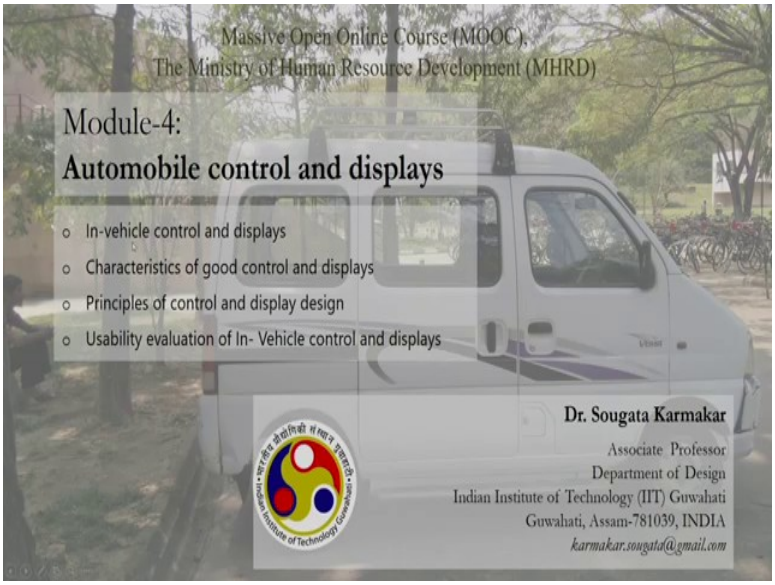
Ergonomics in Automotive Design
Prof. Sougata Karmakar
Department of Design
Indian Institute of Technology, Guwahati

Module – 04
Part - I
Automobile control and displays
Lecture – 05
Principles of Control and Display Design

Welcome to the course; Ergonomics in Automotive Design.

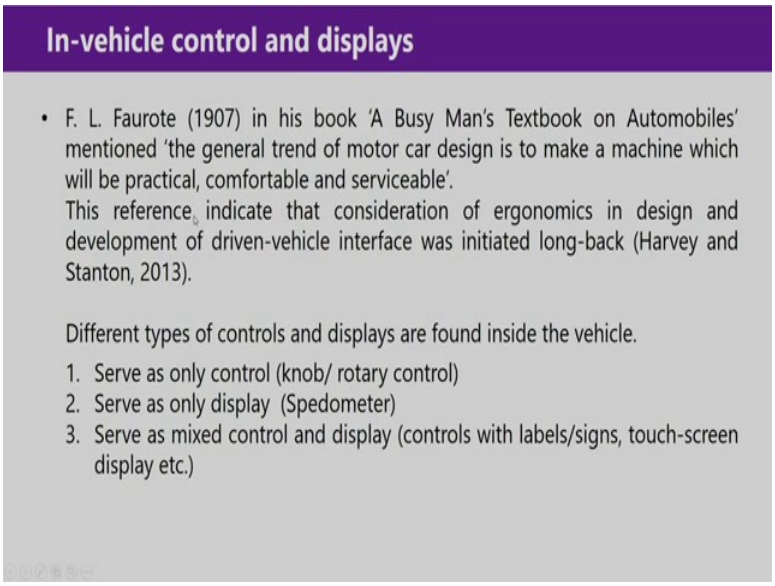
(Refer Slide Time: 00:42)



Today, we are going to discuss our module four, that is automobile control and displays.

So, in this module, we are going to discuss few topics. First one; in-vehicle control and displays. Second - characteristics of good control and displays, and third one; principles of control and display design, and the last one; usability evaluation of in-vehicle control and displays.

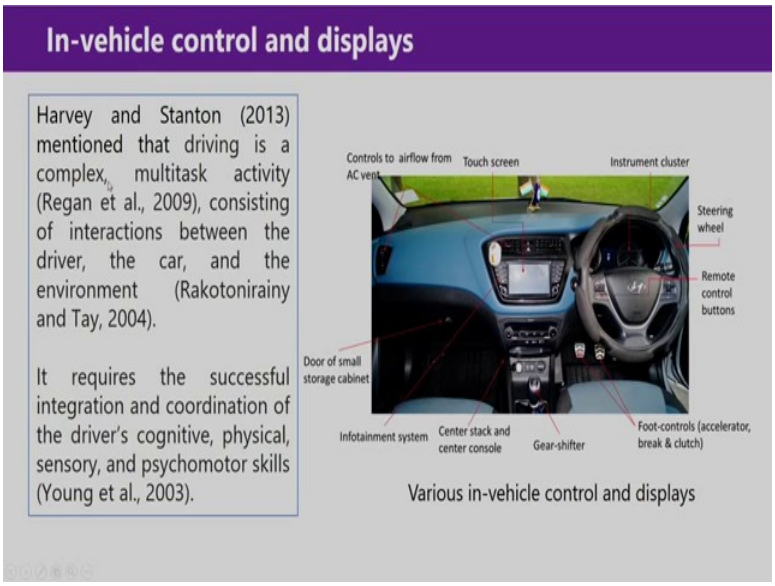
(Refer Slide Time: 01:03)



So, first topic; in-vehicle control and displays. F. L. Faurote (1907) in his book, 'A Busy Man's Textbook on Automobiles' mentioned that; 'the general trend of motor car design is to make a machine which will be practical, comfortable and serviceable.' So, from this reference, we understand that the consideration of ergonomics in the design and development of the driver-vehicle interface was initiated long-back; as early as 1907.

Now, in the vehicle, there are different types of controls and displays, and some of these controls mainly serve as - only control; few are - only displays; on the other hand, there are also mixed controls and displays. For example, control with labels or signs, touch-screen interface. So, these are coming under the example of mixed control and display.

(Refer Slide Time: 02:02)



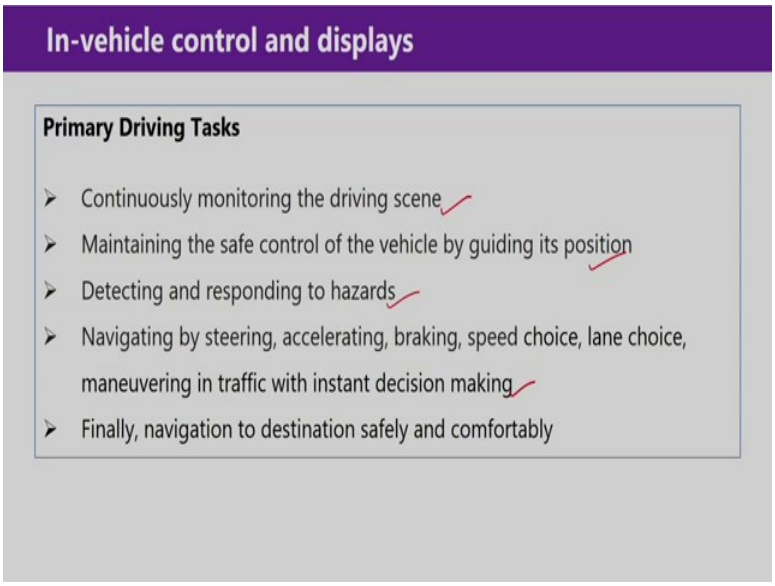
Harvey and Stanton (2013) mentioned that driving is a complex, multitask activity, consisting of interaction between the driver, the car, and the environment. It requires the successful integration and coordination of a driver's cognitive, physical, sensory, and psychomotor skills. Now, if we look; in any of the vehicles and it's inside (various in-vehicle displays and controls), then we will find; there is the steering wheel.

So, this steering wheel is one control; for vehicle navigation. There on the steering wheel, there are some remote controls for various types of operations; like AC control, then audio systems control, so, this type of controls are also available on the steering wheel.

Apart from these controls; there are also so many other controls on the central console. So, there are different types of knobs, buttons; there is gear shifter. Similarly, there are also various types of foot controls; brake, accelerator, clutch. So, these are present inside the vehicle. Apart from these different types of controls, there are also displays. Through the steering wheel, we can see different instrument cluster, so, where there is speedometer, fuel gauge, so, these types of displays are there.

Similarly, on the central console, we can see, this type of touch screen with the infotainment system. So, inside the vehicle, there are different types of controls and displays, which are very much essential for driving as well as non-driving tasks.

(Refer Slide Time: 03:38)

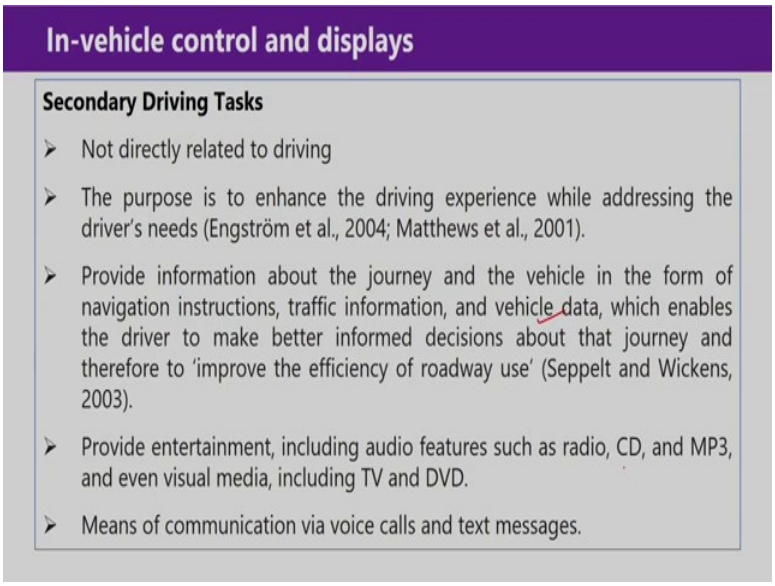


Now, all these controls and displays are associated with different types of in-vehicle task performance. Some tasks are related to the primary driving task; some are related to secondary driving task. So, which are the primary driving task, and how in those primary tasks; different types of controls and displays help; we will discuss.

So, primary driving task; what are those primary driving tasks? First one; continuously monitoring the driving scene. Second; maintaining the safe control of the vehicle by guiding its position, that, how that vehicle will be navigated on the road. So, that has to be guided by using different types of control operations. Detecting and responding to various types of hazards, and we have to take precautions. So that there should not be an accident or near to accident cases.

Navigating by steering, accelerating, braking, speed choice, lane choice, and maneuvering in traffic with instant decision making. So, while drivers are driving, they have to make instant decisions and accordingly they have to operate various types of controls and they have to maintain the speed, maintain the lane, to avoid any sort of accident or mishap. Finally, the ultimate goal of this driving task is to reach the destination safely and comfortably.

(Refer Slide Time: 05:03)

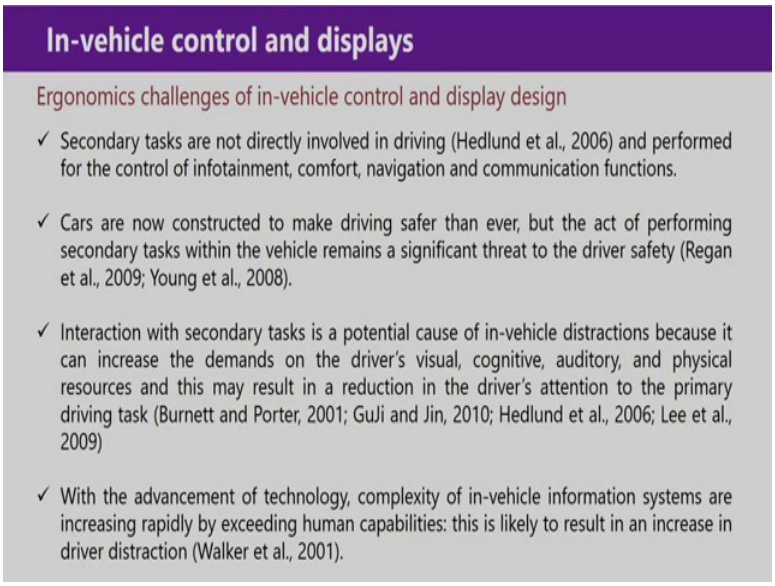


Now, what are the secondary tasks performed by drivers inside the vehicle? So, these tasks are not directly related to driving. The purpose of these tasks is to enhance the driving experience while addressing the driver's needs, then to provide information about the journey & the vehicle in the form of navigation instructions, traffic information, and vehicle data, which enables the driver to make better informed decisions about the journey and therefore to 'improve the efficiency of roadway use'.

So, there are various references mentioned; from where we got this information. Then it provides entertainment including audio features such as radio, CD, MP3, and even visual media, including TV and DVD. So, these various controls and display also helps in communication via voice calls and text messages.

Now; for performing these types of in-vehicle primary tasks, which are related to driving or secondary tasks which are not directly related to driving; for performing these types of driving and non-driving tasks different types of controls and displays are present inside the vehicle.

(Refer Slide Time: 06:11)

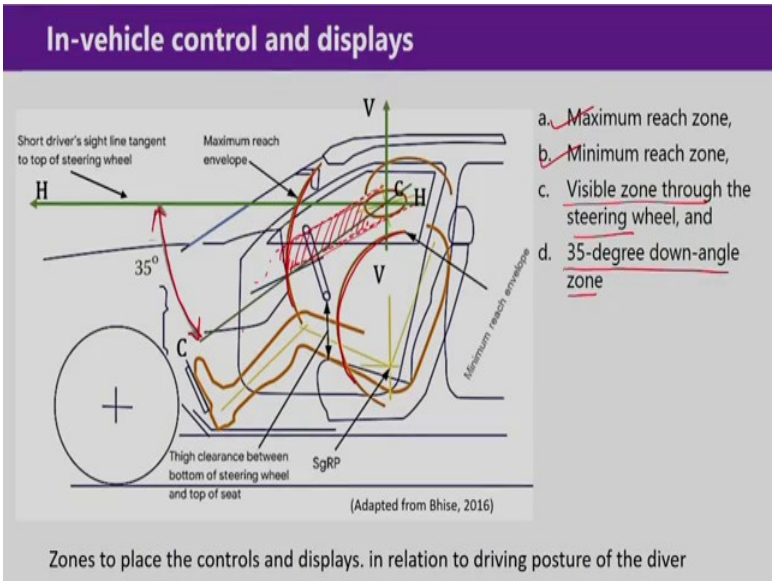


Now, what are the ergonomics challenges for in-vehicle controls and display design? Secondary tasks are not directly involved in driving and are performed for the control of infotainment, comfort, navigation, and communication functions. Cars are now constructed to make driving safer than ever, but the act of performing secondary task within the vehicle remains a significant threat to driver safety.

Interaction with secondary tasks is a potential cause of in-vehicle distractions because it can increase the demand of the driver's visual, cognitive, auditory, and physical resources and this may result in a reduction of the driver's attention to the primary task of driving. And, that is why, when the driver's attention is diverted, and where there is distracted driving, then there is a chance of error and accident.

With the advancement of technology; the complexity of in-vehicle information system is increasing rapidly by exceeding the human capabilities; this is likely to result in an increase in driver distraction; as mentioned by Walker et al., (2001).

(Refer Slide Time: 07:28)



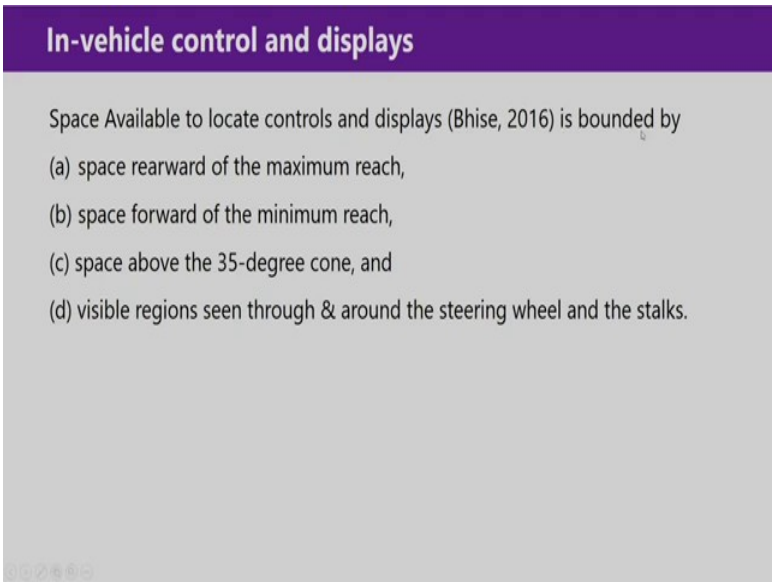
Now, if you look into this image. So, there are different zones or places. Now, if you look into this image, then we can find various zones to place the controls and displays, in relation to the driving posture of the driver.

So, while the driver is seated on the driving seat and is adjusting the seat forward and backward, then which of the area or which of the zones where most of the controls and displays is to be kept for various purposes, that we need to decide. Now, from this image, we can see this line; this curve is for minimum reach envelope. Similarly, this line is the maximum reach envelope. So, this is the minimum reach envelope for the drivers as well as this is the maximum reach envelope. Then, the next important aspect is the visible zone through the steering wheel.

So, this area, upper part of the steering wheel (through the steering wheel rim) and at the half of the steering wheel hub there is a space, through that space we can see the instrument cluster. Next; 35-degree down-angle zone. So, this is the horizontal line of sight, below that 35-degree area. So, this is another area.

So, these are the various zones. Based on these zones; we have to decide where we should keep our different types of controls and displays, to make the driving experience comfortable, easy, and safe.

(Refer Slide Time: 08:56)



Space available to locate controls and display is bounded by space rearward to the maximum reach, space forward to the minimum reach, then space above the 35-degree cone, and visible region seen through and around the steering wheel and the stalks.

Now, if we go back, so, first; we should know what is this minimum reach envelope? So, while the driver with shorter body dimension is adjusting the seat at the forwardmost position, means, moving the seat in forward direction, and at that time while the 5th percentile driver's upper arm is parallel with the seat-back and elbow; it is on the side bolster of the seat-back; at that moment, based on the elbow, making it as the pivot point, the area or the volume which can be accessed by the lower arm, that area or that envelop is called minimum reach envelop.

So, minimum reach envelope is actually decided, based on the access area, or reach area, or reach capabilities of the 5th percentile driver, by their lower arm; while starting point is the pivot point, it is the elbow joint on the seat-back bolster. In this situation, this volume can be accessed by the 5th percentile driver. Now, during this minimum reach envelop, we generally consider the grasp-reach or grip-reach.

So that all these controls which we want to position, that should be positioned beyond this zone. Because, if that zone is, the distance from the driver seat, if that is less than these envelopes or this horizontal distance, then what will happen? It will be difficult to operate; by the 5th percentile drivers as well as; obviously, for the drivers with larger

body dimension and with larger hand dimension. Next area is the; maximum-reach envelope.

So, while we are deciding; which will be the maximum reach envelop, for that purpose, we need to position 95th percentile manikin on the seat, and the forward three-finger arm-reach, while the driver is 95th percentile driver or driver with larger body dimension; he is adjusting their seat at the rearmost position, and sitting on the rearmost position, while they are extending their arm forward; in that scenario, the three-finger reach area is denoted by maximum reach envelope, in different directions; sidewise direction, forward direction as well as upward direction.

So, ultimately in the 3D space; the area or the envelope covered by this maximum arm-reach, that is called maximum reach envelop. Now, while we want to position different types of controls or display, then we should consider this particular zone between the minimum reach envelope, as well as the maximum reach envelop. So, these are the boundaries. So, this is the lower boundary for positioning the control and displays; at the same time, this is the upper boundary.

So, all the controls and display which are frequently used; those controls and displays should be positioned within this zone, means, this is the lower boundary, and this is the upper boundary.

So, within this; the middle zone should be considered for positioning various controls and display. So, this is the maximum reach envelope, and the minimum reach envelop. And between these reach envelopes; that space is used for positioning the control and display. Next is the; visible zone through the steering wheel. Now, if we consider the 95th percentile eyellipse, and from that eyellipse; if we draw these types of line of sight; we consider; this dotted red line.

So, the space between these two dotted lines, which is going through the upper portion of the steering wheel. So, this area is actually used for the purpose of positioning the most important displays.

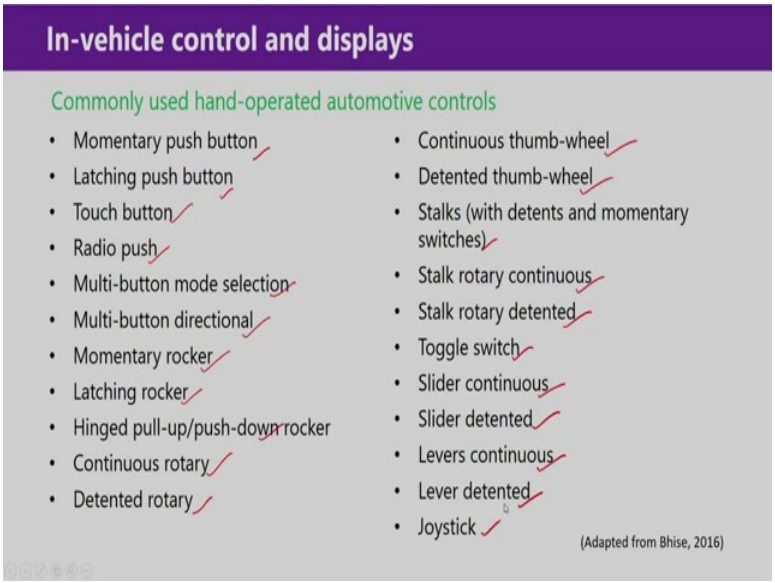
So, that driver can easily visualize during driving. So, while the driver is looking straight forward on the road; only with the minimum eye movement, they can easily see the instrument cluster through the steering wheel. So, this area is decided, based on this; by

making this type of tangent line from the 95th percentile eyellipse. This is the upper boundary, and this is the lower boundary. Now, the next important zone for positioning other displays and control, that is 35-degree downward angle zone.

So, from the center of the eyellipse, if we draw straight horizontal line head; this is mentioned as H-H line, and from that line, if we go 35-degree downward. So, this zone is actually the area, where we can position most of the important displays as well as the various controls, which are frequently used, and which cannot be operated without looking at. So, the various controls and displays, which cannot be used or the controls which cannot be operated blindly.

So, in that case; for easy feasibility, this is the best location. Because, while the driver is looking straight forward on the road, with minimum eye and neck movement, they can easily look at the various controls and display position within this 35-degree downward zone.

(Refer Slide Time: 14:36)



Now, inside the vehicle, there are numerous controls, here is the list; this list is adapted from the Bhise's book, which was published in 2016.

So, from that book; these are the; we have listed various controls used in the automobiles, means, different types of automobile vehicles. So one is; momentary push button, latching buttons, touch buttons, radio buttons, multi-button mode selection,

multi-button directional, momentary rocker, latch rocker, hinged pull-up/push-down rocker, continuous rotary, detented rotary, continuous thumb-wheel, detented thumb-wheel, and different types of stalks, stalk rotary continuous, stalk rotary detented, toggle switch, slider continuous, slider detented, levers continuous, lever detented, joysticks.

So, these types of various controls are available inside the automobile, and those are used by drivers for various purposes.

(Refer Slide Time: 15:51)

Now, if we take the specific example of specific types of controls; then first, we are discussing about continuous versus discrete control. So, what is continuous control? In case of continuous control, we can operate that control switch or control in such a way that its setting goes continuously; there is no specific position. So, while we are moving the control, the entire range of motion is actually giving different control settings.

So, example of such controls is the rotary control for temperature regulation, then various slide switches and levers, on the other hand, if we think about the discrete control. So, in case of discrete control, there are some specific positions or detented location, where we have to set the control, so that, it is not continuous. So, we have to set at this particular position to achieve the particular settings of that control.

So, these types of controls include; rotary controls for fan speed regulation, here is the example of a fan speed regulator which is rotary control. So, this is the off position; then, when we are starting, gradually, we can increase the fan speed by moving clockwise.

There are other types of discrete controls which include detented slide controls, rocker switches, as well as gear shifter. Now, apart from this continuous and discrete types of controls, there are different push buttons. And, these push buttons are available in the central console, as well as on the steering wheel. So, now, here is some example; these are the number for dialing different types of numbers or changing different types of settings (Refer Time: 17:41). So, all these are the push buttons.

So, you can see, these are the push buttons. So, if we press this particular knob, then it will be on and off; then this audio system will be operated by this one.

Similarly, if we move it clockwise or anticlockwise accordingly, volume can be increased or decreased. So, here, this is also, while we are using this for on and off; then this is acting as a push button. Similarly, there are so many other types of push buttons. Since many push buttons or touch buttons can be activated by very little force. So, there should be some provision. So, that hand or palm can be rested near that buttons. So, within the hand and finger; this distance to the button.

(Refer Slide Time: 18:29)

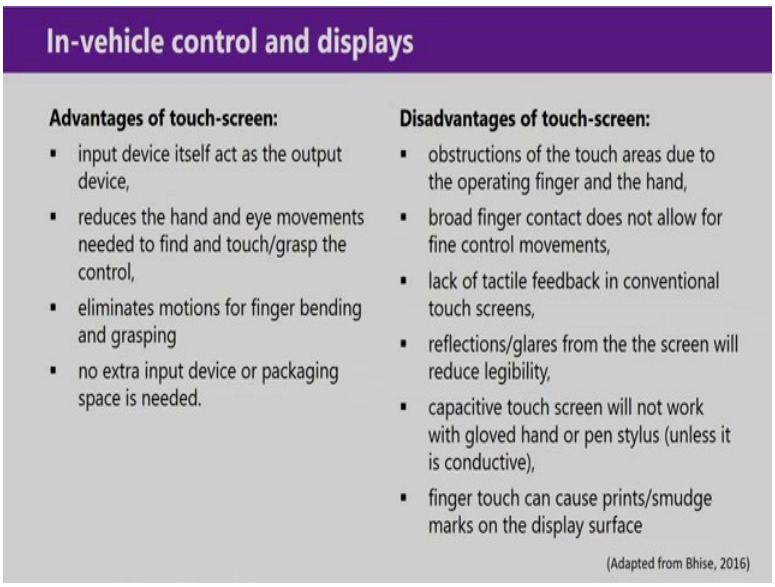
Now, there are other types of controls, like touch screen, and voice control. So, in touch-screen; control surface is overlaid on the top of the display, in case of voice control, the voice recognition system allows recognition of the driver's spoken word and sets system functions. So, this is very much useful for hands-free operation.

So, only by making some particular word or particular sound, we can activate different types of controls and execute that task. Some limitations of the voice controls; drivers may dislike this type of controls because they may feel that they are talking with the instrument or the non-living objects.

Next; temporary disability in voice generation, e.g. in case of sore throat, then the driver or the person who is driving the vehicle he cannot pronounce a particular word or particular instruction properly. As a result; device may not be activated. Then noise in the vehicle may reduce the accuracy of the voice recognition system; there may be delay in voice recognition and also error in voice recognition.

So, different types of limitations are also there, in case of voice-activated controls but on the other hand, there so many benefits or there are also some advantages as you already mentioned; this is good for hand-free operations.

(Refer Slide Time: 19:55)



Now, in case of touch screen, in majority of the advanced vehicles, there is touch screen, in the central console panel or for different types of other displays also; for navigation

purpose, for infotainment purpose. So, in that case, this touch screen, on one hand; there are various advantages, on the other hand, there are various disadvantages also. So, if you look into the advantages side. So, first; these input devices itself act as the output device. So, there is no requirement for separate input and output device.

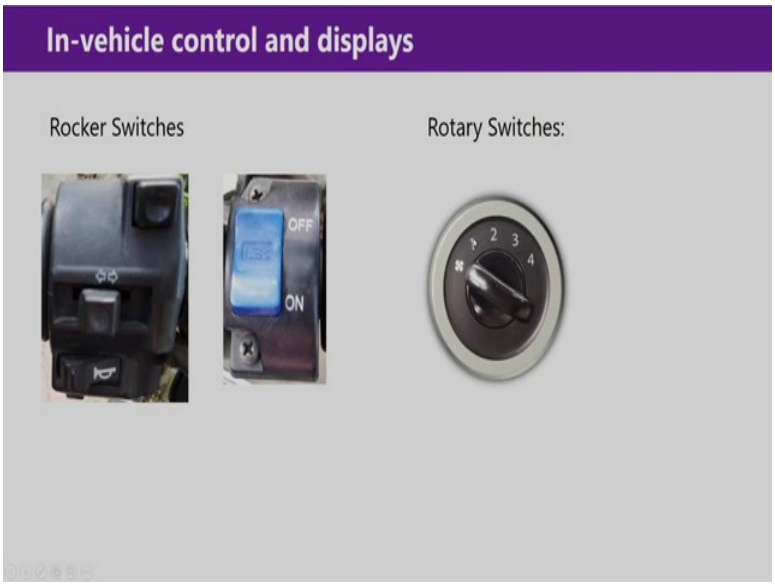
So, the touch screen, which is displaying different types of visual information, on the same screen, by pressing or touching, we can operate the control. Reduces the hand and eye movement needed to find the touch/grasp control. Eliminate motions for finger bending and grasping. Next, no extra input device or packaging space is needed in this case, because as we mentioned, this is the same surface, same display screen actually acts as the control also.

Now, there are also different disadvantages. So, firstly; obstruction of the touch area due to operating fingers, and the hand and due to this obstruction it is difficult to operate, then a broad finger contact does not allow for fine controls in the touch screen; for movement or for the operation of the fine controls, sometimes people may find difficulties. Then lack of tactile feedback in conventional touch screen, but in the advanced touch screen this type of tactile feedback is being provided now.

Then, reflections or glares from the screen will reduce the legibility, particularly during daylight or in a condition where there is light directly falling on these types of touch-screen interface, then there is a problem with the visibility of information or legibility of that display.

Capacitive touch screen will not work with a gloved hand or pen stylus unless it is conductive. Finger touch can cause prints or smudge marks on the display surface.

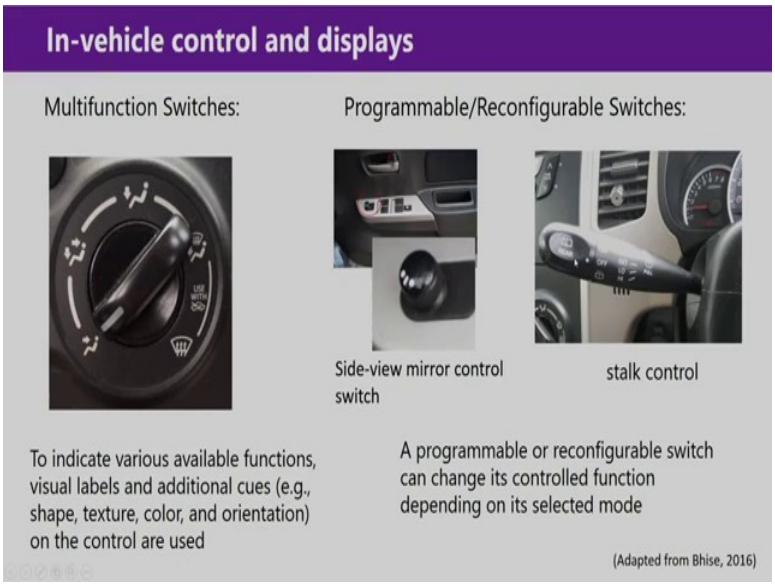
(Refer Slide Time: 22:16)



Now, there are also other types of controls like rocker switches, different types of switch for on and off. So, if we press one side, then another side will be protruded, and when we press another side, then the opposite side will be protruded. So, based on that, we can understand whether that is in on and off opposition; otherwise we can move different types of rocker switches; left to right. Also, this type of button switches for horn. So, these are the examples of rocker switches.

On the other hand, there are different types of rotary switches. So, rotary switches, as this is the example of fan control. So, when this knob is rotated clockwise, then we can increase fan speed, and while we are moving it in an anti-clockwise direction, then we can reduce the fan speed, and we can off that fan also.

(Refer Slide Time: 23:04)



There are also multifunctional switches, here is one example. So, this is for the control of the AC vent, the direction of the airflow, whether it will come from the front and towards the leg. So, different types, if we rotate this control, then we can set it at different positions and accordingly we will be able to achieve different types of settings.

To indicate various available functions, visual labels, and additional cues (shape, texture, color, orientations) are provided on these controls. So, this is one example of this type of multifunctional switches; same switch but based on different settings, we can achieve different types of operations. Another type of controls is programmable or re-configurable switches. In the side-view mirror control switch, if you see this particular one.

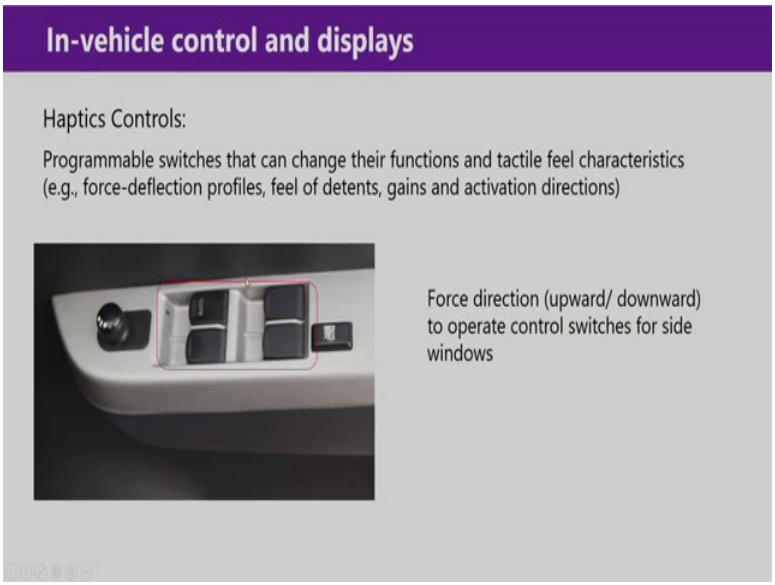
So, here we can hold it, we can rotate it, based on the rotation, we can select whether we want to control the left-side or right-side window. And after selecting that one, then it acts as the, from its base, it acts as the joystick and based on that joystick movement, we can control the setting of the angle of the mirror.

Then, there are also left-side and right-side stalk control with the steering-wheel hub. So, in that case, these stalk controls, this is also re-configurable switches. So, there are various positions; we can move it in forward direction, backward direction to achieve different control settings. Similarly, in this example, while we are thinking about this stalk control for wiper for windshield cleaning.

So, there are; on and off functions for the rear windshield wiper, at the same time, if we move this one in different direction; forward and backward location, we can control the wiper on the front windshield.

A programmable or re-configurable switch can change its control function depending on its selected mode. So, these are the different modes, based on the mode selection; we can achieve different functions.

(Refer Slide Time: 25:15)

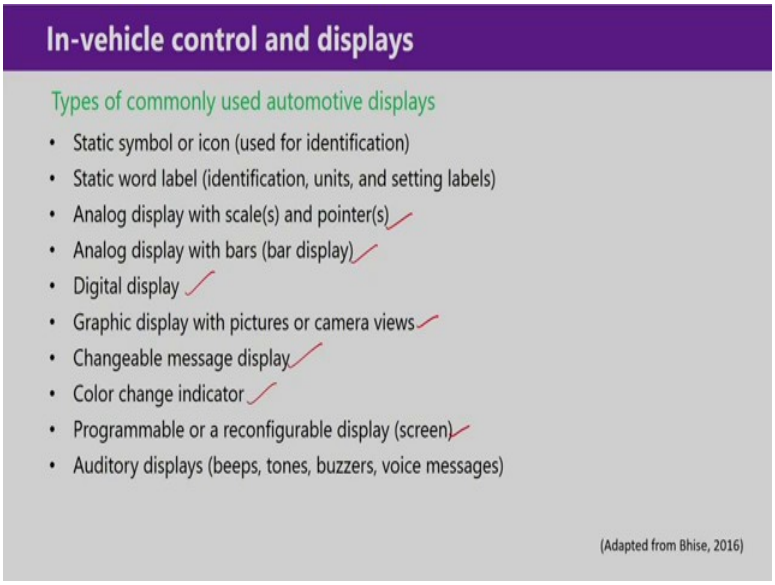


Now, there are also haptic controls. So, these haptic controls, they are actually providing cues. So, with this haptic control, even without looking at the control, we can feel it, we can touch it, and accordingly we can perform the activities. So, generally programmable switches that can change their function and tactile feel characteristics; for example, force-deflection profile, feel of detents, gains and activation direction.

So, by these functions; different types of haptic controls work. So, here is one example; for force direction; whether we will move upward or downward to operate the control switches for side-windows. So, on the door trim panel, these types of controls are there for operating the side-windows. So, in that side-windows; operating that or controlling that side windows up and down, if we move this control switch in an upward direction, the window will also move up, at the same time if we move it in downward direction, then window will go down.

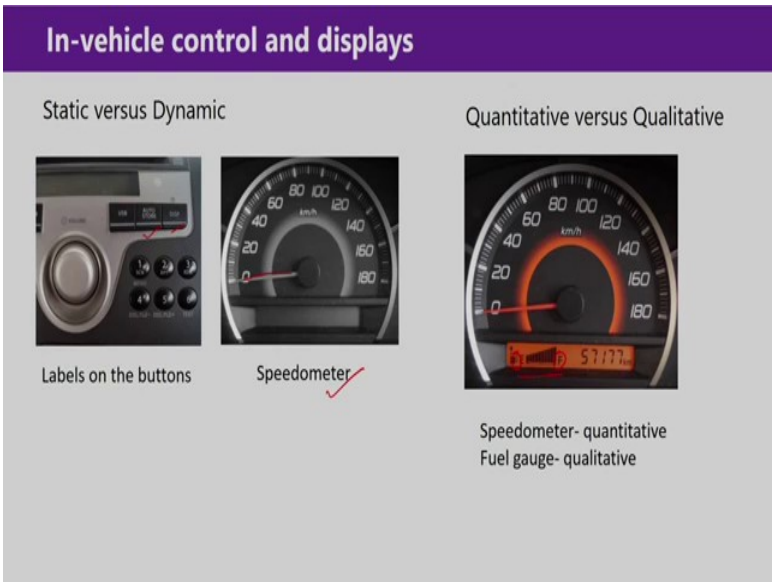
So, this type of buttons are; or control switches are available, which actually give haptic feedback of control operations.

(Refer Slide Time: 26:26)



So, apart from these various types of controls which are available in the automobile, there are also numerous types of displays available. So, here is the list. So, static symbol or icon used for identification, static word label, analog display with scales and pointers, there is also analog display with bars (bar display), then digital display, graphic display with pictures or camera views, changeable message display, color change indicator, then programmable or re-configurable displays, auditory displays like; beeps, tones, buzzers, voice message; different types of sounds come from this type of display.

(Refer Slide Time: 27:15)



Now, if we go for a specific type of display; static versus dynamic, then what are the static displays; what are the characteristics of this type of display and what are the characteristics of dynamic display? So, in case of static display, various information, which is being provided by the display, that is static; so, it does not change over time. So, different types of written material is provided against the controls, that act as the labels, that act as the static displays. So, here are some example, here it is written USB, then; audio, store, display. So, this type of written information near the buttons is actually coming on the static display.

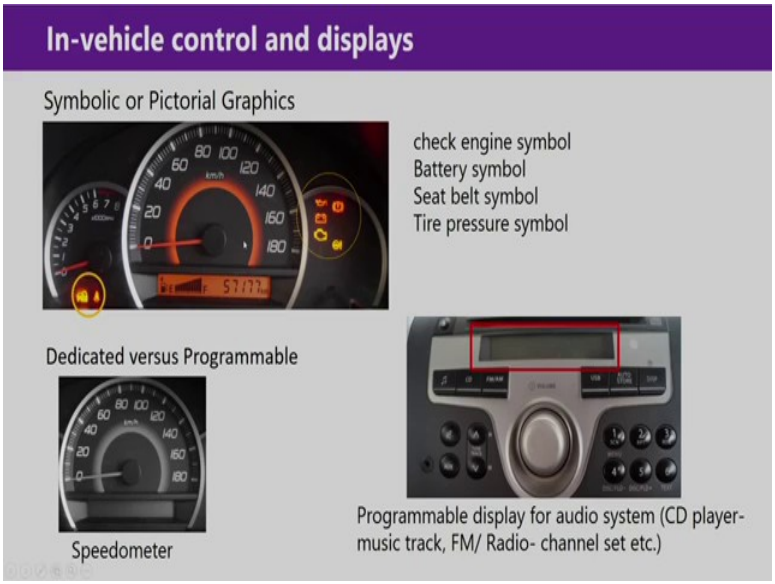
On the other hand, while the display is giving the information dynamically, it means, with the time, that displayed information is being changed. So here, while the speedometer pointer is changing its position from 0 to 40, 60, like this way. So, while there is a change in the displayed information, based on the speed of the vehicle, then this is, we consider as the dynamic display.

So, the speedometer is actually used for dynamic display, then we can categorize this type of displays in two categories; one is quantitative display, another is qualitative display. In case of qualitative display, the information is actually provided in qualitative format, means; there is no particular value, only it indicates the change, the direction. Now, whether say, for example, this one; fuel indicator. So, here ‘E’ for empty and ‘F’ for full.

So, whether the fuel inside the tank is towards the full or towards the empty, that is indicated, but exactly how much is the amount that is not denoted here.

So, this type of display is coming under qualitative display. On the other hand, while the speedometer is showing a particular speed, say 40 kilometer per hour based on the pointer location, then we consider that as the quantitative display. So, that is providing a particular value. So, inside the automobile, we find both; qualitative displays as well as quantitative display.

(Refer Slide Time: 29:26)

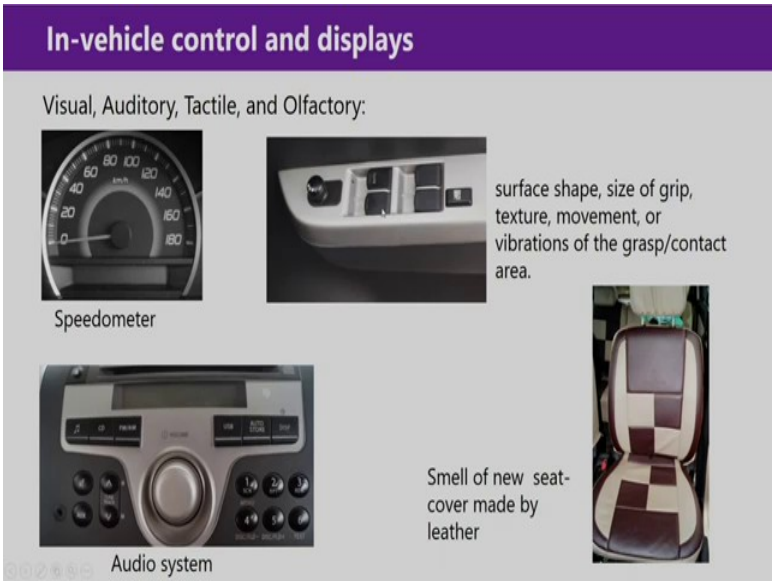


Now, symbolic or pictorial graphics. So, inside the vehicle, there are different displays which actually indicate or convey the information through different types of symbols or indicators. So, for example, here you can see the symbol for seatbelt, symbol for the battery, symbol for the engine, symbol for the oil or fuel. So, this type of, different type of information is actually being displayed by symbolic or pictorial graphics; then dedicated versus programmable, there are also displays which are for a particular purpose.

So, the speedometer is used only for showing the speed of the vehicle. And, it does not (Refer Time: 30:12) tell any other function, but on the other hand, if you look at this type of audio display, this is programmable display. Because audio system; it can act in many ways, based on the selected mode, if we select the CD player, then it will show music track, if is FM or Radio, then it will show the channel setting.

So, same display, but in different mode; if we select CD mode, or Radio mode, or FM mode, based on that it, will display different information. So, this type of display, we consider as the programmable display. And, it is actually the same display being used for multiple purposes, but in case of speedometer, this is a dedicated display; only one type of information it is showing.

(Refer Slide Time: 30:55)



Then there are visual displays based on the different types of our sensory modalities; vision, audition, touch, then olfaction.

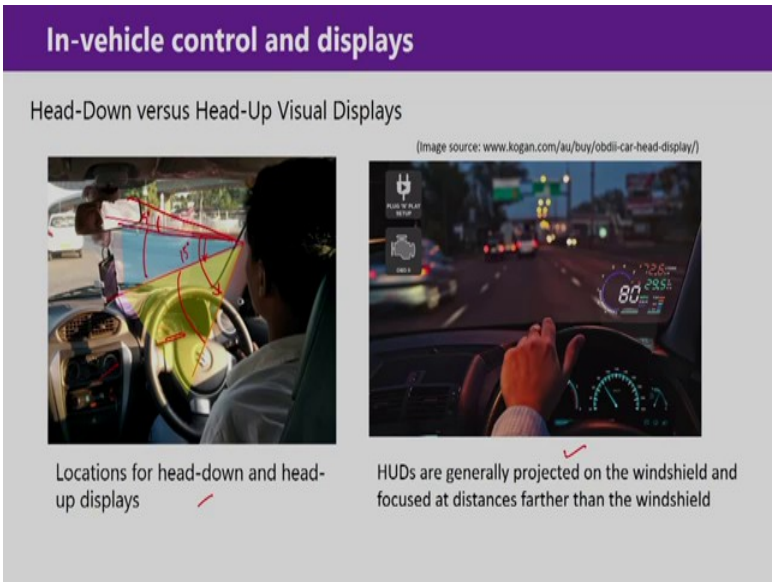
So, based on the different types of sensory modalities, again, we can categorize in-vehicle displays into different categories. So, speedometer, it is coming under visual display because it is showing the visual information. Then, audio system; from the audio system different types of music or different types of sound is coming. So, this is considered as the audio display; then there is surface, there is this type of controls for controlling the windows. So, these types of controls are available on the door panel.

So, these controls are actually coming under the tactile display, while we are touching that controls; through its shape, through its sizes, through its texture, it is actually giving information, that which type of or which control is there. So, we need not to look at that one. Only by touching or only by feeling, we can understand the control type.

So, the surface shape, size, grip, texture, or vibration of the grasp or contact area of this controls is actually giving us the information and that information is the tactile information. Then, if we consider the smell of the leather of the seat cover, that is actually olfactory display. So, the information is coming through the olfactory sense or olfaction.

Now, we are going to discuss about head-down versus head-up display.

(Refer Slide Time: 32:42)



So, first, we should know what is head-down display? And what is the head-up display? So, if you look at this image, then, while driver is looking straight forward; below that straight-forward line of sight, if you go up to 35-degree down. Generally, it is starting from 15-degree; this is for outside visibility.

So, from 15-degree downwards to up to 30-degree downward; this angle is actually used for head-down display. So, all the displays located on the dashboard, then the central instrument panel. So, these are coming under the head-down display, while drivers are looking toward these displays, then eye movement is required, and if the line of sight movement is more than 20 degree, then not only eye movement, there is also complimentary head movement.

So, using both eye movement as well as head moment, drivers actually visualize all these displays located on the dashboard or at this central instrument panel, viewing through steering-wheel.

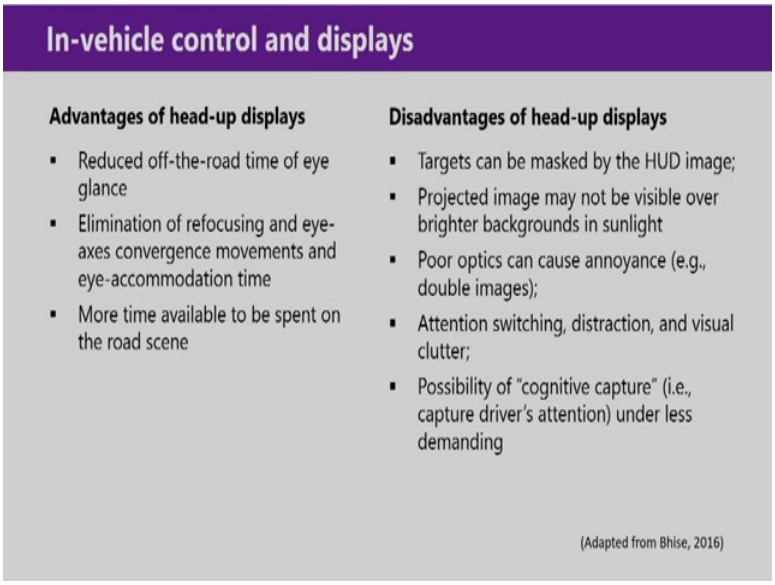
On the other hand, if we talk about the head-up display, head-up displays are generally positioned from the; this straight-ahead line of sight, 15-degree down or at the most 5 degrees upward. So, not only 15-degree down, but at the same time 5-degree upward, so, this zone is actually used for the head-up display. And, head-up displays are generally electronic displays. While drivers are looking at the head-up display, then, there is no requirement of eye movement or head movement, while they are looking at the road scene, they can just change their eye accommodation for focusing on the image projected on the head-up display.

Now, if you look at the second image, this right side. So, this is the example of a head-up display. In head-up display, as I already mentioned, these are the electronic displays, that image is actually projected on the windshield but at which distance? The distance is generally; towards forward of the vehicle, near the bonnet, at the bumper.

So, at this distance, these displays are projected. So, that the driver can easily look at that displayed information without moving their eyes from the primary driving scene, only they require, what they require, they need to change the eye accommodation. So, for that purpose, we know that there is a capability of our eye lens, which can change its focal length by the contraction of the ciliary muscles.

So, based on the variation of the focal length of the lens; drivers can easily accommodate the visual information and accordingly can perceive that visual information. So, there is no requirement of shifting the eyes from the road; at the same time, there is very minimal requirement of neck movement.

(Refer Slide Time: 35:58)



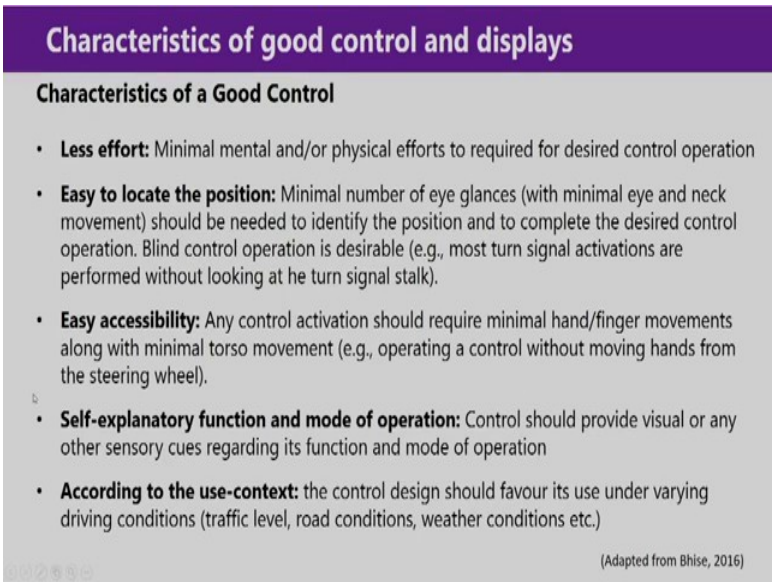
Now, if moving to the next slide. So, this is related to advantages and disadvantages of the head-up display. So, first, we are discussing about the advantages. So, there are various advantages of using head-up displays; it reduces the off-the-road time of the eye glance. Second; elimination of the re-focusing and eye axes convergence movements and eye accommodation time. Third; more time is available to be spent on the road scene. So, these are the various positive points for the head-up displays.

On the other hand, there are also some disadvantages. Fist one; the target can be masked by the head-up display image. Second one; projected image may not be visible over the brighter background in sunlight or day-light condition; bright day-light condition. Poor optics can cause the annoyance, there may be double images. So, while drivers are looking at the head-up display, due to the poor optics, he may find double images, which may create annoyance for him; then attention switching, distraction, and visual clutter.

So, in the same visual scene, where the driver is looking on the road, on the same visual area or view field, while these types of images are projected from the head-up display, then it may create visual clutter and it may also lead to visual distraction from the primary scene.

Then, there is a possibility of cognitive capture; that is, it captures driver's attention under less demanding condition.

(Refer Slide Time: 37:39)



Now, while we discussed about various types of controls and displays, we should also know, what are the characteristics of a good control or a good display? So, we are going to discuss about the characteristics of good control. So, any control, if we consider this is a good control, it must-have requirement of minimal mental and physical effort required to get the information or to operate that control, then easy to locate the position.

So, where the control is located, for that purpose, there should be minimal visual search; with the minimal visual search, we should be able to identify the location of the control. Next, easy accessibility; any control or if we mention, this is for good control, any control activation should require minimal hand and finger movements, along with the minimal torso movement.

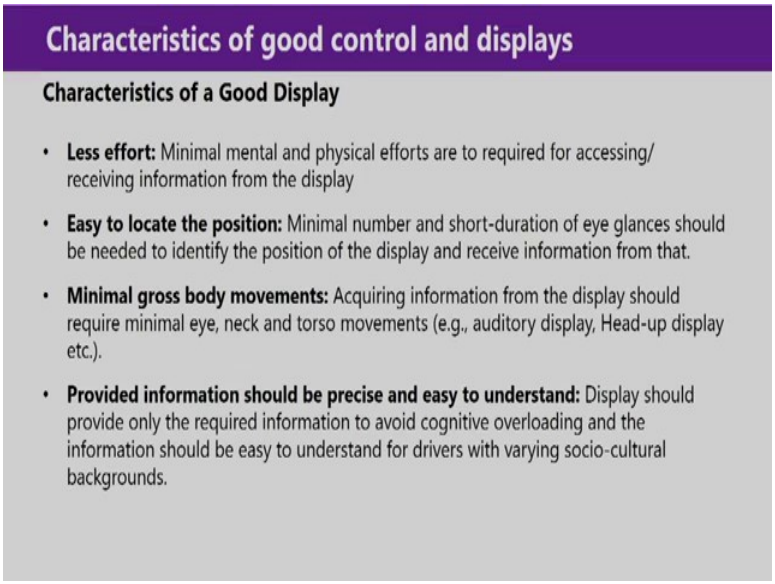
So, whenever the driver is going to access a particular control; his hand movement or finger movement, at the same time, gross body movement; should be as less as possible. Then, the control and its function should be self-explanatory, it means, control should provide visual or any other sensory cues regarding its intended function and mode of operation.

So, in this context, this is important to know about Gibson's 'Theory of Affordance.' So, according to Gibson's 'Theory of Affordance', the product or the object should give visual cues, that, what will be the possible way of action? The same is also applicable

here, while we are designing the control, for good control, it should be self-explanatory for its function and mode of operation.

According to the use context, the control design should favor its user under varying conditions. For example; traffic level, road conditions, weather conditions. If the weather condition; if the illumination level is low or it is raining; in all these scenarios, the control identification and control operation should be easy. So, those aspects we need to consider; to make a control good one.

(Refer Slide Time: 39:57)



The characteristics of good display, here also, the good display should involve less effort. Minimal mental and physical effort should be required for accessing or receiving the information from the display. Easy to locate the position, like the control. In this case; for display, identification, or identifying its position, there should be very minimal visual search.

So, a minimal number and short duration of eye glances should be needed to identify the position of the display and receive information from that. Then there should be minimal gross body movements for acquiring information from the displays, for example, there should be minimal eye movement, neck movement, and torso movement. So, in this case, if we use auditory display, head-up display, then there is obviously, the requirement of less eye movement or neck moment and at the same time; obviously, there is almost no requirement of gross body movement.

So, if it is auditory display, we can hear without changing our body position, if it is head-up display, then we can visualize the displayed information with minimal eye movement, neck movement, or gross body movement is not required. Then; provided information should be precise and easy to understand, the display should provide only the required information, to avoid cognitive overloading and the information should be easy to understand for the drivers with varying socio-cultural backgrounds.

So, whatever information is being displayed, that information should be easy to decode for the driver because the driver may be from different socio-cultural backgrounds. So, displayed information, its language, its way of presentation should be easy to decode by the drivers.