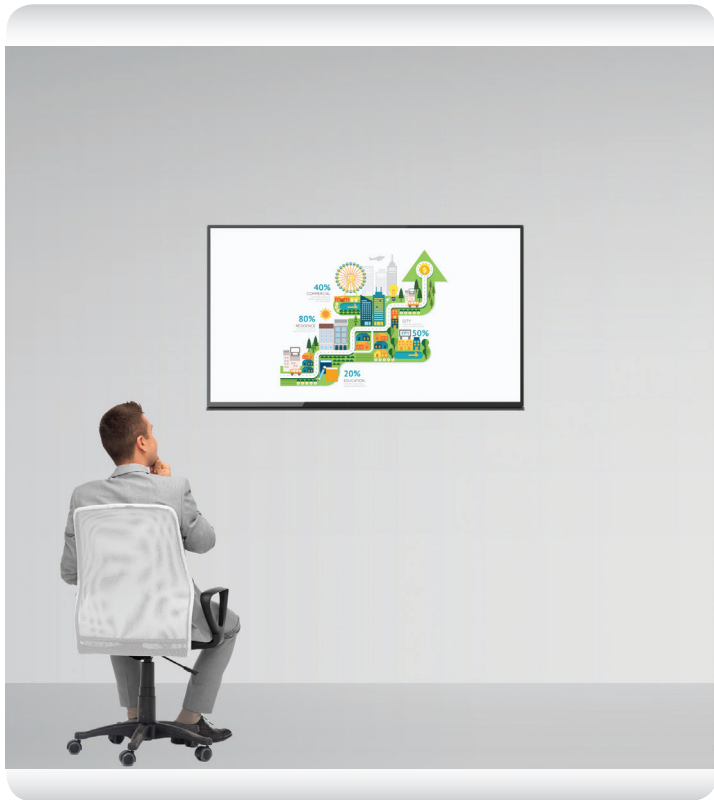


Display Size Matters

How to determine optimal display size for different meeting rooms



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Executive Summary

Digital display devices of every kind have radically changed the way we interact and work in individual and group settings. Those organizations that consider users' interactions with technology are more successful in improving productivity and increasing tech usefulness in meeting spaces. The single most common and important component in many meeting rooms today is a display technology.

This paper aims to:

Help you understand the factors that impact user experience of **visibility and readability** and ultimately engagement and productivity as it relates to **display size**, regardless of the display technology selected. It will also propose two different methods (**4/6/8 and DEV**) to help you select a display size that will ensure effective and efficient meetings for each given room type and size.

In order to establish some parameters, let's look at the physical environment of different meeting rooms and how displays support different methods of interaction.

Large conference rooms and auditoriums: Typically where information is shared by one person to many attendees (*Passive participation*). In these rooms viewing and readability of content shared (presentations, spreadsheets, web pages) is of primary importance for the viewers in processing information and achieving results.

Training Rooms: Much like large conference rooms, typically the information presented is by one person to an audience. Periods of uninterrupted focus and easy readability are required for participants to process the information and learn.

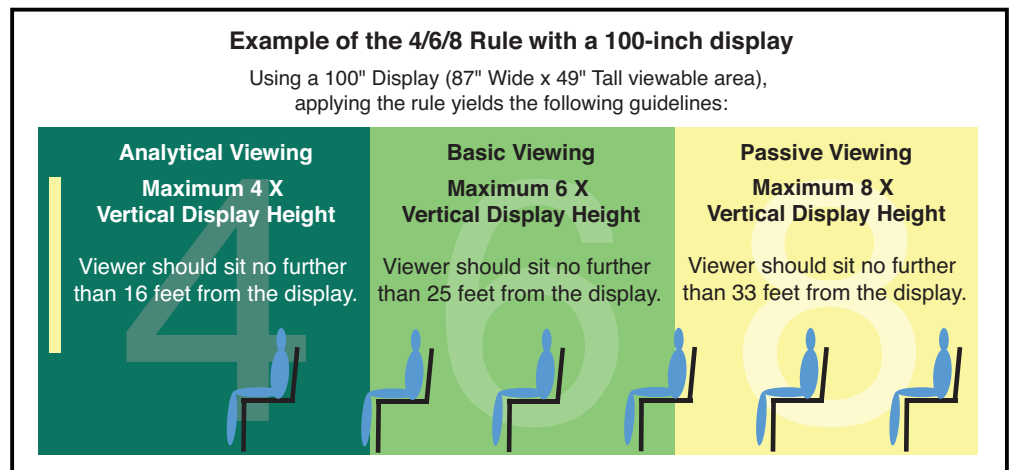
Huddle/Small/Medium meeting rooms: Typically smaller meeting rooms are more conducive to group interaction and creative exchange (*Active collaboration*) where both readability and personal engagement are important. Huddle spaces resemble this use case without the traditional meeting room construct.

As a general rule, the larger the meeting space the less likely for participants to be able to actively collaborate.

Introduction to the 2 Display Size Methods

■ 1st Method: The 4/6/8 Rule¹

In the AV industry, the 4/6/8 rule is a generally accepted guideline for determining display sizing for viewing distances. The rule provides a minimum display size recommendation for the absolute maximum distance (furthest seat in the room) participants will be from the room's display. It states that, depending on which of the three typical types of content being shown in the room, the meeting participant should sit no further away from the display than four, six or eight times



the display's vertical height. (Vertical height means the measure from the bottom to the top of the display). Deciding whether to use a 4x, 6x or 8x multiple of vertical height depends on the content density. The rule recommends three types of viewing and the associated maximum multiple of vertical display height:

Analytical Viewing – Maximum 4 Times Vertical Display Height

- It is possible to make critical decisions from the ability to analyze details within the displayed image. The viewer is analytical and fully engaged with the details of the content (e.g., small-font text and numbers, drawing intricacies, photographic inspection). Examples: Excel files, Charts & Web Content Browsing.

Basic Viewing – Maximum 6 Times Vertical Display Height

- The viewer can make basic decisions from the displayed image. The decisions are not dependent on critical details within the image, but there is assimilation and retention of the information

«
The 4/6/8 rule provides a minimum display size recommendation for the absolute maximum distance (furthest seat in the room) participants will be from the room's display.

»

so the viewer is actively engaged with the content (e.g., information displays, presentations containing detailed images). Fonts used are usually larger and intended for a group to view. Examples: Presentations, multimedia content.

Passive Viewing – Maximum 8 Times Vertical Display Height

- The viewer is able to recognize what the images are on a display and can separate the text or the main image from the background under typical lighting for the viewing environment. The content does not require assimilation and retention of detail, but the general intent is understood. (e.g., non-critical or informal viewing of video and data). Example: video conferencing, one-to-many presentations, or videos.

At distances greater than 8 times the display height, typical text, fonts and objects will not be readily visible to the viewer, resulting in a significant reduction in comprehension. Therefore, it is not recommended to have participants sitting farther away from the display than the “eight times the display height distance.”

«
The Desktop Equivalent Visibility (DEV) method uses a comparison to an employee's individual desktop experience based on ideal ergonomics.
»

■ 2nd Method: Desktop Equivalent Visibility (DEV)

Our personal work spaces have been ergonomically optimized to keep employees happy, comfortable, healthy and productive. In fact, there is significant ergonomics data available on personal workspaces and the effective user experiences of individual desktop displays. OSHA, the Occupational Safety and Health Administration which is part of the U.S. Federal Department of Labor, established and provides those visual guidelines to ensure visibility and avoid eye strain and physical fatigue. This, combined with the well-defined standards of ophthalmologists and organizations like ANSI, Apple, Kodak, the Cornell University Ergonomics Lab, and other industry sources, provides insight not only into desktop display set-up and use, but the role of human eyesight in creating an optimal viewing experience. This is the basis of the Desktop Equivalent Visibility, or DEV methodology – a second method of determining an optimal display size for a given meeting room.² DEV is to be used in sizing displays for huddle spaces, small and medium conference rooms.

The Desktop Equivalent Visibility (DEV) method uses a comparison to an employee's individual desktop experience based on ideal ergonomics. It transfers the optimal personal workspace experience to the group meeting space. According to Kodak's Ergonomic Design for People at Work, it is standard and optimal to have the monitor at arm's length. Between 20 and 30 inches is ideal. For this analysis, we use a viewing distance of 28 inches from a 21-inch diagonal

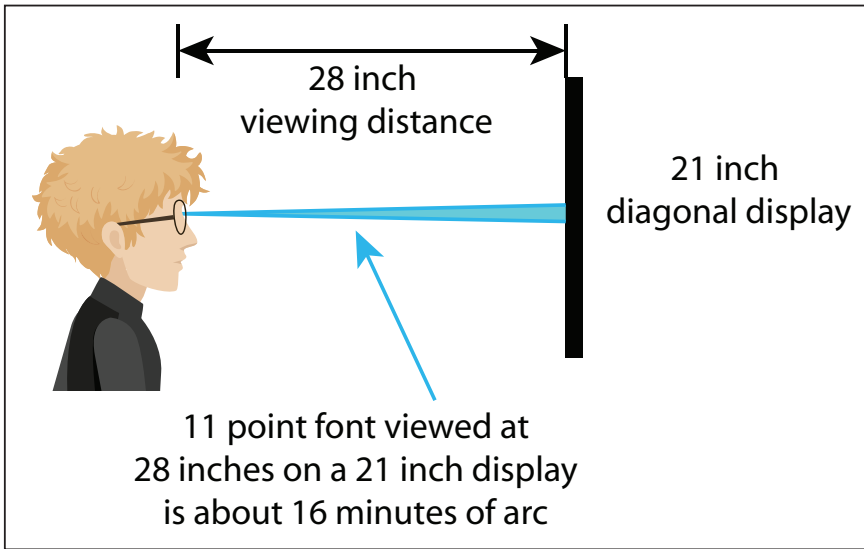


Figure 1

computer monitor display (which is a typical monitor size in today's corporate and business environment) as a conservation representation of the average desktop. (Figure 1.)

Until DEV, this collective knowledge had not been used to ensure effective transition from individual work stations to group areas. As a result, the one-to-many presentation displays being selected now are much smaller than the equivalent average desktop monitor. But just like your personal work station where the user is engaged with their

content, collaborative meetings depend on the same content and engagement, and therefore need to be larger to support the work.

The Desktop Equivalent Visibility method, or "DEV", is largely based on the Snellen vision chart (Figure 2), which sets 20/20 as the base for "normal" visual acuity by using characters to evaluate vision. The character for 20/20 vision is a specific size that the average person can discern when 20 feet away from the image. The 20/40 character is the size that same person could see at 40 feet. If someone can see the 20/40 character at 20 feet and not the 20/20 character, they are said to have 20/40 vision. The key is that the 20/40 character is exactly twice the height of the 20/20 character. In other words, to make an image or display appear the same size when it is twice as far away, it needs to be twice as tall or four times the size overall. The entire science of vision is based on this chart's simple mathematics: If you are twice as far from the character, the character needs to be twice as large for equivalent visibility.

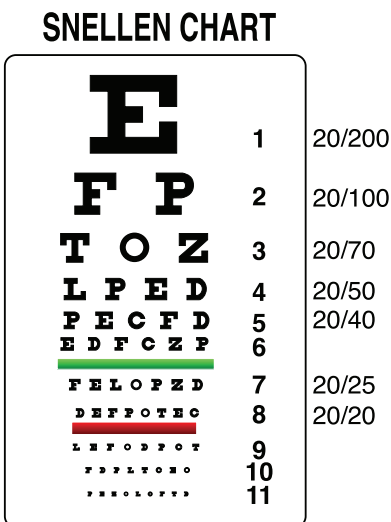


Figure 2

If the 4/6/8 rule were to be applied to this same average display size of 21 inches diagonal, the 4x of 4/6/8 recommends a maximum viewing of the "analytical" distance of 41.2 inches, almost 3 ½ feet away. The 4/6/8 rule used in an active collaboration scenario puts you too far away from the display with a display size too small. In fact, a recent analysis reinforces that displays placed in small and medium conference rooms are too small for effective viewing. More than 82% of the corporate market is using less than 70" displays, 64% are using displays less than 60", displays that are too small to be effective.³

If you are twice as far from the character, the character needs to be twice as large for equivalent visibility

Impact of Proper Display Size on Attendees' Participation

■ Distance and Readability: (Content Consumption)



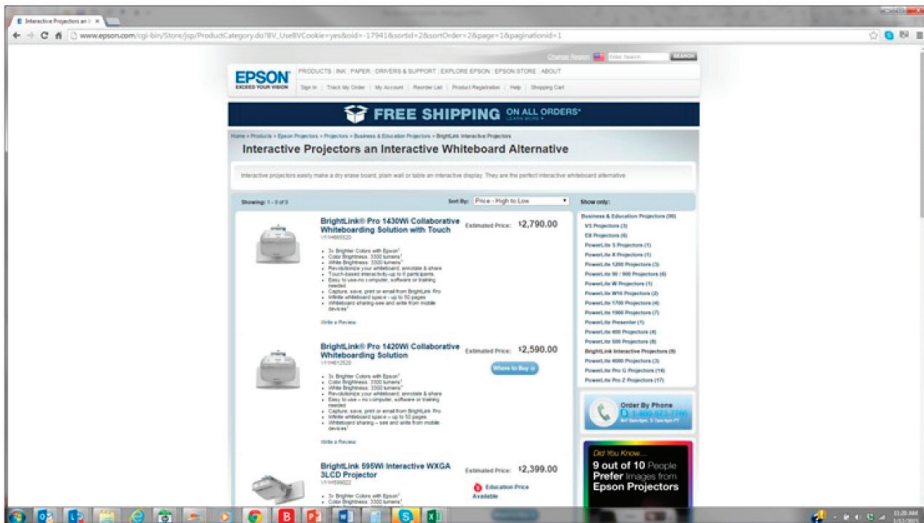
More than 82% of the corporate market is using less than 70", 64% are using displays less than 60", displays that are too small to be effective



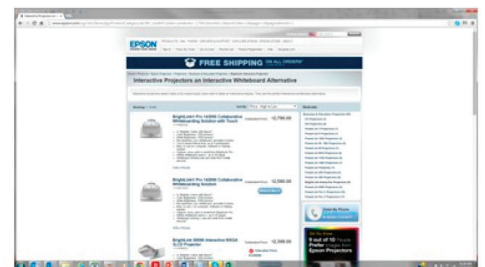
When the concept of DEV is illustrated and compared to 4/6/8, you can see the difference in display size recommendation that will yield. Consider the standard size of an individual desktop monitor (21-inches diagonal in the U.S.) and its proximity (distance) to an average user. Kodak's Ergonomic Design for People at Work places the optimal user/display distance at arm's length, which equates to a viewing distance between 20 and 30 inches [1]. Applying the 4x in 4/6/8 to the display dimensions for a 21-inch monitor generates a maximum analytical viewing distance of 41.2 inches -- almost three and a half feet away from the display. This distance is considerably longer than the Kodak guide's suggested maximum viewing distance of 30" away from a desktop monitor, and will result in a sub-optimal experience. Therefore, results will be sub-optimal when trying to achieve a similar, scaled, "equivalent" experience to a small-to medium room environment.

In addition to distance, another key factor is readability. (For reference, the first and second images in Figure 3 are exactly the same websites viewed at different distances.) You can replicate this in your office by measuring the distance to your

Web Page Viewed from a Specific Distance X (20/80)



Viewed from Distance Double X (20/40)



Viewed from Distance Four Times X (20/20)



Figure 3

monitor and moving back the same range to double your viewing distance. You could also compensate by increasing the text size on the display; however, this will compromise your ability to see all the content together which can affect context.

Determining Display Size Based on Room Size

■ Large Conference Rooms

When determining display size for larger conference rooms and auditoriums, the 4/6/8 rule is the most appropriate tool. Large conference rooms typically have viewing distances greater than 12 feet and an overall length longer than 16 feet. In a room of this size, probably 15 or more participants can be accommodated, and these meetings are more for presentation/review (passive participation). Figure 4 shows acceptable display sizes based on the four times (4x) display height in 4/6/8, which is the best standard to use for the larger rooms. This will enable the room to be used for all analytical viewing and critical decision making as anticipated by the 4/6/8 recommendations.

Display Sizes for Large Conference Rooms								
Based on the 4 times Screen Height of 4/6/8								
Viewing Distance (feet)	Typical Room Length	Minimum Display Size (Diagonal inches)	Acceptable Display Sizes					
			80 inch Display	100 inch Display	120 inch Display	150 inch Display	180 inch Display	200 inch Display
13	16 - 17	80						
14	17 - 18	86						
15	18 - 19	92						
16	19 - 20	98						
17	20 - 21	104						
18	21 - 22	110						
19	22 - 23	116						
20	23 - 24	122						
21	24 - 25	129						
22	25 - 26	135						
23	26 - 27	141						
24	27 - 28	147						
25	28 - 29	153						
26	29 - 30	159						
27	30 - 31	165						
28	31 - 32	171						
29	32 - 33	177						
30	33 - 34	184						
			Not Acceptable				Acceptable	

Figure 4 Analytical Viewing. (you can see that an 80" display will be adequate for only the smallest room)

■ Training rooms

The second type of room is a corporate training room, typically similar in use to a classroom. Training rooms are much larger than general meeting and conference rooms and visual displays are used to illustrate materials developed specifically for a large audience. Viewing distances are often greater than 18 feet and total room length can be up to 45 feet. In this case, the 4/6/8 rule should be used to determine optimal display size. The ideal viewing in this space is six times (6x) the display height in the 4/6/8 rule, which applies to “Basic Viewing/Decision Making.” Figure 5 shows the applicability of different display sizes in larger rooms at the six times height parameter.

Display Sizes for Training Rooms Based on the 6 times Screen Height of 4/6/8								
Viewing Distance (feet)	Typical Room Length	Minimum Display Size (Diagonal inches)	Acceptable Display Sizes					
			80 inch Display	100 inch Display	120 inch Display	150 inch Display	180 inch Display	200 inch Display
18	21 - 22	73						
19	22 - 23	78						
20	23 - 24	82						
21	24 - 25	86						
22	25 - 26	90						
23	26 - 27	94						
24	27 - 28	98						
25	28 - 29	102						
26	29 - 30	106						
27	30 - 31	110						
28	31 - 32	114						
29	32 - 33	118						
30	33 - 34	122						
31	34 - 35	126						
32	35 - 36	131						
33	36 - 37	135						
34	37 - 38	139						
35	38 - 39	143						
36	39 - 40	147						
37	40 - 41	151						
38	41 - 42	155						
39	42 - 43	159						
40	43 - 44	163						
41	44 - 45	167						
42	45 - 46	171						
43	46 - 47	175						
44	47 - 48	179						
45	48 - 49	184						
			Not Acceptable			Acceptable		

Figure 5 Basic Viewing



The key point is that the content being shared and used needs to migrate and scale from an individual's experience over to the group's active collaboration.



■ Huddle Spaces, Small and Medium Conference Rooms

Huddle spaces, small and medium conference rooms are environments where the DEV methodology is recommended. These spaces are usually less than 16 feet in length and are increasingly being used for focused or active collaboration (an extension of the desktop to a work group environment). While an advanced Unified Communications or video conferencing system may extend the use of these rooms to outside participants, the visual display is often used in the room for document-focused collaboration. The key point is that the content being shared and used needs to migrate and from an individual's experience over to the group's active collaboration.

To optimize collaboration start by measuring the viewing distance—from your eyes to the display—of your desktop. Though it is generally dependent on the monitor size, the distance will typically be about 18-30 inches. Use a tape measure to determine the height of your display. The resulting measurements can be used to calculate the viewing ratio of distance divided by height using the formula.

$$\text{Viewing Ratio} = \frac{\text{Viewing Distance}}{\text{Display Height}}$$

Based on the above analysis, the ideal conference room will have a display experience that is identical to using a 21-inch or larger diagonal desktop when viewed from 28 inches away or less. To make sure you are meeting the needs of your users, you can measure a number of desktop situations and document usage

Display Sizes for Huddle/Medium Conference Rooms								
Based on DEV for a 21 Inch Monitor viewed at 28 Inches								
Viewing Distance (feet)	Typical Room Length	Minimum Display Size (Diagonal inches)	Acceptable Display Sizes					
			55 inch Display	65 inch Display	70 inch Display	80 inch Display	100 inch Display	120 inch Display
6.0	9 - 10	54						
6.5	9.5 - 10.5	59						
7.0	10 - 11	63						
7.5	10.5 - 11.5	68						
8.0	11 - 12	72						
8.5	11.5 - 12.5	77						
9.0	12 - 13	81						
9.5	12.5 - 13.5	86						
10.0	13 - 14	90						
10.5	13.5 - 14.5	95						
11.0	14 - 15	99						
11.5	14.5 - 15.5	104						
12.0	15 - 16	108						
			Not Acceptable			Acceptable		

Figure 6 Passive Viewing

to see what is normal in your organization (Note: Use desktop monitors equal to or greater in size than 18" diagonal, at absolute minimum). Figure 6 shows various display sizes for collaboration spaces based on the DEV standard. It's based on the average 21-inch diagonal display when viewed at 28 inches, the longest of the average range of viewing distances that is acceptable desktop equivalency. This table enables the selection of the ideal display size in a given room to optimize the environment for collaboration.

Determining Display Size Based on Room Use

■ Video Conferencing (Remote Participation)

In a conference room, video conferencing is used for two main purposes: to see remote attendees and, through visual cues based on human conditioning, judge their responses and attentiveness. In either case, seeing the individual(s) in the correct scale and resolution is critical. The term video scale here refers to the exposed size of the image of the person being transmitted. While many of us are able to control our facial expressions, often our body language and position gives real clues as to our actual reactions and/or interest. A torso view (above the waist to the top of the head) is the best option for analyzing attendee responses for this reason.

The Society of Motion Picture and Television Engineers (SMPTE) recommends viewing video with 1.6 times the diagonal dimension (i.e. 55", 65" or 100" x 1.6 = viewing distance) from a HDTV display to see an image clearly, while THX recommends a distance 1.2 times that diagonal display dimension. Using these multipliers would recommend that if you were viewing a typical 21-inch desktop monitor, it would require sitting 24-30 inches away based on movie/video standards, and this aligns with the DEV method when replicating an experience in a meeting room that would be similar to an optimal desktop experience.

For effective video conferencing, the 6 times recommendation in 4/6/8 is significantly longer than either recommended by video and film organizations, and the DEV method. Therefore, the 4/6/8 rule is not recommended for effective video conferencing.

Conclusion

■ Summary of when to use DEV or 4/6/8

While room size is a critical factor, the use case also plays a leading role in determining the optimal display size and whether to use the traditional 4/6/8 or the advanced capabilities of DEV.

The 4/6/8 rule has served the industry well for rooms used primarily for larger group presentations and is an appropriate tool to determine display size for rooms used for presentations or one-way interactions (Passive Participation). The 4/6/8 rule should be used in rooms with viewing distances that are greater than 16 feet.

«
**Use the Desktop Equivalent
Visibility Rule (DEV) for huddle
spaces, small and medium
rooms.**
»

General rule of thumb:

Huddle Spaces/ Small / Medium Rooms	→ Up to 16 feet long, Active Collaboration	→ DEV
Large Rooms / Auditoriums	→ Longer than 16 feet, Passive Participation	→ 4/6/8 4x Multiplier
Training Rooms / Classrooms	→ Longer than 16 feet, Passive Active blend	→ 4/6/8 6x Multiplier

For smaller conference rooms and huddle spaces involving intense, active collaboration, DEV should be used instead of 4/6/8 to determine display size when considering active collaboration in spaces with viewing distances of up to 16 feet.

The utilization, and therefore success, of your room deployments are directly dependent on how well the implementation considers both the room size and

the anticipated room use. Choosing the right display size can have a major impact on both the functionality of the room, the adoption and use of the technology, and most importantly the degree to which the tools promote productivity. Use the Desktop Equivalent Visibility Rule (DEV) for huddle spaces, small and medium rooms. Use the 4x of the 4/6/8 rule for large conference rooms; and, use the 6x of the 4/6/8 rule for corporate training rooms.

About Epson

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1. http://docdev.infocomm.org/apps/group_public/document.php?document_id=6266
<http://www.infocomm.org/cps/rde/xchg/infocomm/hs.xsl/22138.htm>
2. Viewing Distance Recommendations from various sources

Agency	Recommendation	Equivalent Inches	Citation
ANSI/HFS	500mm recommended	19.7	1
	300 mm minimum	11.8	
Apple Ergonomics	Minimum recommended	18.0	2
	Maximum recommended	24.0	
US OSHA	Minimum recommended	20.0	3
Canadian OHS	400 mm minimum	15.7	4
	700 mm maximum	27.6	
Mil-Std 1472	400 mm for continuous viewing	15.7	5
	250mm minimum for intermittent viewing	9.8	
British HSE	350 mm minimum	13.8	6
	600 mm maximum	23.6	
Cornell Univ Ergonomics Lab	The monitor should be at a comfortable horizontal distance for viewing, which usually is around an arm's length (sit back in your chair and raise your arm and your fingers should touch the screen).		7
About Health	The best computer monitor distance is typically the distance from your shoulder to fingertips if you reach your hand toward your monitor without moving your shoulder out of line.		8

3. Unit Share of North America Business to Business Flat Panel market by size: Source: Futuresource WW Business (Flat Panel Actuals Q1 2016)

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