
Ergonomics of Touch Screens

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Touch Screens

Introduction

The ability of employees to do their jobs is influenced by workspace attributes, equipment and job content. While deviation from optimal design of work equipment and environments is tolerable, there is a limit to the amount of adaptation to unsuitable conditions an employee can reasonably be asked to make. Beyond this point there is a cost, which can be defined in terms of efficiency, discomfort, frustration and dissatisfaction, work stress, attrition, and increased potential for accidents and personal injury.

There are a number of upper body disorders that can be attributed to poor or constrained postures, repetitive movements or bad workstation or job design. These include tendonitis, tenosynovitis, carpal tunnel syndrome and eyestrain, musculoskeletal stress in the shoulders, neck and lower back. The goal of these recommendations is to ensure the optimal location of a touchscreen at a workstation where the primary work task is defined by touchscreen operation.

From current research findings, one of the most important points is that there is a definite need for adjustable workstations for workers who are screen-based on a more or less continuous basis. This is exacerbated in situations where several people occupy the same workstation. The increasing development and use of touch-activated screens elicits the need for guidelines concerning the location and placement of these at both, seated, and standing workstations.

While the general rule for display-only placement is to have the screen located in the "optimal viewing area", touch screen placement needs special attention, as these must also be located within the reach distance work envelope. The problem where touch screens are concerned is that the optimal viewing height of the display, is only half the issue. Consideration must be given to correct placement for frequent touch interaction. A touch screen placed at conventional eye level will be too high for frequent touch interaction, leading to shoulder and upper arm fatigue. If it is placed at the proper height for an input device, such as keyboard or mouse, then it will be too low for viewing, and may lead to stooped or forward leaning postures

Screen Location

Research has found that there appears to be no logical reason as to why a display should be viewed in positions other than those commonly preferred for paper documents. The emergence of new technologies, flat panel displays, touch screens and smaller VDTs (Visual Display Terminals), will make it possible to move the screen from current locations with ease, and position it in a new optimal location at the workstation. A general workstation design rule is to accommodate the 5th percentile female to the 95th percentile male.

Preferred gaze angles have been found to be steeply downwards. To view a touch screen the angle of view should allow the angle of gaze to be within the range 30 +/- 15 degrees downwards, with the screen not closer than 250mm. At a focal distance of 1m the preferred downward gaze angle is 35 degrees below the ear-eye line, while at a focal distance of 0.5m the angle increases to 44 degrees. Screens should be able to be situated low enough to accommodate this preferred position for different operators.

Height, adjustability and reach distance are very important. A suggested guideline is that the adjustable range of height should allow the touchscreen to be placed low enough that a 5th percentile user of the population can touch the top of the touchscreen without having to lift the upper arm away from the torso, and still allow it to be placed high enough that its lowest edge is no more than 45 degrees below the horizontal line of sight of a 95th percentile user.

Reach Distances

In order to maintain neutral body posture it is critical that the location of the touchscreen does not require a user to lift the upper arm away from the torso to operate it. Allowing for the 5th percentile British user this means not exceeding a reach distance of 405mm.

Standing Workstations

The location of a touchscreen at a workstation must enable the user to both view, and reach, the screen surface comfortably and without the adoption of extended postures. The user should be able to operate the screen with the upper arms in a neutral posture, beside the torso. Lifting the upper arm away from the torso to operate a too-high touchscreen can cause musculoskeletal discomfort and with prolonged use, injury. A touchscreen that is too low causes operators to lean forward placing pressure, and potentially injuring, the lumbar spine. See Figure 1. Recommendations for height ranges are shown in Table 1.

Figure 1: Using a too high, or too low, touchscreen can lead to pain and injury as muscles work to maintain an extended posture

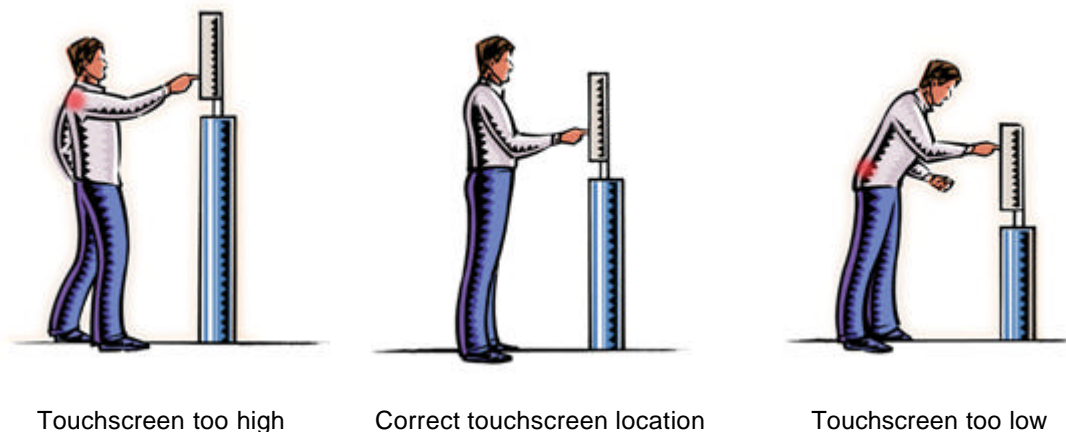


Table 1: Recommendations for height adjustable touch screen mounting.

Workstation Design	Adjustable Height Range (mm)
Standing	1050-1400 (above floor)

Seated Workstations

As with standing workstations, a neutral posture needs to be maintained at all times when frequently using any work equipment, including a touch screen. This requires a correct and comfortable seated posture; where there is a right angle bend in the legs at the knee, feet are flat on the floor, the upper arms are in a relaxed position beside the torso and the head is inclined slightly forward. Table 2 shows seated workstation touchscreen location recommendations, while Figure 2 shows a seated operator using a touch screen from a neutral posture.

Table 2: Recommendations for height adjustable touch screen mounting for a British Population.

Workstation Design	Adjustable Height Range (mm)
Seated	150-350 (above worksurface)
	Height of fixed VDT (Floor to centerline of monitor) should range from 760 to 1065 (above the floor)

Figure 2: A touchscreen mounted at a seated workstation in a position enabling easy and comfortable access from a neutral posture.



Viewing Angle

Though the need for a height adjustable screen surface can be critical, depending on the individual, job function, and number of people using the same workstation, the adjustment itself can create another challenge. When the screen surface is lowered, or raised, the terminal operator may then be viewing the display screen surface at an angle. Due to the nature of the screen surface, this can cause slight fuzziness or distortion of the characters. The viewing angle of a monitor is a key factor when placing the display at the workstation. Some LCD touch screens tend to blur or skew images when they are viewed from angles greater than 15 to 20 degrees above or from the sides. Distortions can be imperceptible, and as such, one may not be conscious of the reason for the experienced eyestrain. In these instances adjustment of the screen view angle is critical. Touchscreens should always be viewed from a position perpendicular to the screen, as this eliminates any distortion. It is important that the screen be located so that ambient lighting does not cause any reflection on the screen surface, as this will lead to visual difficulties. Table 3 lists the recommendations for optimal viewing of touchscreens.

Table 3: Recommendations for angle of view for touchscreens.

Recommendation
Any touch screen with a top of screen height less than 1220mm should be tilted upward at least 30 degrees
Any touch screen with a top of screen height less than 1040mm should be tilted upward at least 45 degrees.
Screen should be perpendicular to the line of sight of user.
Screen angle should be adjustable.

Adjustability

As with any modern workstation it is always preferable and highly recommended that as many elements as possible be adjustable to allow changes to suit the different physical characteristics and preferences of different operators.

The provision of adjustable workstations allows different operators to position the different elements in their optimal viewing positions and work envelope space. Ideally a touch screen should be adjustable in terms of tilt, height and reach distance from the operator. This will allow it to be used in the most comfortable position for each user.

Public Access

Where a touchscreen is located in a public access area to provide information or services, it is essential that it is located so that it is accessible by everyone, including disabled people. For most wheelchair users to comfortably, and easily, access a touchscreen, it should be between 800 and 1200mm above the floor, with a maximum reach distance of 450mm. As with a touchscreen in the workplace, public access touchscreens should always be viewed perpendicularly. To facilitate general access by able-bodied and disabled users, a height adjustable mounting will be beneficial.

Summary

The increased use of touch screens in workplaces and public access areas necessitates the correct location for optimal and comfortable use. Incorrect placement of touchscreens can exacerbate musculoskeletal problems and discomfort, particularly in the upper body, as users adopt stressed postures to operate them. Location of a touch screen needs to be considered in terms of ambient light, height and viewing angle. Where possible, adjustable mounting equipment is recommended, especially where a terminal is used for the primary work task and/or by more than one operator, ensuring that the workstation can be changed to suit different physical attributes, needs and preferences of users.