



## **Overview of Digital 3D Technology**

Digital projection has made single projector 3D solutions much cheaper and of a much higher quality than traditional film projector systems. A single projector can be used. All 3D systems rely on creating separate images for the right eye and left eye. These are projected at very rapid rates, typically at 144 frames per second (called "triple flash" giving 72 images to each eye per second). Different technologies are used to create the separate right eye and left eye image streams.

### **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 or a combination. 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.
- 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.
- So called "active" 3D systems use special eyewear with shutters to control the provision of separate images to the eyes. The eyewear is battery operated and controlled by an IR signal. Xpand use this technology.

One feature of all 3D systems is that they absorb a very large amount of the light that is normally 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 in the system. Typically, light losses of most single projector 3D systems are as much as 85% or even more, compared to 2D mode.

### **Screen implications for 3D systems**

Polarised light systems require a screen that will maintain the polarisation of the light when it is reflected. So called silver screens are used for this purpose. In fact, these screens are coated with a special paint containing fine aluminium flakes. The usual white cinema screens are not suitable, as they diffuse the light and change the polarisation. The signal-to-noise (or extinction) ratio measures the amount of interference between the right eye and left eye images. Typically at least 120:1 extinction ratio on axis is required to maintain a good 3D image. The 3D image has a "ghost image" if the left eye image is partially received by the right eye.

The other 3D technologies use white screens but because of the huge light loss, screens with a high degree of "gain" are required for all screens except small sizes. Silver screens inherently have a high gain level (typically 2.4) so polarised light systems benefit from the intrinsic gain of the silver screen. The implication of this is that, in most theatres, it will be necessary to change the screen when installing any 3D system using a single projector. This will always have to be done with the polarised light system, but often it will need to be done with other systems to achieve adequate brightness levels.

Harkness Screens has recently introduced a 2.2 gain screen specifically for 3D systems that do not use polarised light but which will benefit from a higher gain level.

### Projector and server requirements

Digital projectors using DLP technology can be used for 3D using a single projector. This means Christie, Barco or NEC '2k' projectors. Some DLP projectors using the 1.2inch DMD cannot triple flash on the whole chip which reduces the light available in 3D mode. The 0.98 inch DMD used in smaller projectors does not have this limitation. Sony, who use a different digital technology, have introduced a special dual lens version of their '4k' projector to run 3D.

Because of the huge light losses, high power lamps will normally need to be used in the projectors; typically 6kw Xenon lamps, although for smaller screens 4kw may be sufficient.

A 3D enabled server is required. The Dolby 3D system requires a Dolby server to be installed. Dolby have introduced a licensing programme for other server makers, subject to meeting their technical requirements.

### Implications for 2D viewing

As theatres are not usually dedicated to run 3D movies all the time, 2D movies will be run in the same theatre and on the same screen. Regardless of the system being used, the main implication is that the screen has a higher brightness level than is needed for 2D. This means that the projector light output has to be reduced by changing the lamp or the current. Also, because of the high gain level, the viewing angle on the screen is narrower and, as a result, the seats in the more extreme regions at the front of the theatre may see some variation in brightness.

### Implications for theatre selection

It is recommended, when deciding in which theatre to install a 3D system, to choose auditoria that have a relatively long "throw" in relation to the screen width because this minimises the consequences of the viewing angle effect of high gain screens. Theatres that have relatively short focal length lenses for 2D will contain more poor seats than longer throw theatres. Seats that are outside a viewing cone of 25-30° off screen axis are likely to suffer a poorer viewing experience.

### Screen size and shape

Screens for 3D viewing should be curved. This improves the light distribution. The recommended curve is 1:20 (depth / width).

With a 6kw lamp in a digital projector and a screen gain of 1.8 or more, it is possible to operate 3D on screens up to 45ft with sufficient light levels. Whereas for normal 2D viewing 14ft lamberts is recognised as the norm for digital projection, for 3D it is expected only to achieve 4.5ft-lamberts and films are colour graded accordingly. Real D have an 'XL' version of their system, which can be used for screens over 60ft.

### Eyewear implications

All 3D systems require eyewear. The polarised light systems can use low cost eyewear. This potentially makes them disposable, although there are clearly "green" issues about disposing of large quantities of eyewear after every show. The Dolby system and the active eyewear systems require more expensive eyewear. These have to be collected, cleaned and recycled between shows, with the resultant implications for people and equipment. Active eyewear contains batteries, which at some point need to be replaced and which potentially may fail. The failure rate is, however, very small.

### Costs of 3D systems

Another factor in deciding which system is most appropriate is the financial terms that are offered by the technology provider. There are various outright ownership or revenue sharing models. Cost of eyewear also has to be taken into account.