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Understanding the Difference Between SD and HD

If you have dealt with audiovisual materials in your archive, you are no doubt familiar with the infinite variety of forms and flavors in which the moving image can exist within the physical and digital space. Although this subject can be daunting, two answers you will need to solve this crossword puzzle of audiovisual terms are High-Definition (HD) and Standard-Definition (SD) video.

By now most people are familiar with the term HD. They grasp the concept that it is newer than SD and higher quality. But what does that really mean? To understand both HD and SD it is imperative to see how these specifications contrast. There are three key differences between SD and HD: resolution, aspect ratio, and progressive versus interlaced scanning.

Resolution

The first concept to understand when comparing SD and HD is resolution. Resolution is defined as the maximum number of distinct pixels that can be displayed in an image. Since the resolution of an image is determined by the amount of pixels, it is important to have a clear understanding of what pixels are, as well. Pixels are the smallest point or dot that display color in an image. The word pixel is actually derived from the combination of two words: picture + element. And that is exactly what pixels are! They are the elements that make up pictures.

When you visit the local electronics store and the sales person talks to you about that shiny new television or camera sitting on the shelf, part of his or her pitch might be to cite specifications such as, 1920x1080 or just 1080. But what do these numbers actually mean?

The 1920x1080 specification directly references the number of individual pixels making up the maximum resolution the camera or television can replicate. In other words, the image the device produces is at best made up of 1920 pixels across and 1080 pixels tall, which equates to 2,073,600 individual dots per image. When displayed together the human eye processes these 2 million-some dots or pixels as a single unified picture. The more pixels the better the resolution, the better the resolution the more detail exists in the image, the more detail that exists in the image results in better overall image quality for our eyes to perceive.

Standard-Definition is 720x480 (again, 720 pixels across and 480 pixels tall) in North America. If you have ever viewed old recordings on VHS tapes or other SD video formats, you will notice the image looks softer or almost blurry when compared to the High-Definition images of today. One reason for this is lack of resolution resulting in less detail. By contrast HD has a resolution of either 1280x720 or 1920x1080, which equates to more pixels per square inch, allowing for much more detail than SD.

As if HD and SD were not enough, recently Ultra High Definition (UHD) has become standardized and will provide even greater resolution than HD. The minimum standard for UHD is 3840x2160 pixels, also

known as 4K, but UHD can have a resolution as high as 8K or 7680x4320. For 8K that is 33,177,600 pixels per frame! For a size comparison of SD, HD, and UHD. *See figure 3.1*

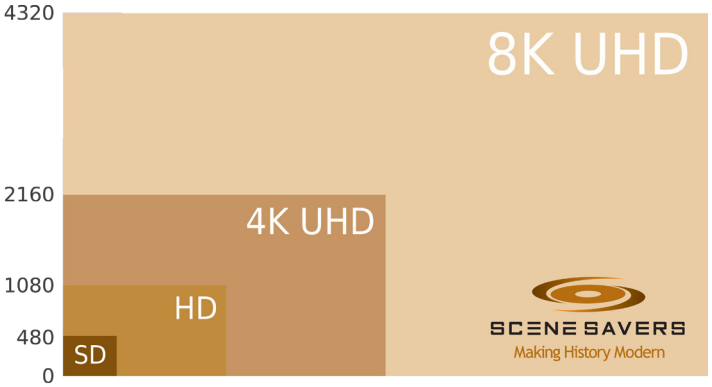

Figure 3.1

Aspect Ratio

The second concept important to understanding the fundamental differences between HD and SD is Aspect Ratio. Aspect Ratio is often expressed as two numbers, separated by a colon, which describe the proportional relationship of the image width and image height. The number before the colon denotes the width, and the number succeeding the colon references the height. To illustrate the point, 4:3, which is a common aspect ratio for SD video, basically states for every 4 inches wide, the image must be 3 inches tall. For other standards, such as 16:9 the same rules apply; for every 16 inches wide, the image must be 9 inches tall. In motion pictures the aspect ratio is usually expressed by dividing the width by the height, example 16:9 would be displayed 1.77. However a major standard for motion picture film aspect ratio is actually 1.85, which is slightly wider than 16:9.

If you have ever purchased or rented a DVD movie and selected the option for 'Full Screen', you will notice the movie plays back in a square-ish aspect. That's because the playback is contained in a 4:3 aspect ratio. On the contrary, if you selected 'Wide Screen' on the same DVD, the playback would be 16:9, and you would notice the aspect of the playback would appear rectangular in nature. *See figure 3.2*

Figure 3.2

So why does aspect ratio matter when it comes to HD versus SD? Well, HD by definition is 16:9 aspect ratio. SD, on the other hand, can be both 4:3 and 16:9 letterboxed (cropped with black bars). Therefore a fundamental difference exists in how SD and HD can be displayed. For a real world example look no further than the evolution of the physical television set. Twenty-Five years ago almost all screens or displays were square in nature, aka 4:3. Fast forward to modern day and everynew television comes equipped with a rectangular 16:9 screen catering to the high-definition content of today. *See figure 3.3*

Figure 3.3

Progressive & Interlaced

Have you ever left a frame of video paused and noticed little scan lines running horizontally through the image? If so, you have experienced interlacing. *See figure 3.4*

Still frame of interlaced video *Figure 3.4*

Interlaced video is a technique for doubling the perceived frame rate of a video display without consuming extra bandwidth. The technique uses two different fields to create a frame of video. Each field is made up of individual rows of pixels; one field contains all odd lines in the image, the other contains all even lines. When watching an interlaced video these lines are painted individually or scanned displaying all the odd fields, then even fields, odd fields, even fields, and so on. The scanning of each field happens so fast, that the human eye is tricked into thinking every frame of video is in fact 100% complete, when in actuality it is not. Amazing!

Progressive scanning contrasts the interlaced technique by displaying every line in a frame drawn in sequence, also known as "sequential scanning". This is advantageous because motion in progressive looks more fluid and smooth. Also, if you step through the video frame by frame or pause the video there are no little horizontal lines resembling the artifacting that interlaced video introduces. *See figure 3.5*

Still frame of progressive video *Figure 3.5*

Going back to our electronics store example, that new HDTV sitting on the shelf is probably labeled 1080p, 1080i, or 720p. As we already know, that number references the vertical resolution of the display, but can you guess what the "i" or "p" stands for? You got it… the "i" means interlaced and the "p" means progressive.

Although progressive scanning is the superior method to display video content, interlaced video has been and continues to be supported by television standards organizations, like the National Television Standards Committee (NTSC). Standard-definition television from its inception has been interlaced

(480i) in North America. High-Definition, on the other hand, can be either progressive or interlaced (1080p, 1080i, or 720p). Ultra-High-Definition is progressive (2160p or 4320p).

Conclusion

This quick overview should provide you with the rudimentary concepts that expose the differences between High-Definition and Standard-Definition video. Having a working knowledge of what makes HD and SD different can be useful. For archives, one must always first consider the original format, as well as the way the asset was originally created or recorded, before considering any type of format or digital migration. If an asset is natively SD, it makes sense to keep any derivative migrations SD too. Fortunately, when evaluating your audiovisual collection, a basic comprehension of SD and HD is one piece of the audiovisual puzzle you will now have in place.