Ergonomics for beginners Industrial design Perspective

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Module No. #03

Human physical dimension concern

Lecture No. # 09

Anthropometry: body growth and somatotypes

Welcome to today's session number 9 in Ergonomics for Beginners Industrial Design Perspective.

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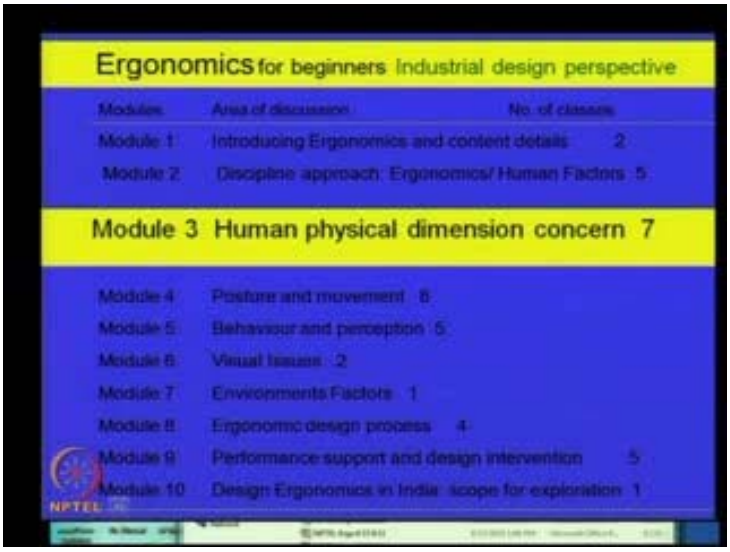

This is under module 3 that is Human Physical Dimension Concerns and out of 7 classes, today's session that is in total number of classes, this is 9th class here. Today, we are going to discuss anthropometry and the basics of anthropometry that is human body growth and somatotyping.

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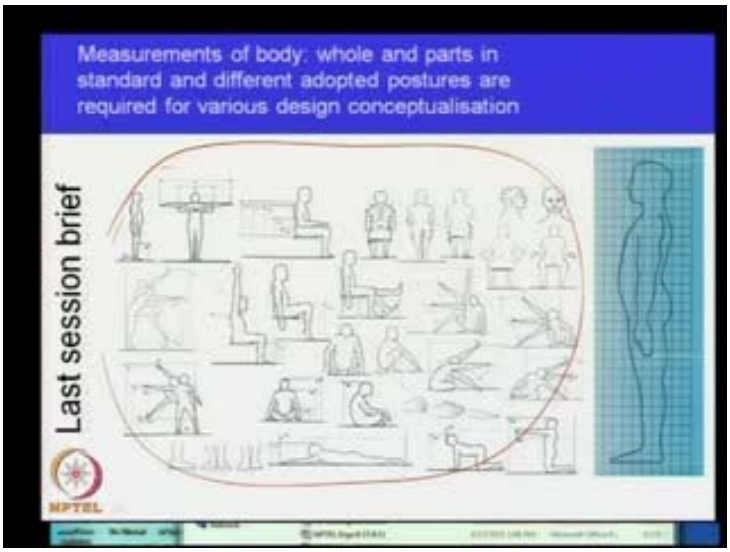

Today, we will just be briefing what we have discussed in last class. In the last class, we have discussed that measurements of body; whole and parts in standard and different adopted postures are required for various design conceptualizations. For that these type of anthropometric done postures and the various measurements are necessary. We will be discussing about these in detail in coming classes.

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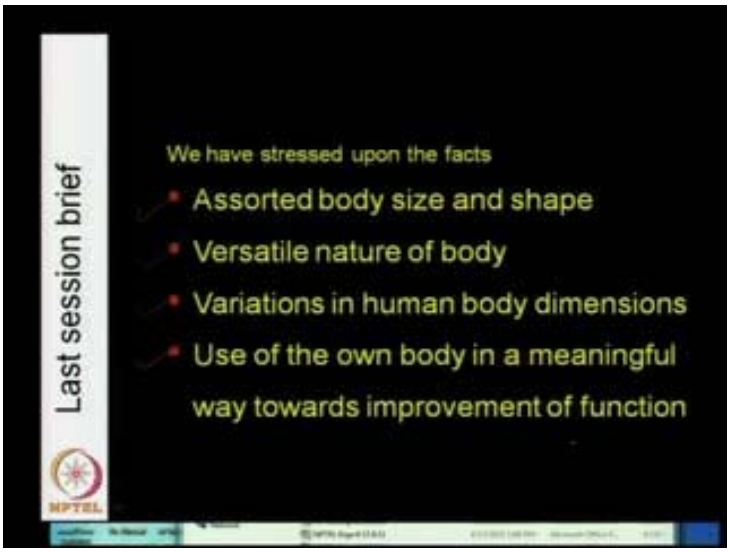

We have traced upon the facts in last classes that we have assorted body sizes and shape. We have versatile nature of body, variations in human body dimensions and all human

body dimensions are not same or similar. Use of the own body in a meaningful way towards improvement of function and that is for our own benefit.

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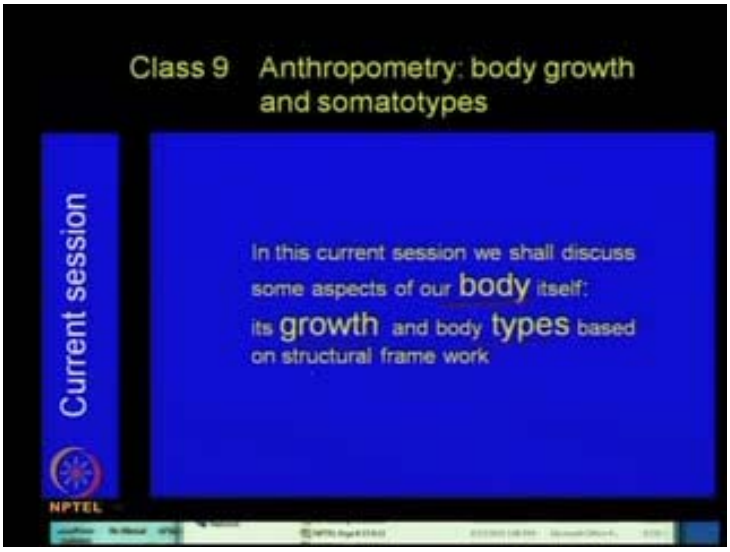

In the current session, we shall discuss some aspects of our body itself and its growth pattern and body types, based on our own structural framework.

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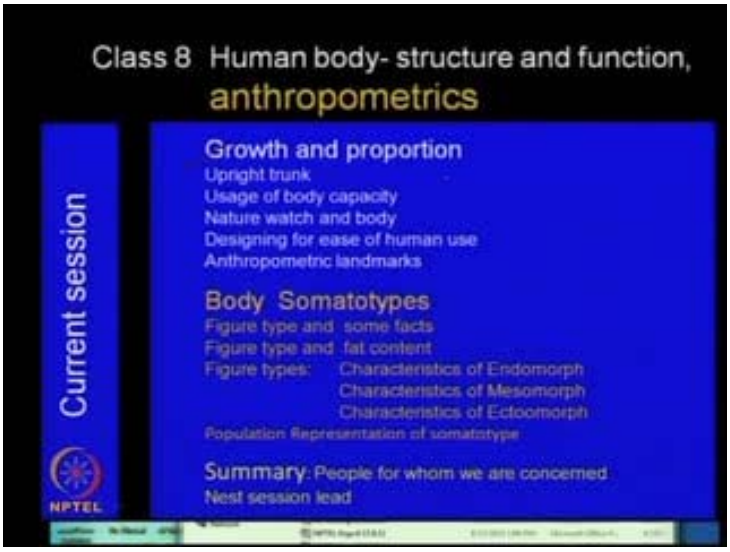

In this session, we are going to discuss in main two parts. The first part is that growth and proportion of different body parts - the upright trunk, usage of body capacity, nature watch and body, designing for ease of human use and anthropometric landmarks. Second

part is body somatotypes that is figure type and some facts, related to that figure type and fat content and based on this fat content, figure types are determined normally.

The figure types are of three types: characteristics of endomorph, characteristics of mesomorph, characteristics of ectoomorph. We have population representations of somatotypes. After these two sessions, we are going to summarize whatever we are discussing today that is people for whom we are concerned to lead them to next session.

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Now, first is the purpose of this discussion - our body growth and proportion.

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Human beings have assorted body sizes that we have discussed earlier. Rates of growth follow certain patterns, but physical development from birth to adulthood does not show same proportional growth of all parts of the body. So, we have body parts of different proportions and it does not follow the same proportion always.

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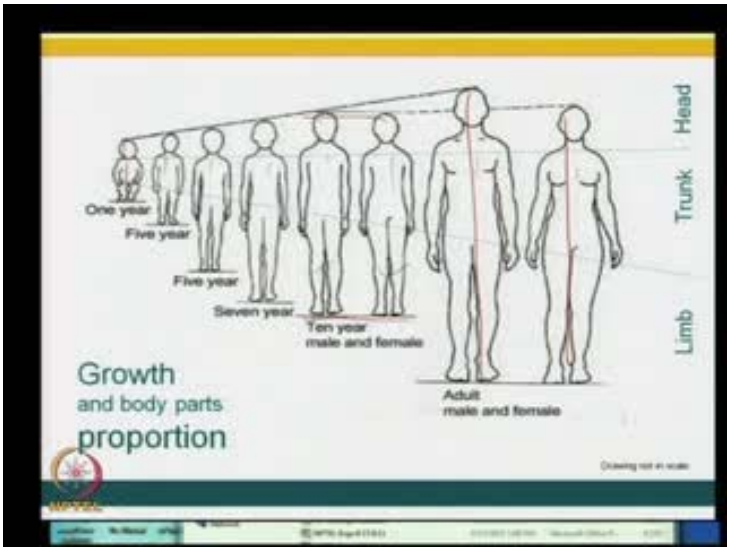

We are going to discuss how it helps us and how it really at there. Now, if you see the growth pattern of this view, the left hand corner is that 1 year boy has the 1 year body. If we see the total head, trunk and other limbs and if we see the growth pattern in a 5, then 7 years, then 10 years male and female and adult male and female, we can see that the head structures, head sizes and the proportion it follows, the trunk sizes and its proportion are not the same and the limbs are also not the same.

It is specifically seen that till the age of 10, the male and female; this is a male body and this is the female body, there is not much of difference seen below that and after that due to puberty and etc, the body type figure changes. Mostly, it is seen that during adolescence, the girl's body growth is faster than the same aged boys, but after this adolescence period is over, boy growth continues. Finally, we can see the structure of male and female being different.

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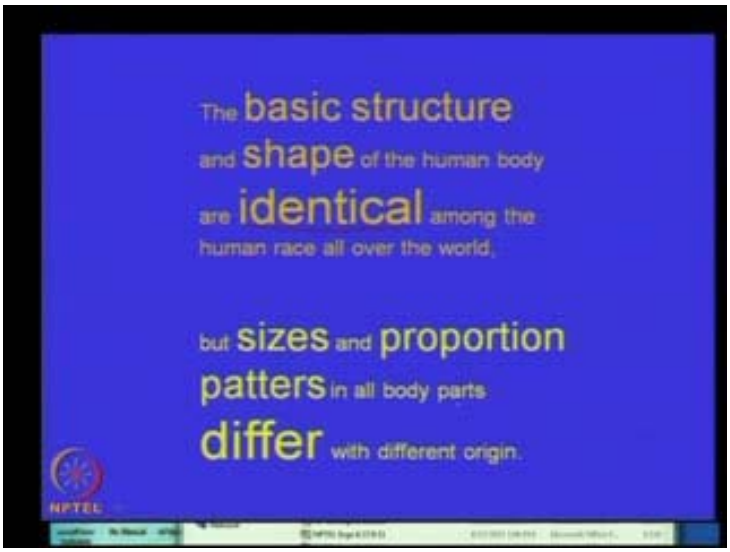

Now, why we need to know this proportion knowledge? It is required because if we want to make it furniture kind of thing; suppose, any specific design below or around 10 years, boys and girls are going to use that. So, there we may not be consider the difference of body sizes, but after that maybe some specific requirement are necessary to consider.

The basic structure and shape of the human body are identical among the human race all over the world, but sizes and proportion patterns in all body parts differ with different origin. It means a person of a specific location or origin may differ with different body proportions, it may be different for people from other source of origin. So, when we are going to develop some product to accommodate that human body, we need to consider this target research group body structure.

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The bony skeleton is the framework or the body and all the vital organs and muscles around it have a skinny cover, which combine to make a perfect human body. We cannot change our body, just a fixed and assorted size with specific proportion, instead we can do design something that fits to our body. That would be our motto, while attempting to develop some designs.

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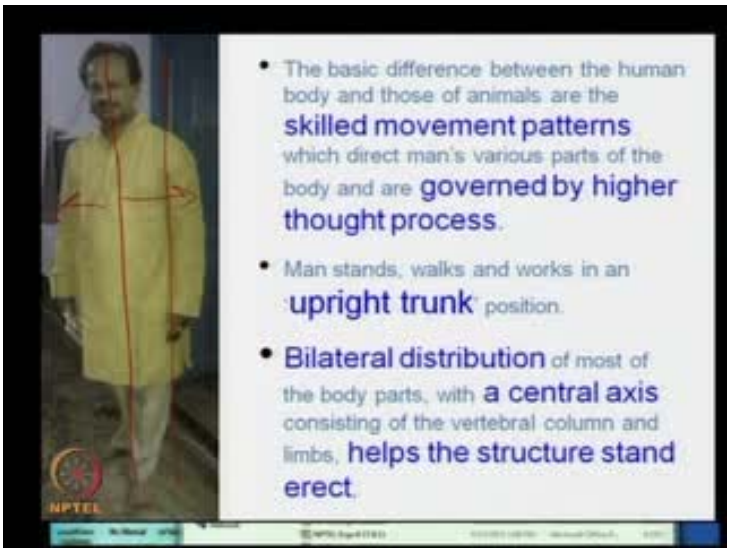

Now, what is the specificity of our body structure than others like animal? If we see, the basic difference between the human body and those of animals are the skilled movement

patterns. We can adopt any body position that the task demands, which direct man's various parts of the body and are governed by higher thought process. Man stands, walk and works in a upright trunk position. Bilateral distribution of most of the body parts with a central axis consisting of the vertebral column and limbs helps the structure stand erect. With this body structure, we can perform some skillful movement that is varieties of tasks that demand us to adopt with postures. So, some benefit is there with our body, but some limitations are also there. While conceptualizing any design, we should consider those limitations, so that some undue demand from our body is not created.

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Earlier, we said that progress created some problems. Now, progress and our body utilization, we can see that first, we can say our body looks like designed for the type of life man lived earlier. Limbs were mainly for survival, for example, it can be said for collecting food and to run away from danger, but these are no more the only uses in the present day context. So, as per our life progress, we have created some specific movements that was not made for this computer. So, there are varieties of movements required that is our acquired skill with this same body and that we have to consider.

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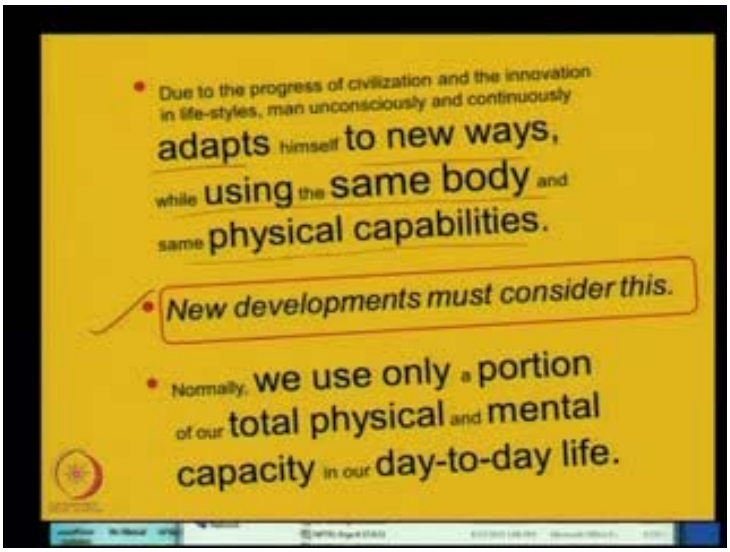

Now, due to the progress of civilization and the innovation of in lifestyles, man unconsciously and consciously adapts himself to new ways, while using the same body and same physical capabilities. So, what we should do now? New developments must consider these factors. Normally, we used only a portion of our total physical and mental capacity in our day-to-day life, mostly in sports field. The situation is created such that we need to use some more things to lead a normal life. We cannot expect that man should use his excess physical and mental capacity. So, we have to give comfort to them and how it can be given is that the new developments must consider these aspects.

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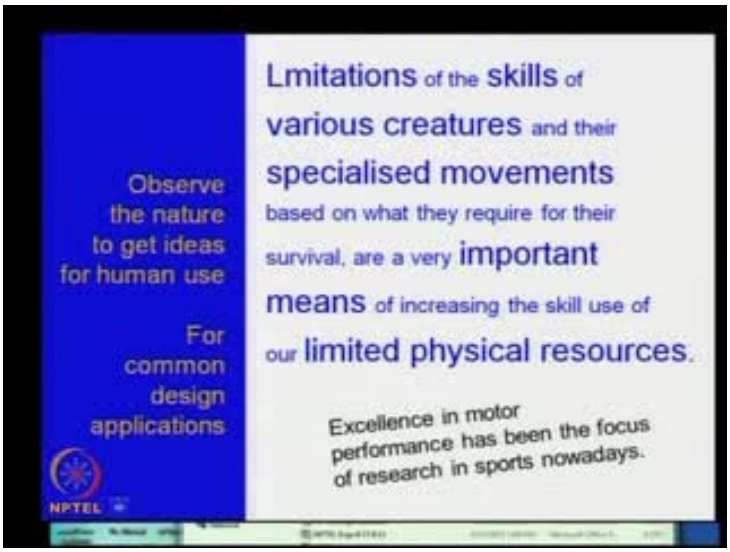

From where, we can get this informations and ideas? Observe the nature to get ideas for human use for common design applications. Now, limitations of the skills of various creatures in nature and their specialized movements based on what they require for their survival are a very important means of increasing the skill use for our limited physical resources.

So, to understand the means and methods, we need to observe natural phenomena. Excellence in motor performance has been the focus of research in sports nowadays, but in other design activities, where it is not necessary; comfort is required. We have to consider these limitations and etc, so our requirement should be below this level.

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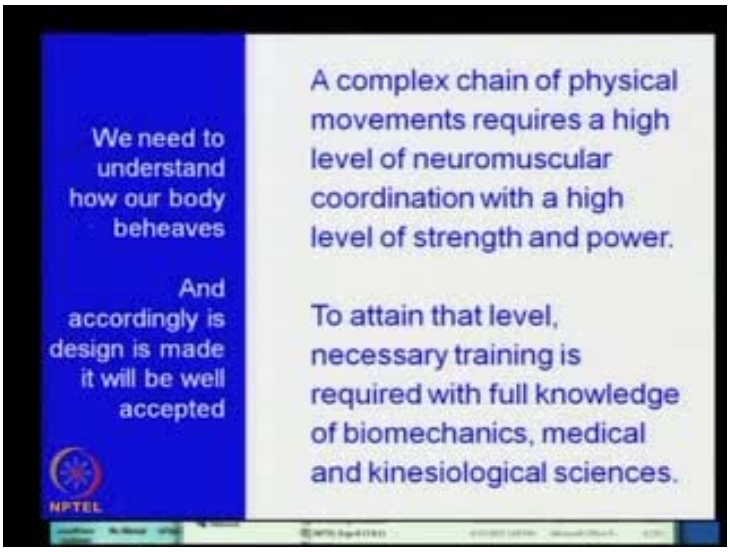

We need to understand how our body behaves and accordingly design is made and it will be well accepted. A complex chain of physical movement requires a high level of neuromuscular coordination with a high level of strength and power. To attain that level, necessary training is required with full knowledge of biomechanics, medical and kinesiological sciences.

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For good design practice, if we see this figure, the developed product is a floor mop. How the design, dimension of this machine is made? According to this operator's physical body dimension, we may get some clue that how human body could be used, while conceptualizing some design ideas.

Today, we are innovating various aids that can minimize or optimize the physical efforts and exertion that are required to use or operate. These aids are to be designed in such a manner that they should consider the normal physical skill of movement within comfortable limits that is design for each human to use. How we can achieve this? If the product's design, dimension and human body's dimension matches each other, then this is possible. So, we need to know human body itself in details and that anthropometry part etc and we are required to understand them thoroughly.

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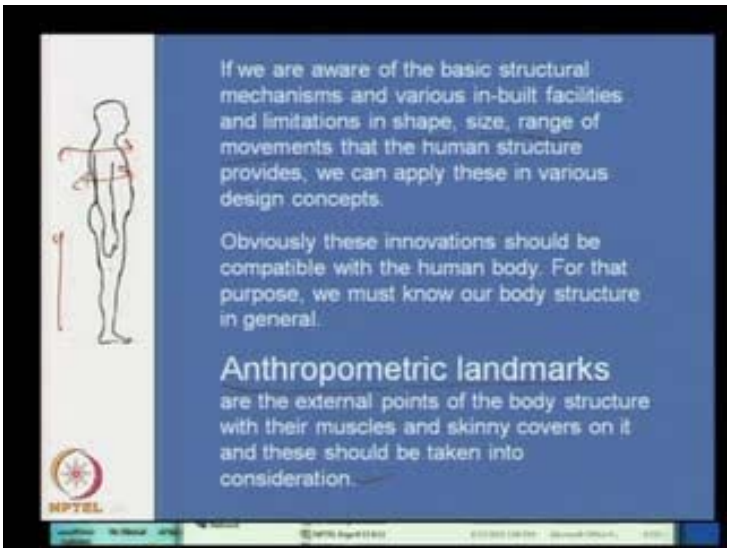

Now, if we are aware of the basic structural mechanism and various in-built facilities and limitations in shape, size, range of movement that body range of movement that the human structure provides, we can apply these in various design concepts. Obviously, these innovations should be compatible with the human body. For that purpose, we must know our body structure in general.

Anthropometric landmarks are necessary to understand. These landmarks are the external points of the body structure with their muscles and skinny covers on it and these should be taken into consideration, while making a design attempt. So, different body points should be at the different landmarks. So, it is the height, length, depth and then breadth etc. They are the different anthropometric parameters and the different points in the body are the landmarks that we are going to discuss in next session in detail.

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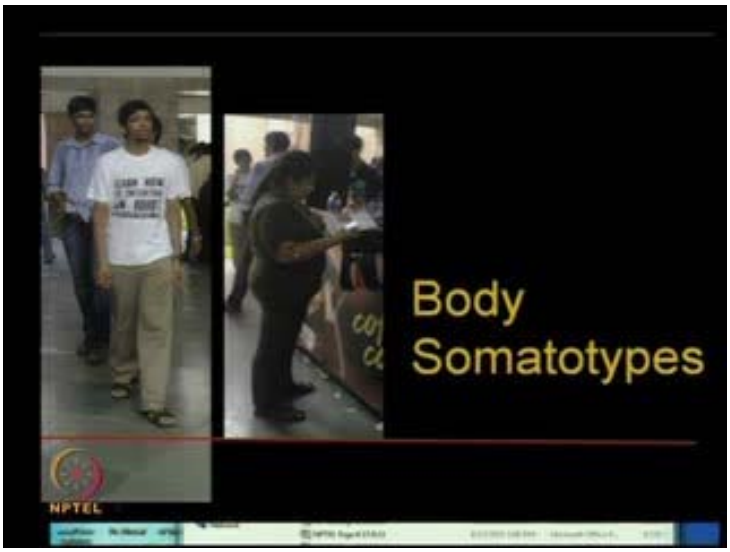

Now, we would like to go to the second stage of today's discussion that is body somatotypes. Body somatotypes are that how body looks like – lean or thin, fat and normal. How we can say that it is a normal body? For this, we are going to discuss the body somatotypes; soma means body and types mean body types.

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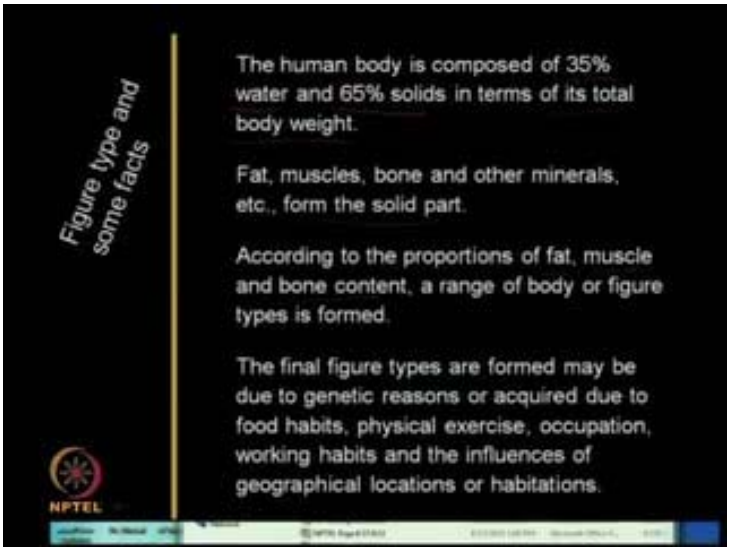

Now, some facts and type, the human body is composed of 35 percent water and 65 percent solid in terms of its total body weight. So, 35 percent water and 65 percent solids

in terms of total body weight. Fat, muscles, bone and other minerals etc, form the solid part that is the 65 percent of our total body weight.

According to the proportions of fat, muscle and bone content, a range of body or figure types is formed. The final figure types are formed due to genetic reasons or acquired due to food habits, physical exercise, occupation, working habits and the influence of geographical location or habitations. Why, in a family a person suddenly becomes very fatty or in a family everybody is fatty or lean and thin? Why it happens? It maybe due to the genetic reasons or malfunction of genetic matter and another can be due to food habits and etc.

If a person use to work in a field, where heavy manual work is necessary; there fat deposition will be less. So, muscle content will automatically be more and there will be less chance of becoming very fatty. If a person becomes sedentary or less work, then there is a chance of getting fatty.

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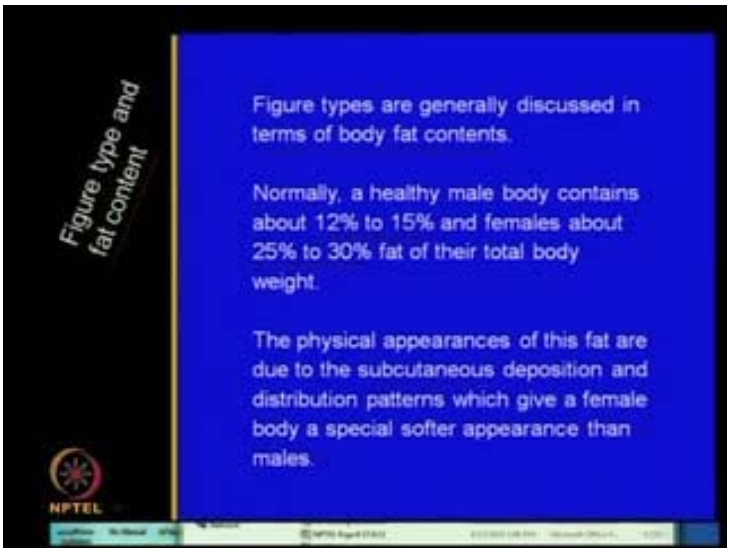

Figure types maybe genetic or acquired. Figure types mostly depend on the fat content. Figure types are generally discussed in terms of body fat content. Normally, a healthy male body contains about 12 percent to 15 percent of body fat and females about 25 to 35 percent of fat of their total body weight. Normally, the physical appearance of this fat are due to subcutaneous deposition and distribution pattern in different body parts like

abdomen, shoulder, thigh etc. This give a female body, a special softer appearance than males.

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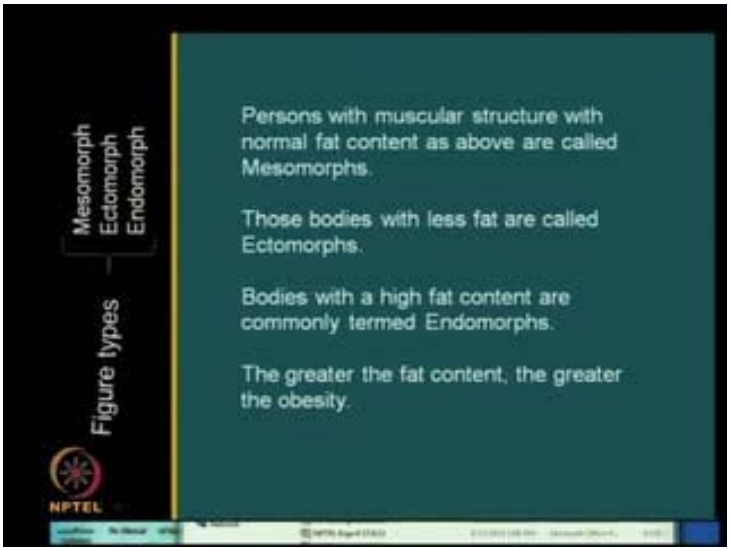

Now, figure types - there is a total of three figure types- mesomorph, ectomorph and endomorph. Ectomorph is the lean and thin body types, so fat content will be less in comparison to bone and muscles. Endomorph is the fatty body type, where fat content is very high. Mesomorph is where, the earlier stage fat content is there and it means normal muscular body type.

Now, if we see the slide here, the descriptions are there that persons with muscular structure with normal fat content as above mentioned are called mesomorph. Muscular body with less fat are called ectomorphs. Bodies with a high fat content are commonly termed endomorphs. The greater the fat content, the greater the obesity and obesity comes from this endomorph body types.

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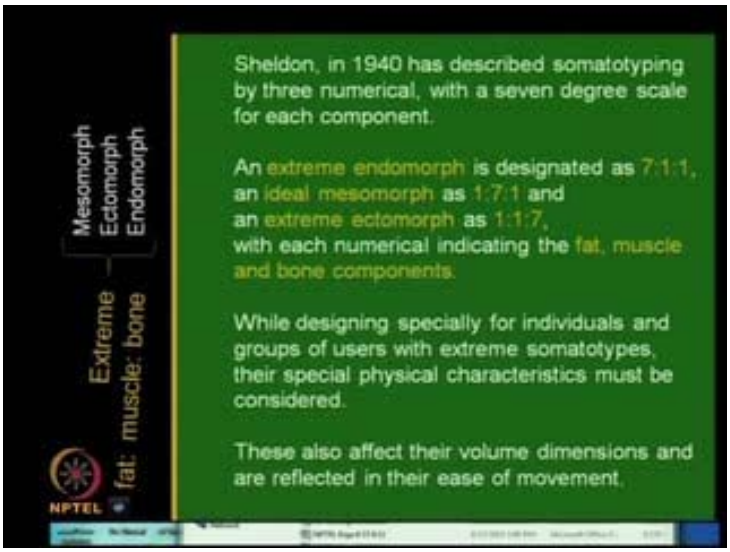

Now, lean and thin body maybe very extremely lean and thin, fat maybe extreme fatty body. How we can rate this? The extreme mesomorph, ectomorph and endomorph has fat, muscle and bone content. Sheldon, in 1940 has described somatotyping by three numericals, with 7 degree scale for each component; fat, muscle and bone.

Extreme endomorph fatty is designated at 7:1:1, it means relatively 7 and in this 7 degree scale rating, 7 is the fat, 1 is muscle and 1 is bone. An ideal mesomorph as by rating is 1 fat, 7 muscle and 1 fat. An extreme ectomorph; lean and thin body is 1: 1: 7. It means 1 rating for fat, 1 rating for muscle, 7 rating for bone with each numerical indicating the fat, muscle and bone components. While designing specifically for individuals and groups of users with extreme somatotypes, their special physical characteristics must be considered.

Now, these also affect their volume, dimensions- length, breadth, depth and are reflected in their ease of movement. It means lean and thin person at ectomorph will have more range of movement as they in subcutaneous layer, fat is very less. So, heat resistance will be some problem there. In fatty person, the movement range will be less as more fat is there in subcutaneous layer. So, heat resistance will be just opposite than that of ectomorph life. If I want to employ this person in certain area, where a specific design he has to operate or in a special environment he has to work anything like heat and etc. So,

how to select manpower for that what type of body figure would be preferable that is the concern for this discussion.

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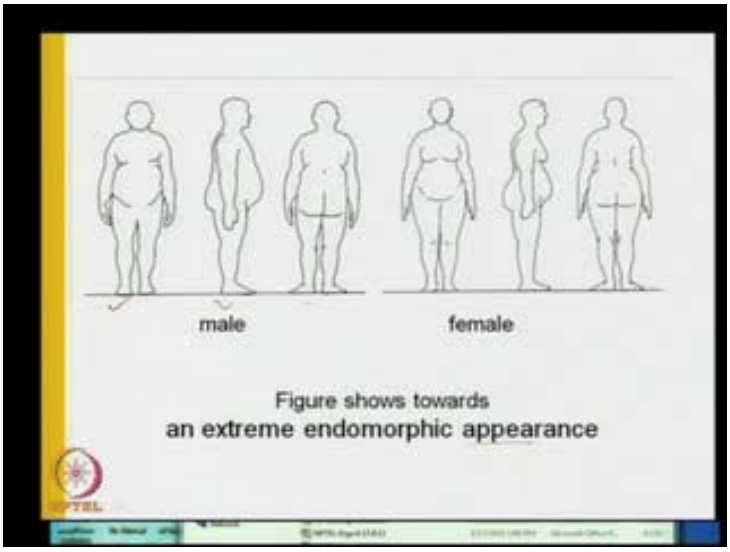

Now, if we see the extreme figure types, now an extreme endomorphic appearance is fatty. We can see the figures in front side and back. The figures look like this for male and for females.

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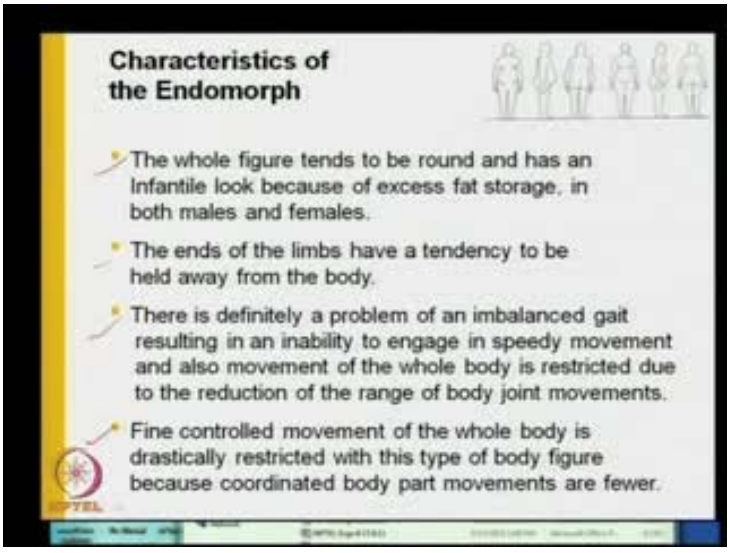

Now, what problems we have here? They have the characteristics of the endomorph; specific characteristics of fatty people. The whole figure tends to be round and has an

infantile look because of excess fat storage in both males and females. The end of the limbs have a tendency to be held away from the body. When they stand, their hands are normally outside and we can say see in this figure, their hands are going outer side. There is definitely a problem, often imbalanced gait, while walking that results in an inability to engage in speedy movement.

The movement of the whole body is restricted due to the reduction of the range of the body joint movements. Fine controlled movement of the whole body and the different body parts coordination movement is drastically restricted with this type of body figure. It means endomorph fatty body figure because coordinated body part movements are fewer.

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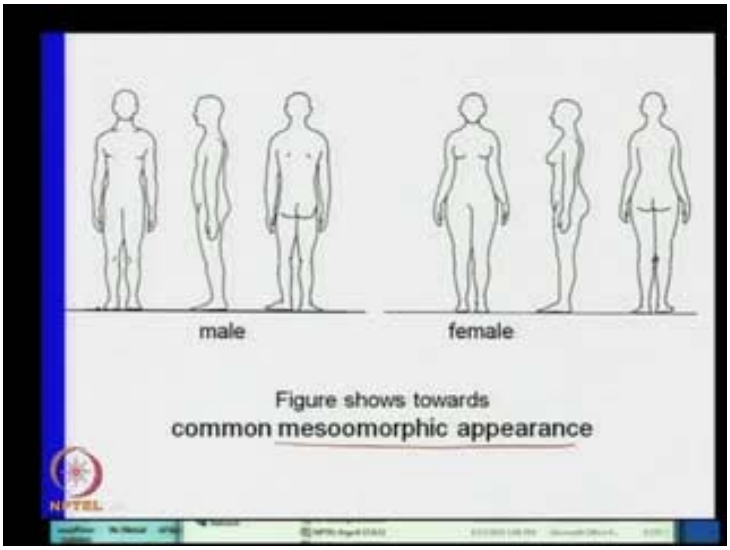

Now, if we see the mesomorph that is normal body figure. This figure shows towards common mesomorphic appearance. It can be said that this squarish type of body figure, limbs are vertically placed, as they stand erect, both for males and for females.

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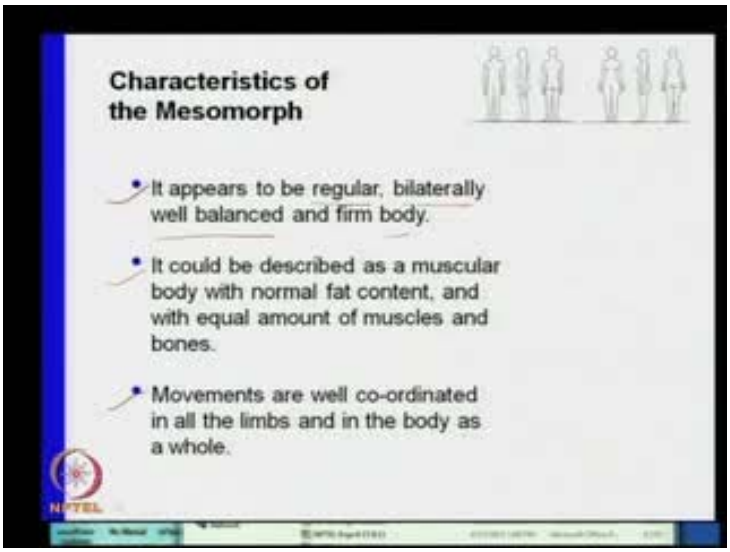

What are the specialties of extreme or the characteristics of the mesomorph? It appears to be regular, bilaterally well balanced and firm body. It could be described as a muscular body with normal fat content and with equal amount of muscles. Bones movements are well coordinated in all the limbs and in the body as a whole.

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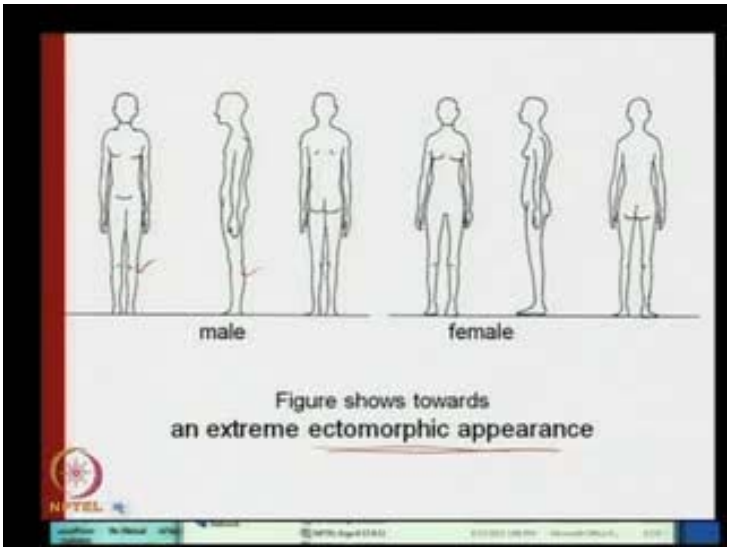

Now, we will see some figures towards an extreme ectomorphic appearance; lean and thin. So, these are for females and male; front side, backwards not very graceful standing posture for female also.

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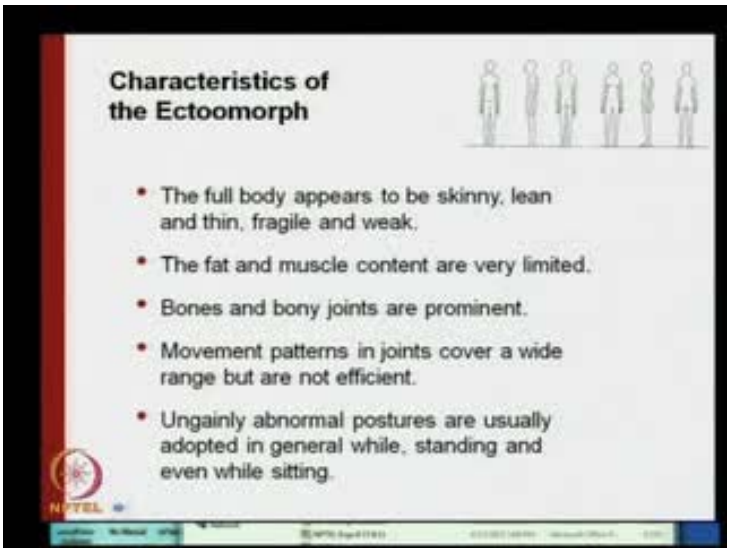

Now, specific characteristics of ectomorph is that the full body appears to be skinny, lean and thin, fragile and weak. The fat and muscle content are very limited. Bones and bony joints are prominent. Movement patterns in joints cover a wide range, but not efficient because muscles are less.

Ungainly abnormal posture are usually adopted in general while, standing and even while sitting. So, these are the specific body figure types and their specialties. We need to consider this, when we are trying to develop some design to feed a specific target group.

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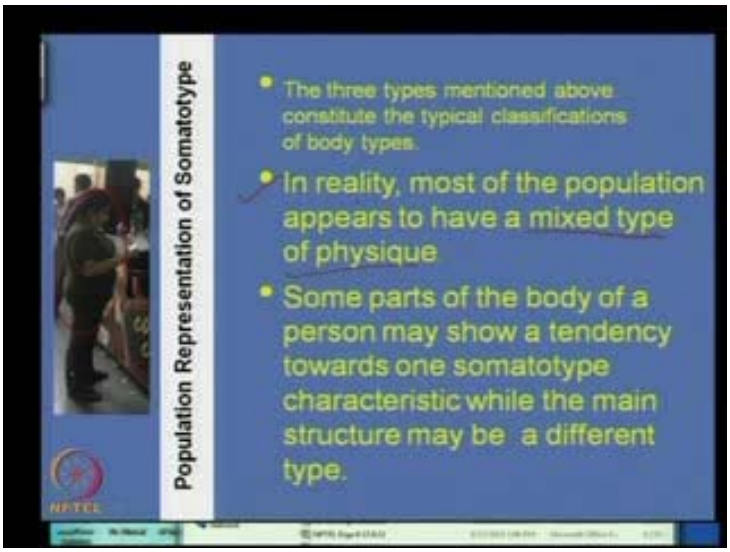

Now, in a common population, how the representation of somatotypes are there? Whether in a specific type group or population, is everybody is very fatty or lean and thin or normal? What would be the distribution for that? There are three types mentioned above that constitute the typical classifications of body types.

In reality, most of the population appears to have a mixed type of physique. Some parts of the body of a person may show a tendency towards one somatotype characteristic, while the main structure maybe a different type. In this figure, we can say that this portion may give a very endomorphic look and sometimes, in some body figure. legs or limbs maybe narrower or may not be like that.

In certain case, it is seen that the belly portion, the abdomen is very thick and buttock is very thick, but head portion and other limbs are not like that. So, in a same body, presence of different types of body figure characteristics is also possible, not only in a population group, but in a single body figure. Accordingly, we have to design for their use.

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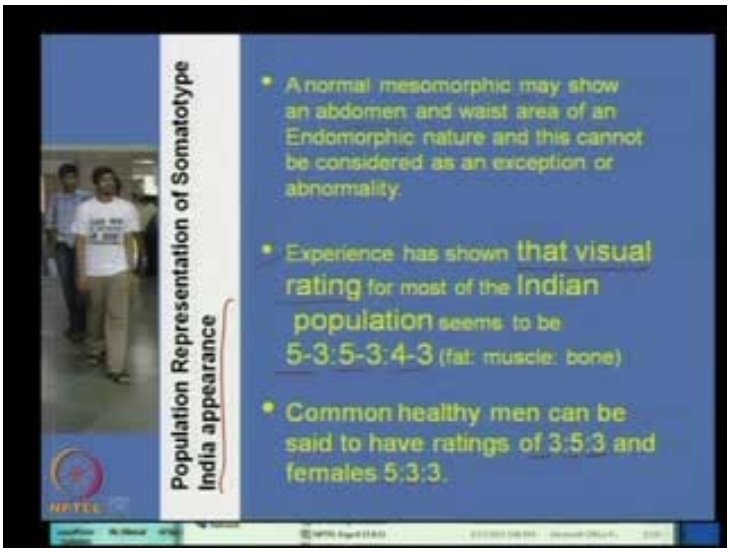

Now, in Indian population, what is its relevance? A normal mesomorphic may show an abdomen and waist area of an endomorphic nature and this cannot be considered as an exception or abnormality. Experience had shown that visual rating for most of the Indian population seems to be fat with that 7 degree scale described by Sheldon muscle in 5-3 and bone 4- 3, it is just a visual rating.

Common healthy men can be said to have ratings of 3:5:3, 3 rating is for fat, 5 rating is for muscle, 3 rating is for bone. For females, it will be fat for 5, 3 for muscles and 3 ratings for bones. By this, we can say that population representation of somatotype, specifically for Indian appearances in common.

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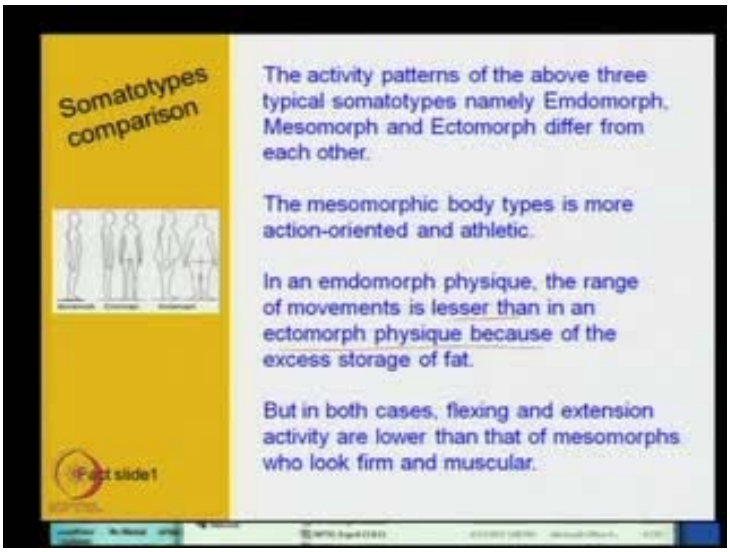

Now, somatotype comparison - the activity pattern of the above three typical somatotypes namely; endomorph, mesomorph and ectomorph differ from each other. The mesomorphic body type is more action oriented and athletic type. In an endomorph physique, fatty the range of movements is lesser than in an ectomorph physique because of the excess storage of fat. In both cases, ectomorph - lean and thin and endomorph - fatty, flexing and extension activity are lower than that of mesomorphs, who look firm and muscular. For lean and thin person, less muscle and for fatty body type, endomorph but not so effective muscles, this is happening.

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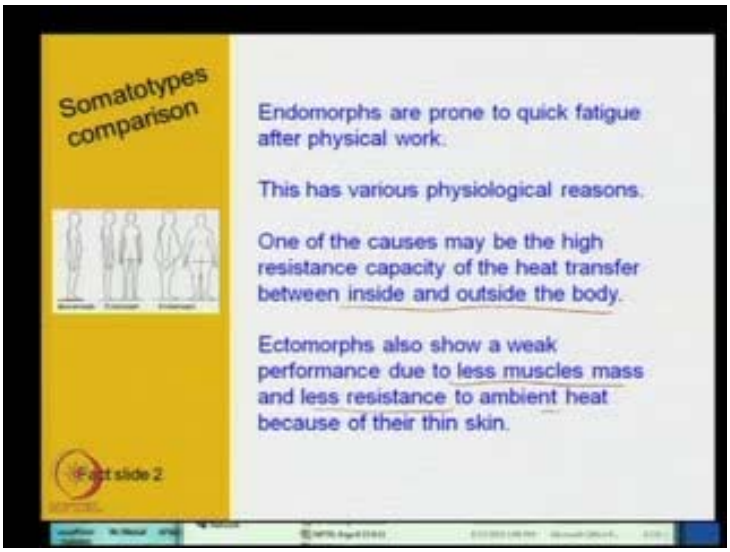

Endomorphs are prone to quick fatigue after physical work because the heat generated inside is not going out properly due to the thick fat content on the skin. This has various physiological reasons. One of the causes maybe the high resistance capacity of the heat transfer between inside and outside the body and it is regulated with the presence of fat layer. Ectomorphs also show a weak performance due to less muscle mass and less resistance to ambient heating because of their thin skin.

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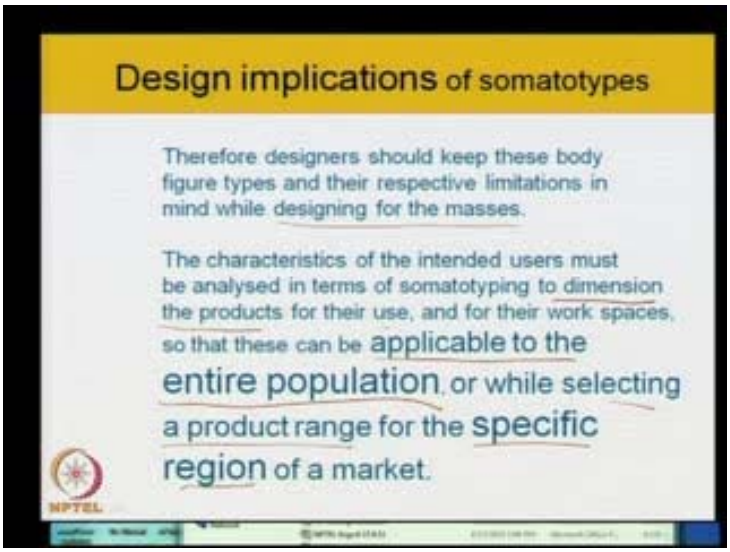

Now, what are the design implications of somatotypes? Designer should keep these body figure types and their respective limitations in mind, while designing for the masses, whether a same single type of design is good for ectomorph. If we present in a society or a population, where other type of body figures will get same comfort or not and we need to think something on that.

The characteristics of the intended users must be analyzed in terms of somatotyping to dimension the product for their use and for their work spaces, so that these can be applicable to entire population or while selecting a product range for the specific region of a market.

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Now, a specific observation tentative, we can say that there may be many reasons for the different body structures. It has been observed that normally the city dwellers are well built and are inclined more towards endomorphism fatty type than the village population in India. It is a common observation and it may be due to lifestyle.

Now designing application is that if a park as shown in this figure; in this park, the entry has whirling gate. What would be the size of this space, so that a body can go in and have a circular movement and can go that side? What would be the space requirement for that? If we decide a body dimension based on ectomorphic; lean thin body type, then a fatty person cannot go in. If we take the extreme fatty type, then it would be excess dimension given because in that population, maybe very few extreme cases; the fat person are there. For general purpose, it will be unnecessarily more, so that the purpose of this gate is to selectively allow persons to go in will be lost. So, here the thing is that we have to properly judge the population group with this figure types and take the range of figure types that we allow to pass through this and accordingly, the range of body dimension should be considered.

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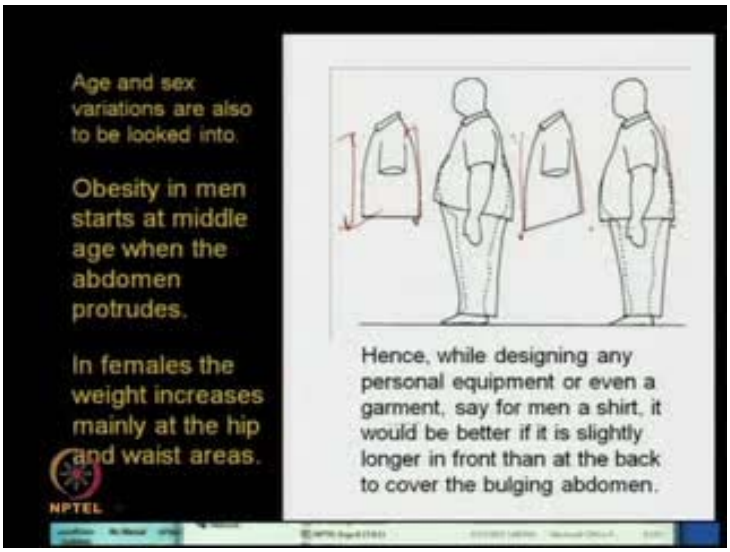

Age and sex variations are also to be looked into. A myth is that in certain part of India, ladies have thick buttock. In certain places, it may not be like that. Now, if we want to make a special design, where both the groups are accepted to use, what is to be done? A myth is that all men are very tall and so if we want to take a male dimension, where the person needs to cross accommodating the body height. Take only the male figures in a certain group and it may not also be proper because in that population, we measured the maximum height. In some other population, some ladies are taller and in other ways, the body circumference may not be same. We cannot say that it is always larger in an aged lady than a young man and it is also not true. So, depending for age and sex, the specific causes has to be considered.

Now, obesity in men starts at middle age, when the abdomen protrudes and the same for female. In the females, the weight increases mainly at the hip and waist areas. So, the body figure type also differ in male and female. In age wise, what happen is, while males grow in the abdomen part, when they are growing older and the ladies have the hip and waist. This another example in this right hand corner; in this figure, it says that while designing a chart, any personal equipment or even a garment for men shirt would be better, if it is slightly longer in the front. These two are not the same size, this is little longer than this one in front, than at the back to cover the bulged abdomen.

So, what is happening? If I wear this, it will be the same height and it will be same like this for ladies. The same similar principle or similar matter can also be considered while talking about their waist and hip area. Now, with this, we are coming to the concluding session; the summary to lead the next class and whatever that we discussed today is the summary.

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Now, people for whom, we are concerned for designing their body growth and body type. First is that people like to see themselves well built and fit with maximum range of motion in joints. This user image association with a design development programme bears the same mindset. Whereas, we all greatly differ from that image of so called standard body; this is very difficult to say that what is standard body. There are variations of body sizes that do not always confirm to perfect symmetry and proportions among body parts.

Sometimes to overcome those unwanted features, we overdo clothing and use varieties of decorations, which in turn affect in negative ways in movement and etc in our body. Our design activity must consider various body types and limitations thereby; our design activities are to aid all the users; not a specific group of population or a specific group of figure type, rather than making a design and then asking them to fit in.

First, see target group and find their body type and then design to fit, but if we design something for a specific body type and then ask other body type to fit in, it will be

difficult. So, we need to consider this matter. Specifically, designers must look into this aspect and these are the ergonomic aspects. It means to make human compatibility design solutions and these are the scientific backups of that.

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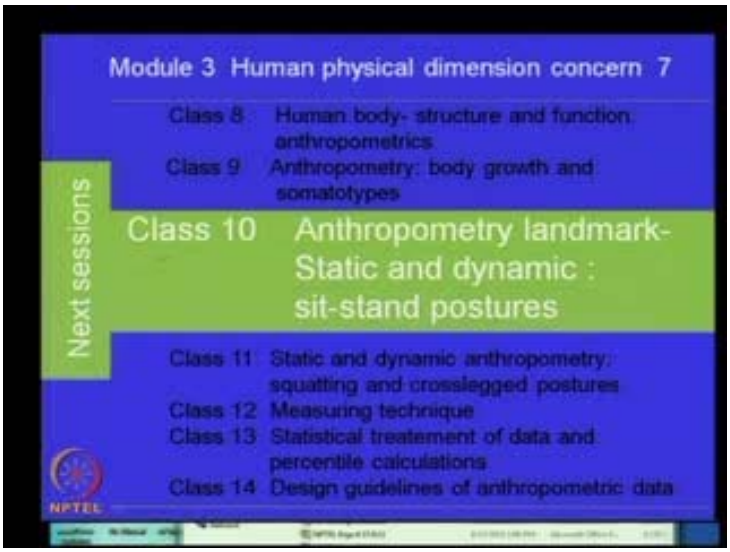

In next class, we are going to discuss the session number or class number 10. It is about anthropometry landmarks, specifically for static and dynamic sit-stand postures.

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In the next session, we shall discuss anthropometry landmarks. It means different body points of this locations and then height, length, breadth, circumferences and depth etc.

We will discuss in next class and with this, we are concluding today's session. Thank you.