3D light losses examined

by Harkness Screens' Andrew Robinson

One of the major benefits of digital projection is that it offers the ability to present high quality 3D images with a single projector. 3D, in turn, is behind the success of hit movies such as Avatar, Up, and Alice in Wonderland, all of which rely on 3D technology to create separate offset images for the viewer's right eye and left eye which are then combined in the brain to give the perception of depth.

Less well known is that for all commercially available 3D technologies there are significant differences in presentation brightness which affect the choice of cinema screen.

It should be noted that there are also single projector film-based 3D systems available, and that the key points made in this note will also apply to these systems. Some different considerations apply to two-projector 3D solutions.

3D Technologies

There are 3 principal technologies used for 3D systems in cinemas:

Polarised light systems.

These rely on light being polarised in different forms to create the right eye and left eye image. This can either be done by circular polarisation or linear polarisation. This technology is well established and has been used for a long time with film projection. It is used by Real D, which is the most popular system used with digital projection in cinemas. Master Image also use a variation of this technology.

Colour separation.

Dolby use a system based on different wavelength triplets of visible light to create separate right eye / left eye images. This, like the polarised light system, is a passive system.

Active 3D systems

These systems use special eyewear with electronic 'shutters' to separate the images to the eyes. The eyewear is battery operated and controlled by an infrared signal. Xpand use this technology.

Light losses

One feature of all 3D systems is that they absorb a very large amount of the light that is available from the projector in 2D mode. The light loss is a result of having to create separate images for each eye, which immediately loses 50%, and there are further losses from the filters at either end of the system – the booth and the glasses. Because of the huge light losses, high power lamps normally need to be used in the projectors; typically 6kw Xenon lamps, although for smaller screens 4kw may be sufficient. RealD's XL system recovers some of this lost light and has a higher overall efficiency making it very suitable for larger screens. Typical light efficiencies at the eye (through the eyewear) compared with 2D are:

3D TECHNOLOGY	LIGHT EFFICIENCY FACTOR
Real D Z-Screen	15%
Real D XL	27%
Dolby	12%
Master Image 3D	18%
Xpand	18%

Screen implications

These light losses compared with 2D are on the basis that all aspects of the system, other than the 3D filters and eyewear, are the same in 2D and 3D modes (projector lamp power, screen gain, and so on). In practice, polarised light systems require special silver screens to maintain the polarisation and these screens have an intrinsic 'gain' of 2.4. Gain is measured against a reference standard but the gain of a silver screen is approximately 2.4 times that of a matt white cinema screen.

Polarised light 3D systems (Real D and Master Image) therefore benefit from the 2.4 gain and this compensates to an extent for the light losses. The other 3D technologies (Dolby and Xpand) use white screens and if these are matt white (gain 1) they will be significantly less bright in 3D mode than a polarised light system, unless the screens are changed for a high gain screen. White screens with gains up to 2.2 are available for these 3D systems.

Of course, once the screen is changed to a high gain screen for 3D (be it silver or white), then in 2D mode the screen will be overly bright, depending on the light efficiency factor of the 3D system. It will be necessary to reduce the lamp power and this is best achieved in most cases by changing the lamp to a lower kw lamp, though it is also common practice to reduce the power current to the lamp via projector settings, thus reducing screen brightness.

3D TECHNOLOGY	BRIGHTNESS IN 3D MODE (FL)	BRIGHTNESS IN 2D MODE (FL)
Real D Z-Screen	5	33
Real D XL	5	19
Dolby	5	42
Master Image 3D	5	28
Xpand	5	28

The 'accepted' standard for 3D presentation is around 5 FL. If the brightness in 3D mode is higher than this, then the 2D mode brightness will be greater than that indicated above. As the standard for digital 2D presentation is 14FL, all the 3D technologies will be overbright without reducing lamp power, although the adjustment with Real D's XL is relatively small.

Of course, there are worthwhile operating savings from downsizing to a smaller lamp in 2D mode (lamp life and power costs).

Harkness Digital Screen Selector

Harkness Screens offers a web-based application to determine the screen product options for selected screen size, projector, and lamp combinations in both 2D and 3D modes. By answering a few quick questions about the screen size and equipment being used in a particular cinema, the Selector suggests Harkness screen options to optimise performance and cost.

The Digital Screen Selector features a user-friendly interface with no software download required and uses industry-accepted standards and vendor data to compare different operating scenarios and is intended to be a guide for cinema operators when consulting with projector, lamp and 3D technology providers.

It can be found at www.harkness-screens.com/login.php