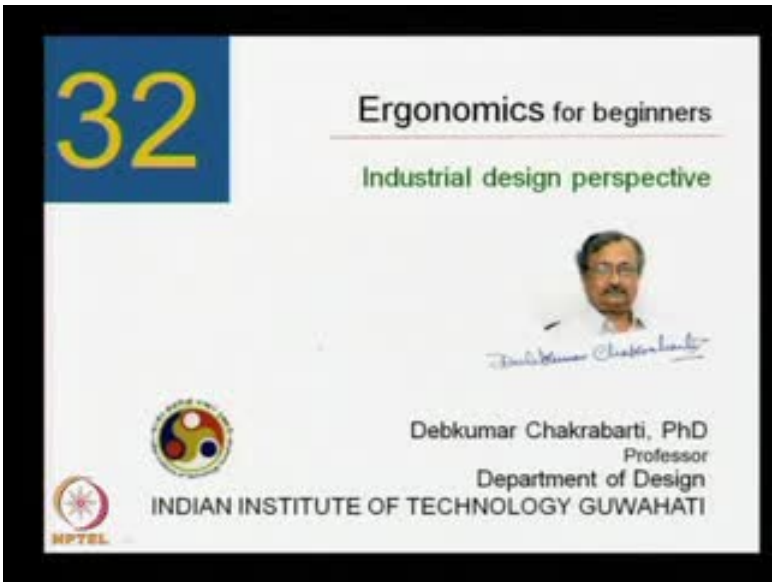
Module No. # 08

Ergonomic design process

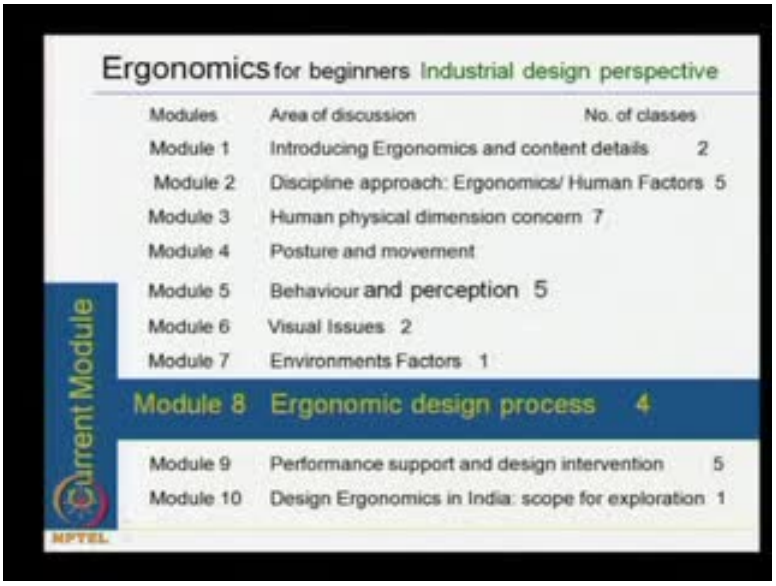
Lecture No. # 32

Ergonomics criteria/check while designing

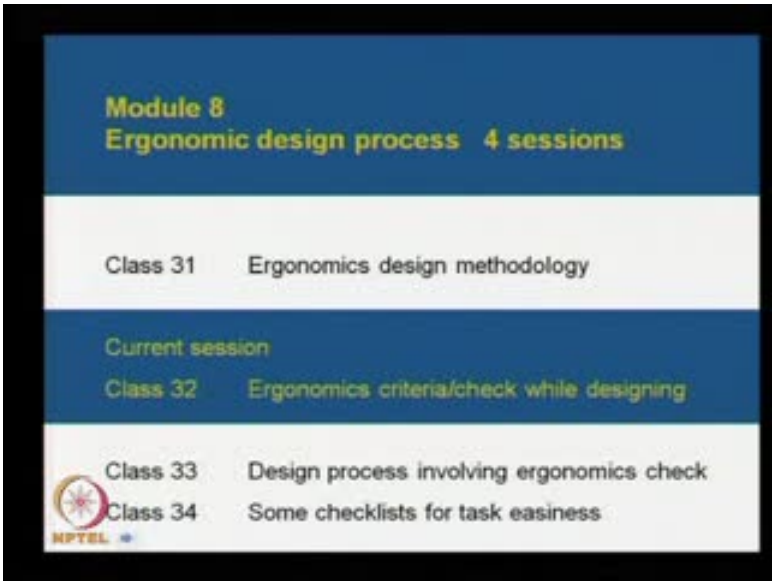
(Refer Slide Time: 00:21)



(Refer Slide Time: 00:28)

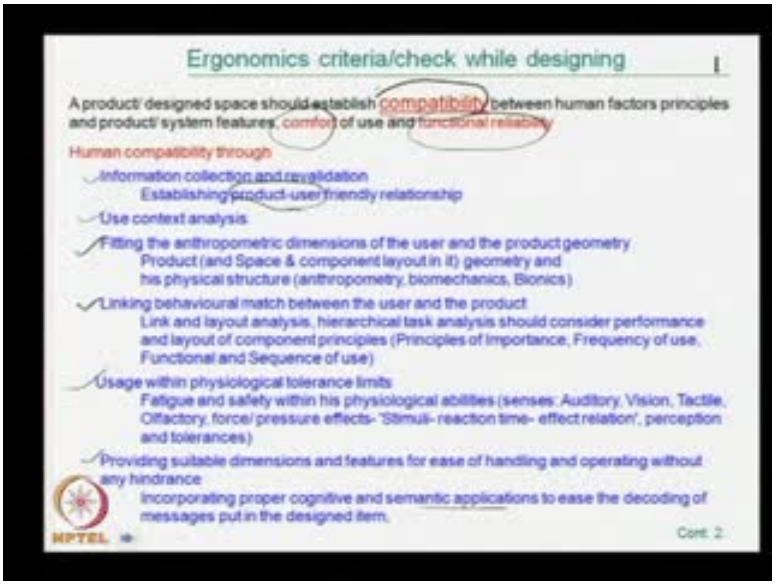


(Refer Slide Time: 00:38)



Welcome to the 32 session of ergonomics for beginners industrial design perspective. The current module is module number 8 - ergonomics design process. Out of the four classes, in this module, so the current session, the class number 32, the ergonomics criteria and check while designing. The rest two, the design process involving ergonomics check and some checklist for task easiness will follow in 33 and 34 classes.

(Refer Slide Time: 01:12)



So, today is the ergonomics criteria and check while designing. Now, in this slide the 2 consecutive slides mentions a brief or as a summary of this, where it says: that a product or a design space should establish compatibility between human factors principles and product or system features, and then comfort of use and functional reliability.

Now, how we can get these points? In earlier classes, last class we mentioned that from the real life observation and experience some good points, some awkward issues that have come up or that are coming up in terms of compatibility with the users, those issues generates these points; from that only the criteria and etcetera it comes.

So, the compatibility, comfort, and functional reliability, if you want to check it, then we can say that, the human compatibility through information collection and revalidation, that is establishing product user friendly relationship means, when I am using a product, that product may be available product or when you are developing a product, the prototype, when you use it, whether that product features matches with the desired aspects of our compatiblitiness. That is, whether it is good? It is matching with my body dimensions, my psychological perception filling, etcetera? Whether it creates any problem?

So, these issues, that is the establishing product user friendly relationship. Now, and again, the user context analysis, the user's context analysis means where this product would be used.

If we develop a pencil and if we fill that, it would be used by a child. Then, the fineness of that tip and if it is brittle, then it will be not accepted by that child. So, then what type of specific design check should be consider so that child should not get disturbed, if the lead breaks quite often.

Like that the users context analysis. If we make a chair or a stool to sit, whether that stool, if it is a metal made stool and if that is used near a hot place or a very cold place then, it may not suit to use it. There some kind of heat resistance treatment has to be given. So, this type of context analysis is necessary. The fitting the anthropometric dimensions of the user and the product geometry, that in earlier sessions we have discussed in great length this issue.

The product and space and component layout in the space itself, geometry and is when the users physical structure that is anthropometry, biomechanics and bionics needs to be considered. After that then comes the linking behavioral match between the user and the product; under this aspect, we can say that link and layout analysis, hierarchical task analysis should consider performance and layout of component principles.

Here, the 4 set of principles are here used normally that is principle of importance. When we are making some components layout to get the total function done, what is the importance of those specific components? Accordingly, it has to be arranged in that location.

Frequency of use, that element, how many times, in a given period, to be used that accordingly. If it is more used, then it has to be closer to the person functional. To get the function done and the sequence of use means to do a get a function done, what at the operations in sequence that has to be considered. So, these are the linking behavior match with match between the user and the product.

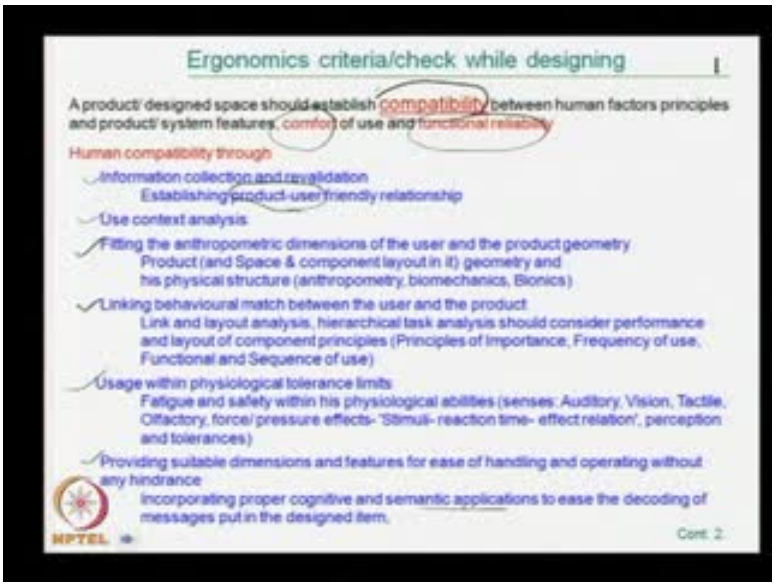
Next comes, usage with in physiological tolerance limit. If we make a staircase, where the steps are little higher, then, if I want to use that, then it may not permit in my physiological limits.

Now very interesting thing is that, when, now, we have developed some escalator systems. Now, there are many people who gets really feel trouble when to step the first step when the escalator is in movement. So, at that movement it is noticed that hardware

increases. Now, the fatigue and safety within his physiological abilities like senses, like auditory senses, within ability, whether he can hear like that way.

If we put a helmet in such a way that everything is closed. So, the hearing will be problem. Vision, how he can see, if it is within the visual limits, visual field limits, etcetera. Then tactile, how to fill differences with a tactile, olfactory smell?

(Refer Slide Time: 01:12)



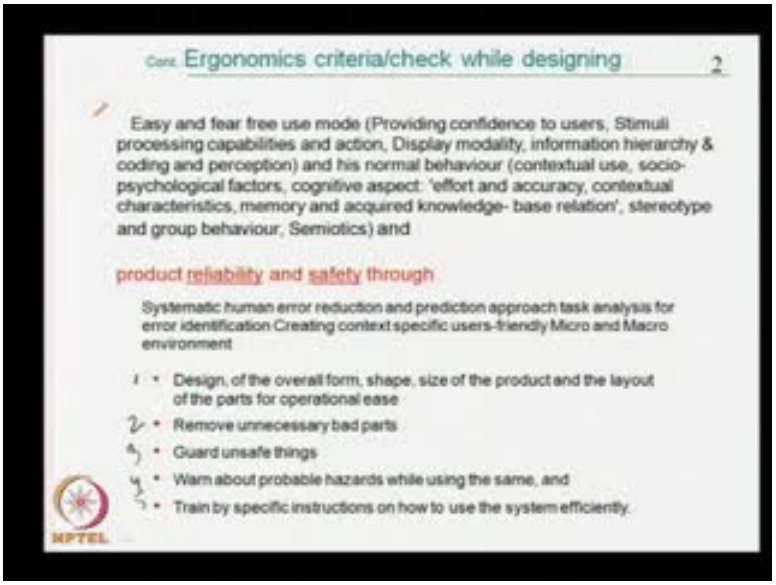
Now, the smell is another thing is that, smell very quickly we can get adapted to the smell, but smell is very good to give a quick attention. Like, if a gas cylinder l p g gas cylinder leaks, that markup and that chemical is mixed there; if gas leaks there, then, that with that smell, suddenly you can recognize something that gas leaks, but if it stays for a quite long time, then we may not get that type of a continuous attention.

So, in that space cases, whereas sudden attention is necessary, the olfaction may be useful. Force and pressure effects, like here stimuli reaction time and effect relation. In this case, we can say that, suppose, when we make a crane to move, in that case, if a very feather touch button is there, then by a mistake of that there may be some big damage. In that case, whatever the reaction we are expecting while using that joystick or something, it has to be little more informative means you should feel that something bigger is going to happen, but in computer or in a mobile telephone that feather touch button, it may be possible or is useful because they are that type of safety danger is not there.

So, this is the stimuli reaction time and effect relation has to be consider in that context and then perception and tolerance limit. How we perceive the things from shape, size, plane, presentation as a whole and the tolerance limit? How much I can tolerate these things?

So, this is within the physiological tolerance limits. Now, another thing that the providing stable dimensions and features for ease of handling and operating without any hindrance. So, the layout would be in such a way that to approach to a certain elements other elements presence should not disturb. Incorporating proper cognitive and semantic applications to ease the decoding of messages put in the designed item is necessary.

(Refer Slide Time: 12:06)



Now, the second slide in continuation, we can say that and so, whatever we mentioned earlier, this is that human compatibility through these issues and the easy and fear free mode of use, that is providing confidence to users a trust.

When I am wearing a spectacle, it should be in such a way that it should not slip off from the face. How I can get that feeling? If we take a glass of water, glass made glass, if someone asks to drop, it is little difficult to drop it because we know that, if we drop, what effect is going to happen, it breaks unnecessary.

So, now, a driver who regularly drives a car, good driver, it is very difficult for him to dash against a tree or something or an wall on the road side, very difficult, because these

are the inbuilt something that stops him to do that. So, these are the something is there that ease and fear free mode of use, that providing confidence to users, stimuli processing capabilities and action.

When driving car, if a tree comes in front or a something comes in front, obviously, we take a turn means, the stimuli processing capabilities and action, display modality, information hierarchy and coding and perception.

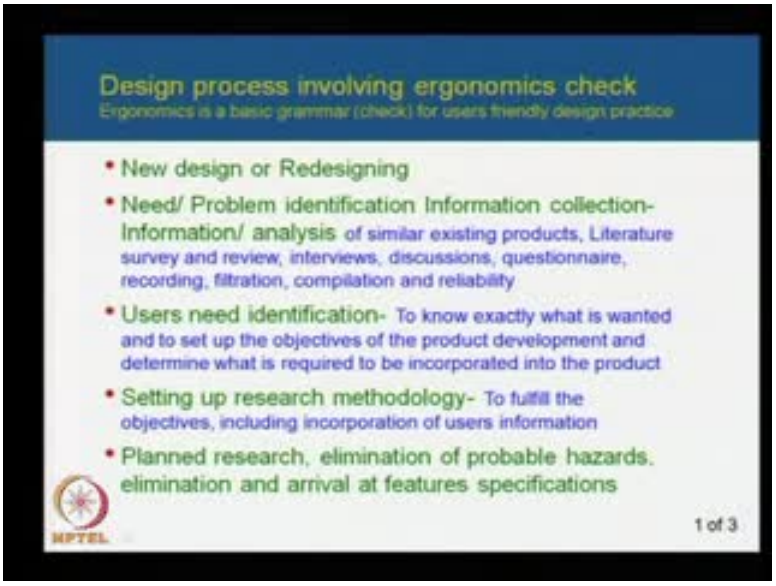
An electronic item, where a small indicator bulb is there; so, when we increase the intensity with a regulator, this bulbs intensity also increases. So, this is the link between this. My intension, whether it is working, it is an effect through that light intensity. So, these are the cases, and then, this is the hierarchy and coding and perception is which like this and his normal behavior, it is contextual use socio psychological factors, cognitive aspects such as effort and accuracy, contextual characteristics, memory and acquired knowledge base relation has to be considered. The stereotype and group behavior and semiotics are necessary. So, these are the product compatibility with human nature and human abilities physical and mental.

Now, the product reliability and safety is through systematic human error reduction. When I make a product, there are some mistakes; may be there some errors. So, gradually one after another, check the points and reduce and prediction approach, task analysis for error identification, creating context specific users friendly micro and macro environment, through these five steps one can follow.

First is that design of the overall form shape, size of the product and the layout of the parts or operational easiness. Number 2 will be remove unnecessary bad parts, if there some bad or unnecessary parts are there, that gradually remove without altering the intended function. Third is that, if we cannot remove all the bad parts, then at least try to give a guard to that. Now, how we can give a guard, there are many theories, many possibilities are there.

Number 4 is that warn about probable hazards. While using the same warn means by issuing some warning, information or inbuilt some indicators and etcetera, that give warning. Number 5, it appeals train by specific instructions on how to use the system efficiency. So, these are the, some of the steps, 5 steps, we can use to ensure the product reliability and safety.

(Refer Slide Time: 17:47)



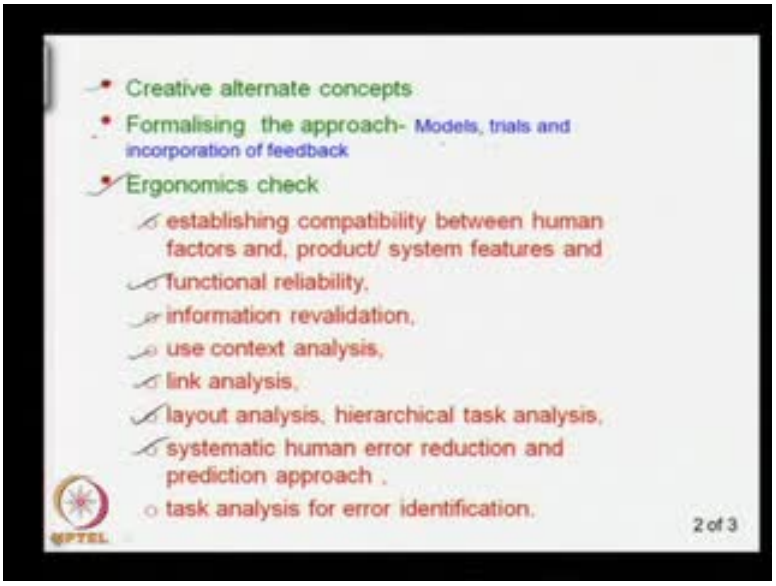
Now, with this, the design process involving ergonomics check that is ergonomics is a basic grammar that is check kind of thing for users friendly design practice. With this, some steps are normally considered; those steps, we are going to discuss now.

First is that, we have to consider whether the attempt is for a new design or redesigning. If it is a redesign, then what are the faults are there? How we can make it better? That should be considered. If a new design, then thinking, it is future issues, elements needs to be considered need and problem identification, that is information collection, information analysis of similar existing products, literature survey, and review interviews, discussions questionnaire, recording, filtration of the recordings of the information, compilation and reliabilitiness, from all those, information received.

Then users need identification: to know exactly what is wanted and to set up the objective of the product development and determine what is required to be incorporated into the product.

Setting up research methodology: to fulfill the objectives including incorporation of users information, planned research, elimination of probable hazards, elimination and arrival of features, specifications are necessary. So, these we are going to speak in 3 slides.

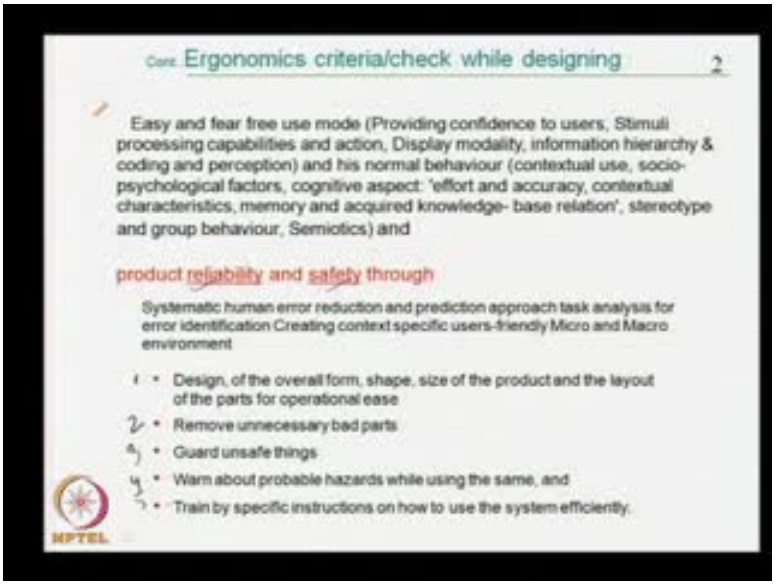
(Refer Slide Time: 20:14)



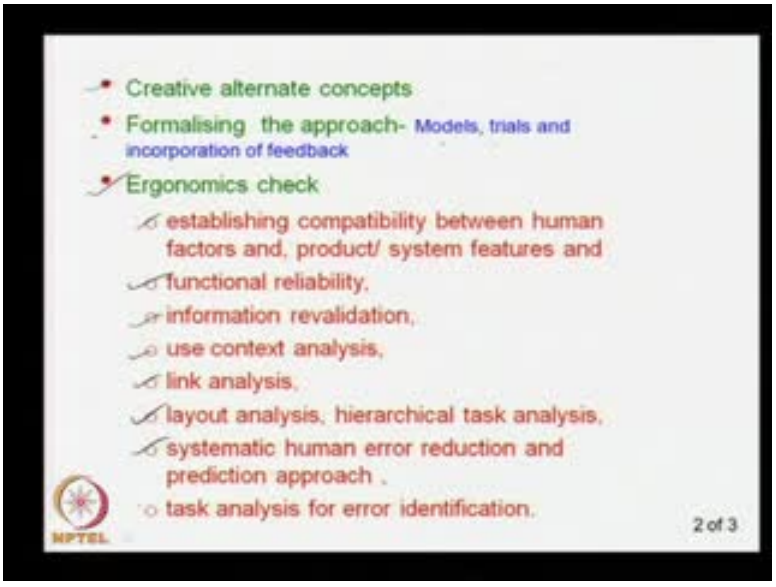
Now, the second slide say that the creative alternate concepts make alternate concepts; from that, some can be selected formalize the approach, the models, trials, and incorporation of feedback. Now comes the ergonomics check. The specific ergonomics checks are see the possibilities and information for establishing compatibility between human factors and, product and safety and systems features and functional reliability, information revalidation - whatever information we received whether it is really good or after doing certain experiment, whatever our assumption was there, it changes or it does not continue. So, then some new thought.

The information revalidation, use context analysis, link analysis among all the components, layout analysis, hierarchical task analysis, systematic human error reduction and prediction approach. In last slide, we mentioned this in details the 5 points this 5 points are here that we are mentioned here.

(Refer Slide Time: 21:40)



(Refer Slide Time: 21:47)



(Refer Slide Time: 21:59)

Now, the task analysis for error identification. These are the ergonomics checks are normally taken in a product development. For final design concept and prototype development analytical prototyping, it may verification of it is feasibility through feedback from probable users and experts; design refinement make final design and prototype and then commissioning operation and maintenance needs to be considered. So, these are the total product development features.

(Refer Slide Time: 22:44)

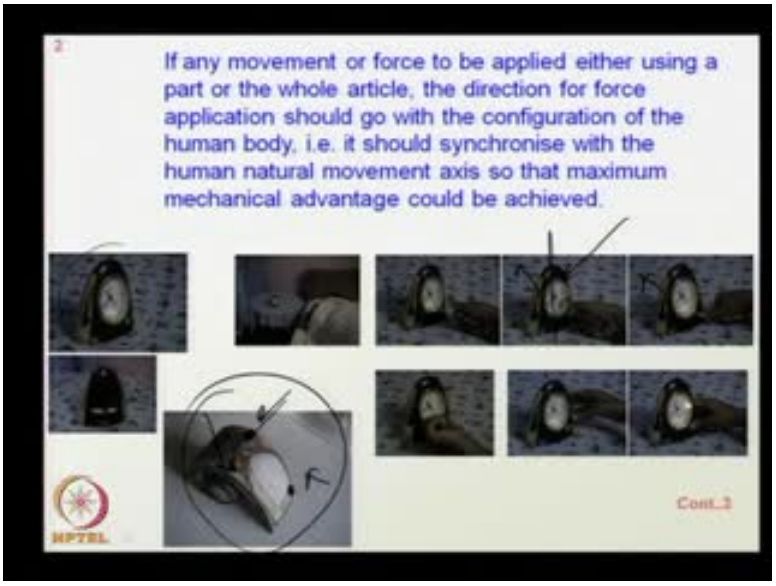
Now, after developing the product, evaluation is necessary. How far it is really good? So, data collection and evaluation of outcome measures, we need to consider exploratory sequential data analysis through quantitative and qualitative handling of continuous observational data, while using that product. Effectiveness of testing of complex systems, usability testing, maintainability, human factors audits is what human factors were considered and whether it is really achieved. Assessing cost and benefit of human factors, this while considering these things whether it is really achieved good.

(Refer Slide Time: 23:29)

Now, we will see some of the specific aspects, specific issues. Ergonomics criteria designing or redesigning a product or a system: under this, number one that, shape of a product be aesthetically appealing, and product geometry and users anthropometry - structural limitations - must fit each other for ensuring safety as well as better function.

And size be handy to operate and easy to maintain, casing of internal parts should be in such a fashion that if there is any fault in a single part, it should be replaced easily. Thus, here the two examples are provided here. This example is that, tea leaf in a tea garden that shearing device, this is the holding handle and etcetera. It is designed in such a way and different specific parts can be replaced. This is a waste W C commode that to cover, here, the front part is kept free. So that in this, if it is necessary, some plastics thin sheets can be inserted here. So that it can make a cover like this.

(Refer Slide Time: 25:18)



So in a public place, so, if the, when the this cover is used here the person can use it. After use the new sheet of may be placed in after replacing the older one to give a fresh look to always. So, these are the concepts can be used. Now, in this case, a special concept is made that, how we can make the form. If any movement or force to be applied either using a part or the whole article, the direction for force application should go with the configuration of the human body, that is, it should synchronize with the human natural movement axis so that maximum mechanical advantage could be achieved.

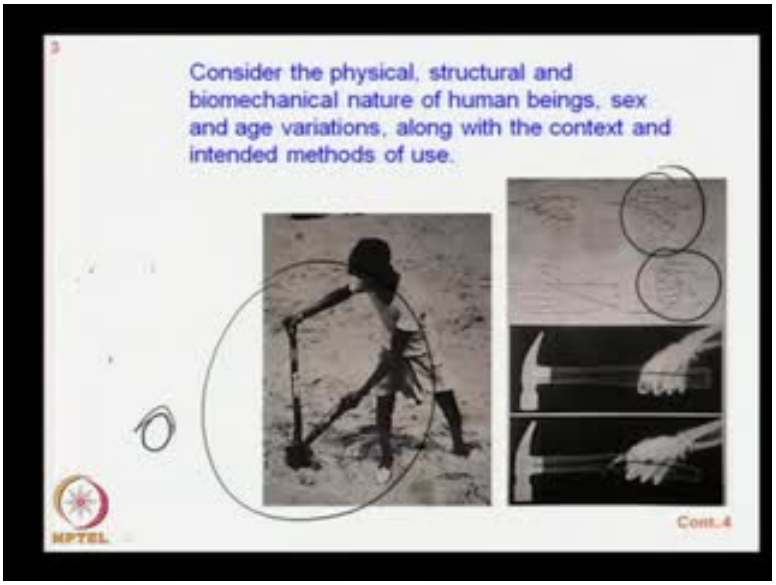
If there is a lever to operate, if it is at the body front, this is little difficult to operate, but if it is kept little side may be 30 degree or something like that, here person, if we pull that lever, then it will be easier because what (( )) because our normal body it goes with our normal body movement at 60.

Now, with these, how we can make a form? This is a case where a table clock here, when alarm is put as per normal behavior. When the person is sleeping and this one is ringing, he wishes to switch to stop the alarm, but the shape is that in different way of placing the switches, different way of placing the switches, it goes back like this way and sometimes it falls.

So, what is happen? He has to hold it in both the hands to switch off. So means what happen? The force direction and the product position or product step and size, it does not match. So, a development was made in such a way that, if this is a product of this form,

then ,wherever we may put keep the switches, either here or here, anywhere, the force may come from any spot, the product will remain at that position. So, like this the basis of this product development is that direction of force and product should maintain a single spot.

(Refer Slide Time: 28:04)



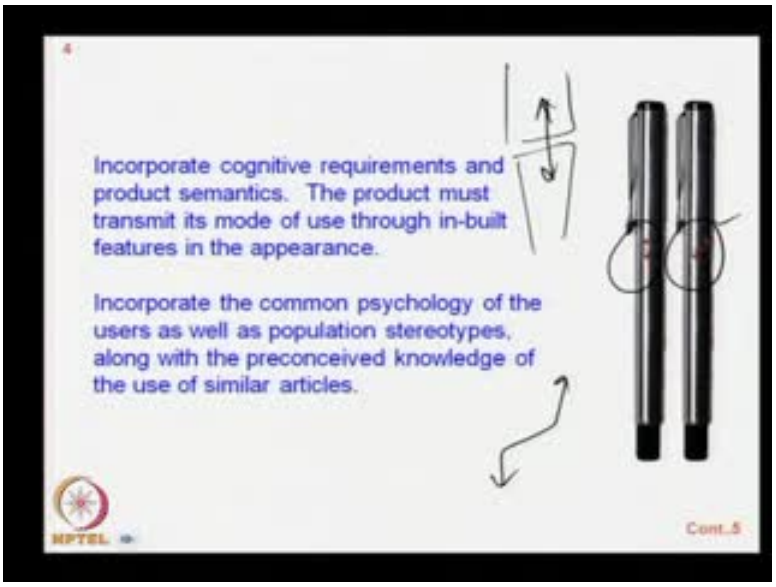
Another issue is that, consider the physical, structural and biomechanical nature of human beings, sex and age variations, along with the context and intended method of use. Normally, a small hammer, if we see this product, the pliers, if the pliers are normally handles are like this, straight angle, so, while holding it, then our hand goes like this way. So, this is an angle cup forms here like this. So, to abort this angle formation, if we can make like this type of figure here, a handle is like this little like bent. So, what is happen? Here if we hold, then holding will be like this. So, less bending is there. The same, similar way, the small hammers, it is a straight handle and if it is little bent handle, it is been returned. Now, in this case, it is said that - if we see our arm and we hold we hold it, so this position holding position and this axis it has some angle around 20 to 30 degree angle like that.

So, these, the holding area, if we can have this angle, then it will easier to hold and then operate like that way. That also depends context specific applications. Now another aspect of this is that application of force. In this case, a shovel, a single hand shovel, it is

difficult because of working like this, so this static load comes on hand. So, a development was made a separate handle is given here.

Now with this separate handle, now it looks that it is a very good position, but actually what is happen, when operating it, the arm remains in a static position and instead betterment, it gives problem more. So, with this, it is considered that, if this position, if we can have, if we can have in this, a ball and socket type of joint, where, what is happen? While throwing the sand or the soil, this arm can we can move it and this also we can slide on the main handle. So that type of things one can use it.

(Refer Slide Time: 30:49)

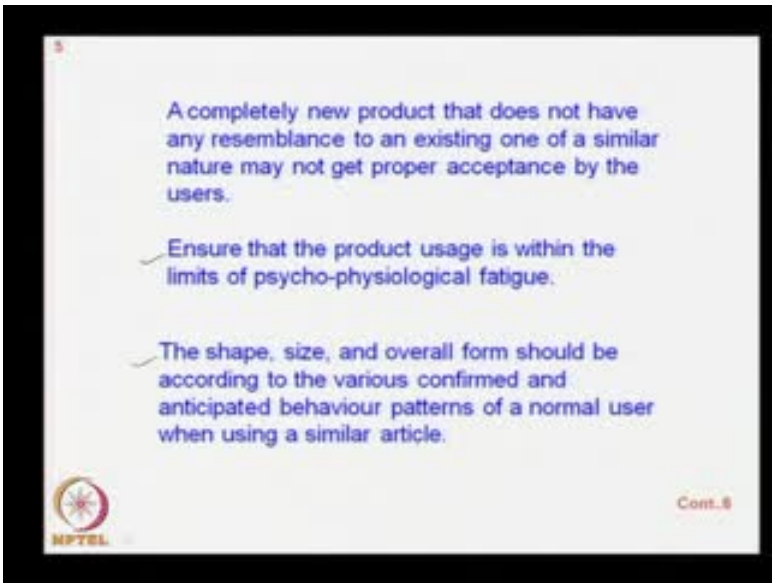


Now another aspect is that incorporate cognitive requirements and product semantics. The product must transmit it is mode of use through in-built features in the appearance. Incorporate the common psychology of the users as well as population stereotypes, along with the preconceived knowledge of the use of similar articles. As per example, we can say that this 2 pens; these 2 pens is very difficult to recognize whether it requires to open the cap in a spiral way or just pull push. For that, if we have a system like this means, if it is like this way, in the cap and the body, then this sign is, it tells us that it is a pull push type of fitting.

And if this one, in this case, if it is like this way, like this, then it can say, it says that it needs twisting to open. So this similar type of application in utensils whether lid has to close like pressure cookers, etcetera and many others can be used. So, here what is

happen, the psychological filled with this symbols; the symbols gives input to know how to operate this things.

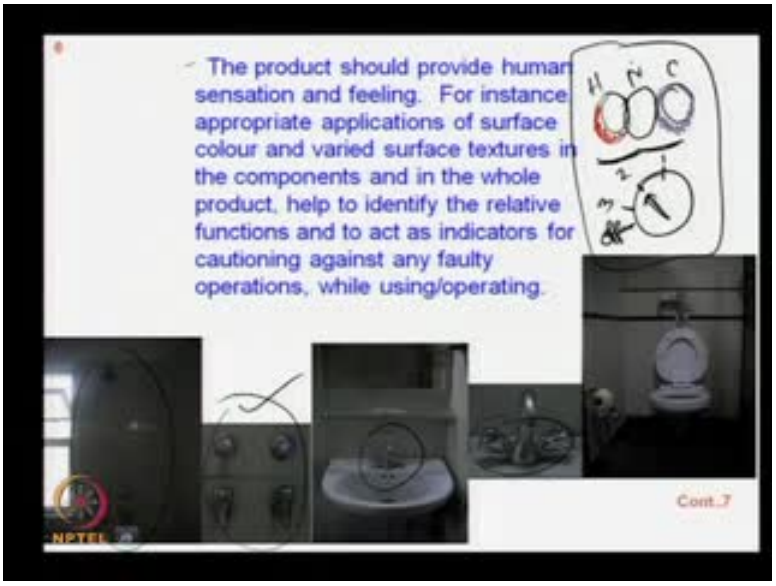
(Refer Slide Time: 32:33)



Now, a commonly, a completely new product is a common sense that, a completely new product that does not have any resemblance to an existing one of a similar nature may not get proper acceptance by the users. A complete new product we may not accept it. So, to operate that, some kind of first experience is necessary to recognize the products utility.

Ensure that the product usage is within the limits of psycho-physiological fatigue value. A product is given to me that I cannot operate, I tried to operate it with many trial and errors, etcetera and finally I failed, it gives a physiological fatigue filling. So, some necessary clue should be given how to operate it and that clue should have the resembles with an existing one product, so that we can relate it. The shape, size and overall form should be according to the various confirmed and anticipated behavior patterns of a normal user when using a similar article and then some anticipation should be added, if a specific type of operator or user wishes to use.

(Refer Slide Time: 34:44)



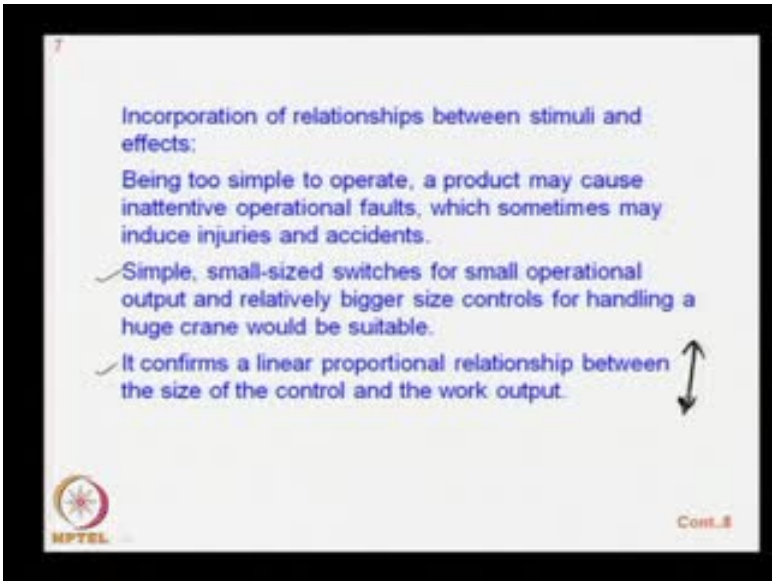
That is the inclusive design and exclusive design matter also can come up with this. From this, a question comes that - symbolic presence of mode of operation, whether it meets the real need. The product should provide human sensation and filling. For instance, appropriate applications of surface color and varied surface textures in the components and in the whole product, help to identify the relative functions and to act as indicators for cautioning against any faulty operations, while using or operating.

With this criteria some examples are here that in this product, in this left corner is a shower, and then, the showers, the tap, and then the knobs are there and here a combined water tap where cold water and hot water facilities are there like that. So, in this case one question comes that if there are knobs are there like this, two knobs are there, one knob to mention that hot, so we can have a red color and another one to show, we can have a red color thing here and another one we can show that blue like this a blue for normal water.

If there is another one with a that requires hot water, normal water and cold water. Then, at this position, what would be the normal waters color code and the cold waters color code? and then, what will be the arrange layout arrangement of these three knobs? So that quickly we can recognize which one is hot? Which one is cold? Which one is normal?

In certain electrical switches it is that is off button and then maximum speed, then minimum speed and average medium speed and then lower speed is there. So, when you move like this way, so, when you are switching off then you are (( )) it has to come, it has to cross that maximum point and then to come to off position. So, this type of, then what would be the actual feeling, the perception of task requirement and it is symbolic presence, it is necessary.

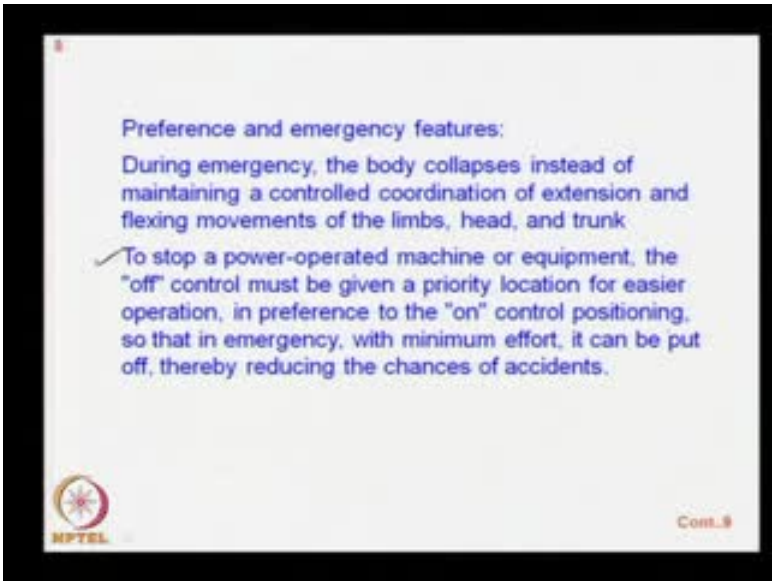
(Refer Slide Time: 38:16)



Incorporate Incorporation of relationship between stimuli and effects. Few minutes before, we mentioned about this matter. Now, being too simple to operate, a product may cause inattentive operational faults, which sometimes may induce injuries and accidents.

Simple, small sized switches for small operational output and relatively bigger size controls for handling a huge crane would be suitable. It confirms a linear proportional relationship between the size of the control and the work output. So, this we have to confirm in our design, so that the persons feeling this matter, one can, without any specific attention, one can use it.

(Refer Slide Time: 39:39)



Now, the preference and emergency features: during emergency, the body collapses instead of maintaining a controlled coordination of extension and flexing movements of the limbs, head and trunk. It is said that when your able body, we tend to expand our body size; when there is any problem, we try to squeeze our body, fall and our limbs, comes closure to the center of the body.

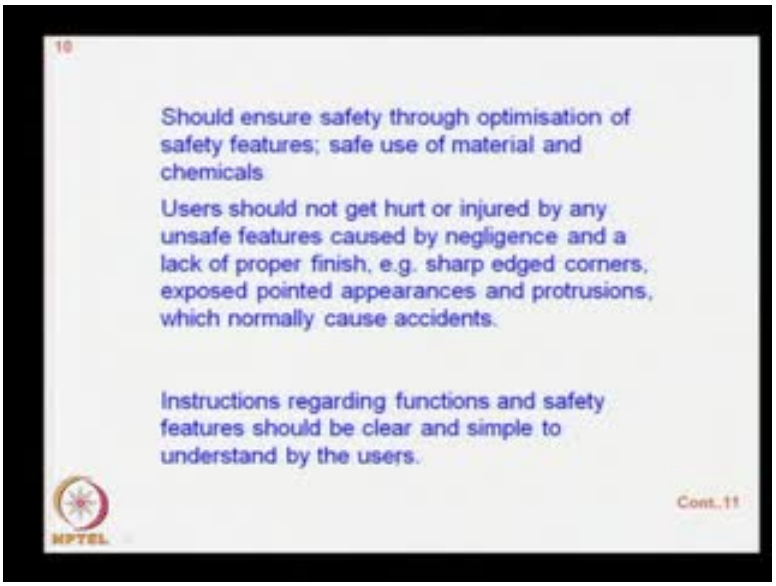
To know, how we can use these in design? To stop a power operated machine or equipment, the off control must be given a priority location for easier operation, in preference to the on control positioning, so that in emergency with minimum effort, it can be put off, thereby reducing the chances of accidents.

The As per position wise, if the switches are above your head or above your shoulder level, then off switch will be closure to you, and then, the on switch will be top. in the If the it is lower than your body center still that off button should be near and on should be distance. So that, while making it on with effort, we need to on, but while putting it off with a less effort, it should be put off, but in certain cases like a computer server of an organization where without any specified or a specialized person, no one should switch off that machine, there it should be reverse.

(Refer Slide Time: 41:59)

So, context wise, specific application is necessary. In this case, the groupings of similar body parts of an article used for the same purpose or for similar activities are necessary. So, like this way and then, the groupings, etcetera these all are considered. Placement of parts of a single article should not create any hindrance while operating any function.

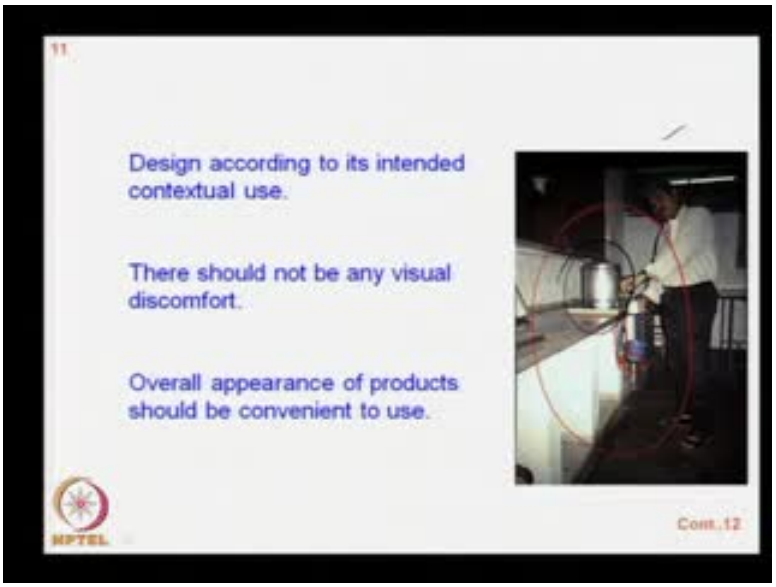
(Refer Slide Time: 42:26)



Should ensure safety through optimization of safety features; safe use and material and chemicals. Users should not get hurt or injured by any unsafe features caused by negligence and a lack of proper finish, as for example, sharp edged corners exposed

pointed appearances and protrusions, which normally cause accidents; it should be avoided.

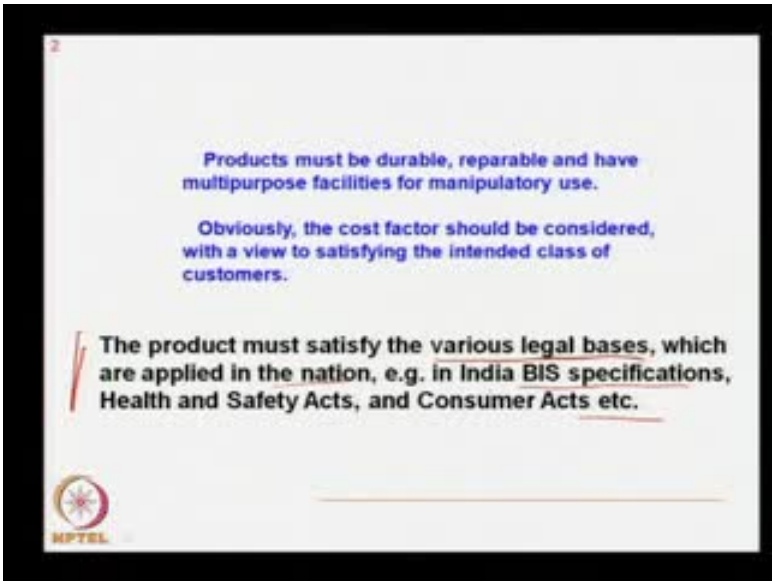
(Refer Slide Time: 43:21)



Instructions regarding functions and safety features should be clearly mentioned and simple to understand by the users. Here, the language component is also important and instructions symbolic application, how it is easier, and whether, it is within the capabilities of the target users group need to considerate.

Now another thing it can be said that: design according to its intended contextual use; there should not be any visual discomfort; overall appearance of products should be convenient to use. This figure, the right hand side of the slide says that: it is a faculty tea club, tea area, when we use this tea machine, the dispenser machine, the tea drips. So, there may be many design solutions but simpler was made that a platform was made and from there the two strings where hung and with this two strings, a simple water mug was placed here. So that a drips that come falling on this and it accumulates here and it is very easy to clean it and to maintenance a and it is affordable really, in fact, we can see the low costing development type of thing. So, these type of the context specific requirement and then, what would be the best solutions with least cost make it necessary to mention.

(Refer Slide Time: 45:15)

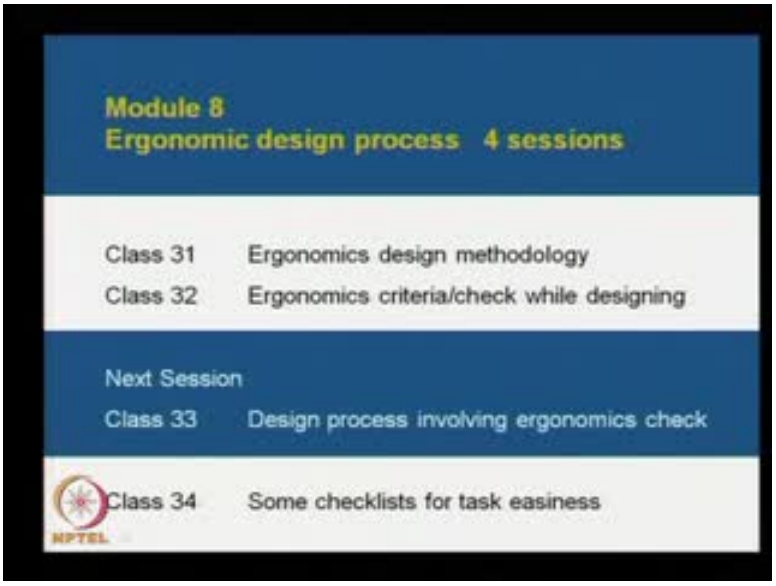


Products must be durable, reparable and have multipurpose facilities for manipulator use. People do not like to buy a specific product for a specific purpose only, like, if I need a specific product and in a year, so, once only we use it; we may not like to buy and keep in our home. There, it would be better, if in a community wise, if it is purchased and lend it over to people or users as and whenever necessary based.

So, these types of things are also necessary to consider. Obviously, the cost factor should be considered with a view to satisfying the intended class of customers. It is said that the higher income group of people, they may go for new experiments; very lower income group people, they may go for the similar type of things, but cheap material because cost is a factor there, but the major group, users group, at the middle class group, normally, they do not prefer to go for experimentation, they need a trust for the product that can satisfy their need as well as can remain within that affordable capabilities.

Now, what type of product development we are trying to do? To satisfy what type of need? What would be our target users group? These are the basic necessities to answer, while taking a design development program. The product, finally, it can say that, whatever we develop or we do, the product must satisfy the various legal bases, which are applied in the nation, as for example, in India B I S specifications, health and safety acts and consumer acts, etcetera, various regulations. All these things, while framing, they considered all the good points, that is necessary.

(Refer Slide Time: 48:48)



So, if while developing, if these are considered, then obviously, the product will get a good benefit. So, with this, we are concluding this session, and now, the next session the class 33, in that class we will discuss the design process involving ergonomics check with some specific design applications. So, till then, thank you very much. So, we will meet in next class. Thank you.