Deciding how large a videowall should be is more than a matter of determining how many display devices are required to fill a space on a wall.

Deciding how large a videowall should be is more than a matter of determining how many display devices are required to fill a space on a wall. The manner in which the videowall will be used, the types and quantity of information to be presented, and the size and shape of the room should be considered before selecting the quantity and type of display. A videowall in a public setting for digital signage will have far different physical requirements than a videowall in a command and control center.

Determining the Shape or Aspect Ratio

When specifying a videowall system, a design engineer has the flexibility to define a specific layout for the displays. Videowalls two screens high by four screens wide, three screens high by four screens wide, or four screens high by four screens wide are common. However, each of these arrangements results in a different overall aspect ratio, which is defined by the layout of the screens as well as the aspect ratio of the individual display devices, which could be 4:3,

5:4, 16:9, or 16:10. Videowalls may also have creative shapes with no defined aspect ratio.

What is the "best" shape or aspect ratio for a videowall? If the objective is to make the videowall as large as possible, then its shape will be driven by the layout of the room. A shallow, wide room with a low ceiling will likely necessitate a short, wide videowall. Other room characteristics may result in a videowall shape closer to a square. But room layout is not the only important factor when determining the height and width of a videowall. The size and aspect ratio of the source content and their intended arrangements on the videowall will also influence its shape and design.

A good first step is to determine the types and resolutions of input sources to the videowall, and how many of them must be displayed together. Discussing this with the end user, and deciding how source windows should be arranged on the videowall, will help determine the best overall screen arrangement.

It will also be beneficial to sketch three or four storyboards with various window layouts. Be sure to maintain each source's original aspect ratio when designing these layouts. While many videowall processors will allow images to be stretched, zoomed, or cropped to fill a window of any shape, the end user may find it distracting if content is not represented in their native aspect ratios. See Figure 2-10.

When creating sample window layouts, it is also important to consider which sources should be shown at native resolution, those which may be downscaled or reduced in size, and content that should be upscaled or enlarged. Having an idea of scaling requirements for the source content will help you determine relative sizes for the source windows on the videowall. The nature of the source content will be a determinant of how legible it may be when scaled. High resolution imagery may be reasonably legible when downscaled. Content can often be displayed in

Figure 2-10. Videowall images may be distorted if content is not presented in their native aspect ratios.

Original source aspect ratios maintained

Original source aspect ratios not maintained – results in image distortion

small windows as "thumbnails" to save space while being adequately discernible, and then upscaled or enlarged upon user control for closer examination.

While videowall processors allow images or graphics to be reduced in size, text or symbols may not remain legible if downscaled, or even when shown at native resolution. In this case, upscaling may be necessary, possibly leading to use of larger window sizes that may require enlarging the videowall. Properly sizing fonts for videowalls will be discussed later in detail.

Once you are confident that your sample window layouts meet end user expectations, you can be sure that you have a good idea of the overall shape for the videowall, determined by the layout of the room and the source content to be presented. You should also estimate the physical and pixel dimensions for the videowall. Additional considerations, including pixel density and individual display or projected image size, will help you finalize the actual dimensions and configuration of the videowall.

Pixel Density

A videowall should be capable of delivering the highest quality images possible to all viewers in the environment. In addition to brightness and contrast, pixel resolution is another contributing factor to image quality. Viewers tend to perceive images with good resolution as sharp, detailed, and above all, free of visible pixel structure. The ability to see pixels on-screen is dependent on the viewing distance from the display, the native resolution of the display, and the content being presented, among other factors. Pixel structure is more likely to be noticeable in content with text, shapes, lines, and fine graphic details, than in full-motion video.

The resolution of a videowall can be defined by the total number of horizontal and vertical pixels in the display array. It can also be described by the pixel density, or the number of pixels per unit

area. Pixel density is determined by the individual display unit, in terms of its native resolution as well as screen dimensions. Pixel density remains constant, regardless of the size or layout of the videowall.

The ideal pixel density for a videowall can be determined based on the distance for viewers closest to the screens, so they do not see visible pixel structure. A unit of angular measurement, known as an "arc minute," is used to describe how much of a viewer's vision is occupied by an object. An arc minute is equal to 1/60th of a degree, with 360° comprising a complete circle. The theoretical limit of human visual acuity, or the ability to discriminate an individual object or between objects in space, is approximately one arc minute or 0.0167°. For video, this means that below this limit, a person should not be able to resolve individual pixels. See Figure 2-11.

Viewers tend to perceive images with good resolution as sharp, detailed, and above all, free of visible pixel structure.

Figure 2-11. Pixel structure will not be noticed if the pixel pitch, or spacing between pixels, forms an angle less than one arc minute in a person's viewing field.
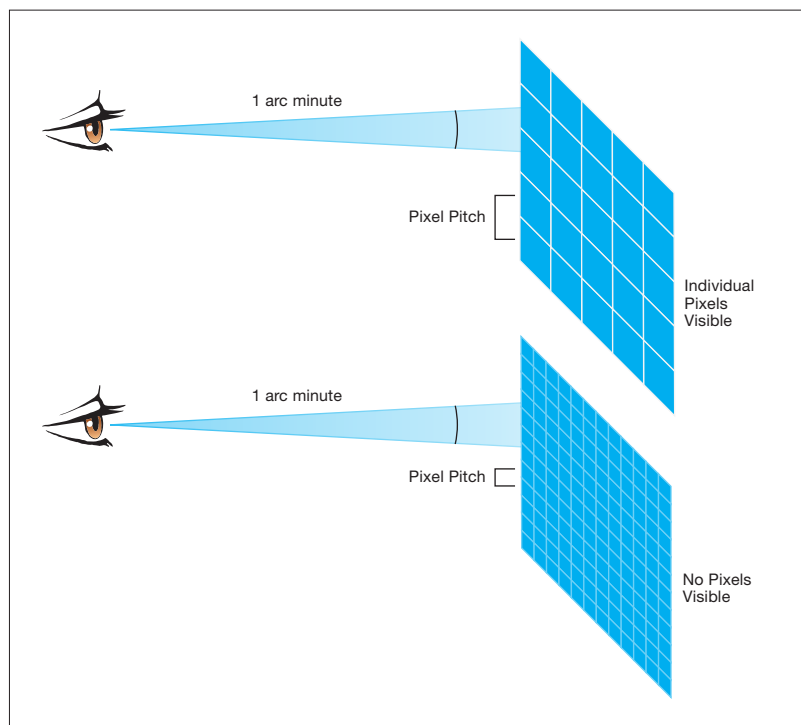
LCD panels generally deliver more than sufficient pixel density for close viewing distances, including the largest models. Pixel density will likely be an important consideration when projecting large images.

The sidebar provides detailed information on calculating pixel density. At a close viewing distance of 10 feet (3 m), the pixel density would need to be at least 28 PPI, or pixels per inch, to avoid visible pixel structure. As points of comparison, a 50 inch (107 cm) 1080p LCD panel has a pixel density of 44 PPI, while a 70 inch (178 cm) WXGA projection cube has a pixel density of 22 PPI. If the end user demands that multiple high resolution sources be displayed pixel-for-pixel, then it may be necessary to increase the pixel density beyond the minimum. LCD panels generally deliver more than sufficient pixel density for close viewing distances, including the largest models at 70 inches. Pixel density will likely be an important consideration when projecting large images. Table 2-4 lists some recommended minimum pixel densities at various viewing distances.

Summary

To help determine the best physical shape and size for a videowall, keep the following points in mind:

- The general shape and size of a videowall is frequently determined by the layout of the room and space available on the wall.

- Drafting window layouts will help you better define the shape and dimensions of the videowall. Be sure to account for:
  - The types of input sources
  - The aspect ratios and native resolutions of the sources
  - Legibility of content, particularly text, and the possible need to enlarge them
  - The maximum number of sources to be displayed simultaneously

- Ensure the display you select for the videowall has sufficiently high pixel density, so the closest viewer will not see pixel structure.

Together with these suggested guidelines, be sure that the final videowall design and configuration satisfies eye and head tilt considerations, as discussed previously on page 15. ∎

How to Calculate Pixel Density

Calculating Pixel Density Based on Viewing Distance

The minimum pixel density for a videowall, based on the viewing distance and the visual acuity limit of 1 arc minute, can easily be calculated. All that is needed is a tape measure and a scientific calculator, or a mobile device running a scientific calculator app. Ensure the calculator is set to degrees, rather than radians.

Begin by measuring, or estimating the distance from the videowall to the viewing position closest to the wall. Then, this basic trigonometric formula can be used to calculate pixel pitch, or the physical separation between two pixels.

Pixel Pitch = Viewing Distance x tan (1 arc minute / 60 arc minutes per degree)
= Viewing Distance x tan (0.0167°) = Viewing Distance x 0.000291

where the viewing distance and pixel pitch are specified in inches. Pixel density, in PPI or pixels per inch, is then simply the inverse of pixel pitch:

Pixel Density (PPI) = 1 / Pixel Pitch (in)

Example: For a viewing distance of 10 feet (3 m), or 120 inches,
Pixel Pitch = 120 in x tan (0.0167°) = 120 in x 0.000291 = 0.035 in (0.9 mm)
Pixel Density = 1 / 0.035 in = 28 PPI

Calculating Pixel Density for a Display

Pixel density can also easily be calculated for a display, using the equation for the Pythagorean theorem:

Diagonal Pixels = $\sqrt{\text{Horizontal Pixels}^2 + \text{Vertical Pixels}^2}$

Then, dividing the diagonal pixel resolution by the diagonal screen dimension gives you pixel density.

Pixel Density (PPI) = Diagonal Pixels / Diagonal Screen Dimension (in)

Example: For a 52 inch (132 cm) diagonal 1080p LCD panel,
Diagonal Pixels = $\sqrt{1920^2 + 1080^2}$ = $\sqrt{4,852,800}$ = 2203
Pixel Density = 2203 / 52 inches = 42 PPI

Table 2-4. Recommended display pixel density based on the closest viewing distance

VIEWING DISTANCE	MINIMUM PIXEL DENSITY
5 ft (1.5 m)	57 PPI - pixels per inch
10 ft (3 m)	28 PPI
15 ft (4.5 m)	19 PPI
20 ft (6 m)	14 PPI