

Screen selection for digital projection

Operating costs for digital projectors can be more expensive than 35mm projectors. Andrew Robinson of Harkness Screens explains how using screens with higher 'gain' can reduce ongoing operating and initial installation costs. Digital 3D also introduces additional screen considerations.



The number of digital projectors installed worldwide in cinemas at the end of 2008 is estimated at 7,500. Some 250 have been added since.

A significant number of these are being used to show digital 3D, but all will be showing movies in 2D. It is expected that, in spite of the current economic slowdown and associated funding difficulties, the installation of digital projectors will accelerate in the coming years. Today in the US there are over 5,000 digital cinema projectors installed, so there is a significant amount of operating experience being gained.

D CINEMA PROJECTORS DECEMBER 2008

	Sites	Projectors
World	2125	7336
Asia Pacific	456	1041
Europe	720	1262
North America	904	4987
Latin America	45	46

PROJECTORS AND LIGHT OUTPUTS

Digital projectors use special Xenon lamps, which have shorter arcs and higher envelope pressures than the corresponding lamps used in 35mm film projectors. The lamps give a more focused light beam, which is needed for digital projection, but have a shorter life than standard 35mm film projector lamps.

Digital projectors using the 2k Texas Instruments DLP cinema technology (from Barco, Christie and NEC) come in different model sizes to suit different size auditoria. Sony also have different models using their SXRD 4k technology.

Light outputs of these projectors are greatly affected by a number of factors and, in

2K PROJECTORS AND LAMP POWER OPTIONS

	Lamps (kw)	Max lumens
CHRISTIE		
CP 2000		
SB/XB	2-6	30000
ZX	3 (SD lamp)	17000
	3	14000
	2	9000
M	2	12000
BARCO		
DP 3000	3, 4.5, 6.5	30000
DP 2000	3, 4	18000
DP 1500	2, 3	14000
DP 1200	1.2, 2	11000
NEC		
NC 2500S	4.5 - 6	26000
NC 16000C	4	17000
NC 800C	1.25	6400
SONY		
SRX R220	4.2	18000
SRX R210	3	13000
	2	8000

practice, the light level on the screen may be significantly reduced from the maximum output theoretically available from the projector. As a result, the screen may not achieve the brightness levels recommended of 14 ft. lamberts (SMPTE 431).

Factors affecting the light output include:

- The screen aspect ratio in the cinema - is the largest picture size "scope" or "flat"?
- How the digital projector is set-up to project different formats; the type of lenses used, including the possible use of an anamorphic lens.
- The life point of the lamp: at 50% of warranty life, typically 25% of the original light output is lost, and at full warranty life typically 40% is lost.

2K DIGITAL PROJECTORS FILM FORMATS

The two most common movie formats are:

- Cinemascope 2.35:1
- Flat 1.85:1

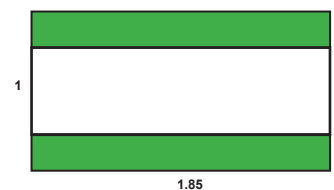
Screen size can be adjusted by

- keeping screen *height* constant
- largest picture is 'scope'



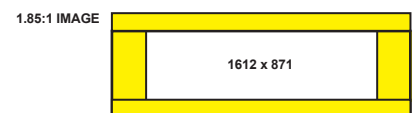
or

- keeping screen *width* constant
- largest picture is 'flat'



Native 'scope' screen:

- The full resolution of the DMD is 1080 x 2048
- Changing film formats with 'constant height' screens can be done electronically by reducing the area of DMD that is used.



- Up to 37% loss of available light - using motorised lenses reduces this loss significantly.

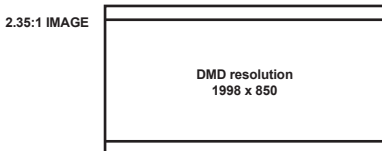
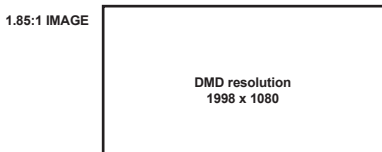
Alternatively using an anamorphic lens for 'scope' picture:



- this maximises the use of available light - 10% light loss from anamorphic lens
- requires activation of anamorphic lens
- these anamorphic lenses are expensive
- this is the only practical approach on large cinemascope screens

Native 'flat' screen.

- The full resolution of the DMD is 1080 x 2048
- Changing film formats on 'constant width' screens is easily achieved electronically



- With digital projection, light is reduced changing from 1.85 screen to 2.35 screen, but so is the screen size. Brightness levels are maintained. This is an advantage over 35mm when the opposite happens.

OPERATING COSTS OF DIGITAL PROJECTORS

The different models of projectors are offered with different lamp sizes. These lamps, as well as usually having shorter warranty lives than 35mm projection equivalent lamps, are more

OPERATING COSTS WITH DIFFERENT LAMP POWER AND POTENTIAL COST SAVINGS

Lamps kw	User price \$	Warranty life hours	Lamps p/annum	Lamp cost \$ p/annum	Power cost \$ p/annum	operating cost \$ p/a	\$ p/hour
2	800	2400	1.7	1333	800	2133	0.53
3	900	1400	2.9	2571	1200	3771	0.94
4	1250	1000	4.0	5000	1600	6600	1.65
4.5	1200	1000	4.0	4800	1800	6600	1.65
6	1800	600	6.7	12000	2400	14400	3.60

Based on 4000 hours annual operation

expensive. Also, with digital projection it is not recommended (and sometimes contractually not permitted) to run the lamps beyond the warranty life, whereas with 35mm film projection the lamps are typically in practice run 50% or more over their warranty life.

The table above shows how operating costs of running a digital projector vary with lamp size. This assumes an annual 4,000 running hours for the cinema and is believed to be representative of typical installations. It is interesting to see that reducing a bulb size roughly halves the annual running costs. Also reducing bulb size may enable a smaller model projector to be used, which in itself will be financially beneficial.

SCREEN SELECTION

This is where screen selection becomes important. It is possible to use higher gain screens to increase light levels to the audience, and thus potentially to be able to use smaller lamps. The tables below show the incident light required on axis to achieve 14 ft. lamberts with different screen gain levels.

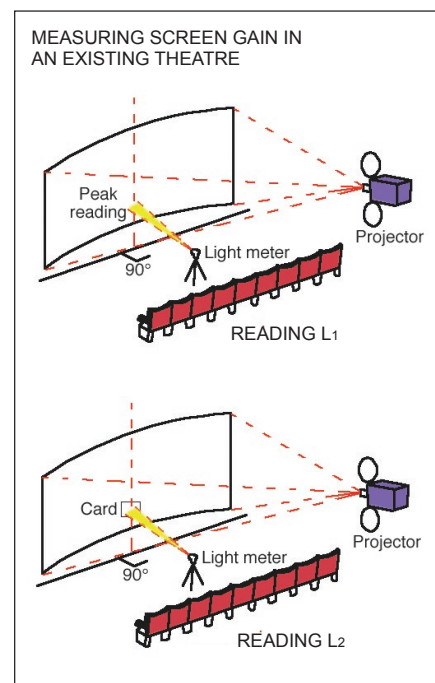
Incident light (lumens) on screen to achieve 14ft lamberts (after set up losses).

Screen gain	Screen width (ft) / <i>cinemascope</i> format				
	40	50	60	70	100
1.0	9500	14900	21500	29200	59600
1.4	6800	10600	15300	20900	42500
1.8	5300	8300	12000	16200	33100
2.2			9800	13300	27100

Screen gain	Screen width (ft) / <i>flat</i> format			
	40	50	60	70
1.0	12100	18900	27200	37100
1.4	8600	13500	19400	31600
1.8	6700	10500	15100	27600
2.2			12400	20100

The savings in operating costs from using a higher gain screen can recover the costs of the screen in 1 to 2 years. If a smaller projector can be used, the savings may be enough to pay for the whole screen cost, so all the operating costs savings going forward are a benefit.

Clearly it is necessary to be able to establish the gain level of the screen in an existing theatre.



This is relatively easy to do using a light meter and reference card of gain 1.

Screen gain = $L_1 \div L_2$

It is worthwhile also to measure absolute light levels in foot lamberts.

3D CONSIDERATIONS

If the projector is being used to show digital 3D content (using a single projector), other

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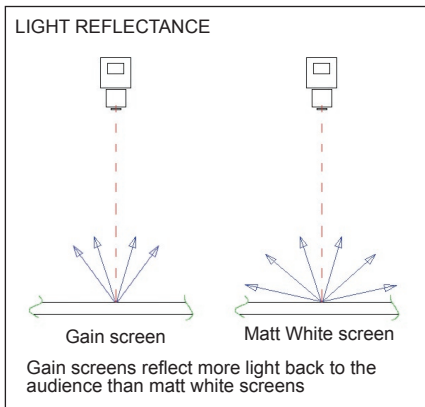
Provider	Technology	Light efficiency (1)	Screen type	Eyewear	Max screen size (2)
REAL D	Polarised light and Z screen	15% XL 27%	Silver 2.4 gain	Passive	45ft, >60ft with XL
DOLBY	Wave triplets and filter wheel	12%	White 1.8/2.2 gain, except for small screens	Passive	40ft with high gain screens; <30ft with matt white screens
XPAND	Synchronised projector and eyewear shutters	18%	White; gain on bigger screens	Active	50ft with high gain screens
MASTER IMAGE	Polarised light, rotating polarising wheel	15%	Silver 2.4 gain	Passive	40ft

(1) Light measured through eyewear compared with projection in 2D mode on same screen gain.
(2) To achieve a minimum of 3.5 ft. lamberts in 3D mode.

screen considerations come into play. For a start, all digital 3D technologies “lose” a lot of the light that is available in 2D mode, as a result of the filters and eyewear that are used (see table above). This means that powerful lamps have to be used, and usually high gain screens, to achieve an acceptably bright image. Also, depending on the 3D technology used, a specific type of screen may be required. 3D using polarised light (which is the most popular) requires a “silver” screen. This technology will not work with the usual “white” cinema screen. In this case, the screen will have to be changed. Silver screens can be used satisfactorily to play 2D content, but the lamp power will need to be reduced or the screen in 2D mode will be over bright. Other 3D technologies use white screens but they still need high gain, as the light losses are similar.

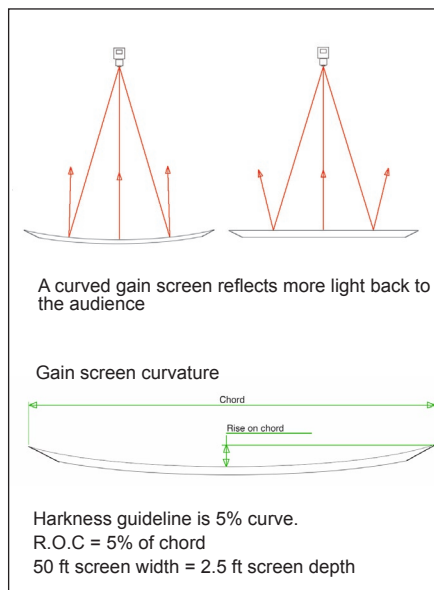
MORE ABOUT SCREEN GAIN AND THEATRE GEOMETRY

High gain screens achieve a greater brightness because more of the light falling on the screen is directed back to the audience. Gain is a measure of this increase in reflectivity. There are international standards for the measurement of gain. Harkness Screens follows the method of BS 5550. Matt white screens (with a gain typically of 1) scatter light in all directions, much of it wastefully towards the walls and ceilings.



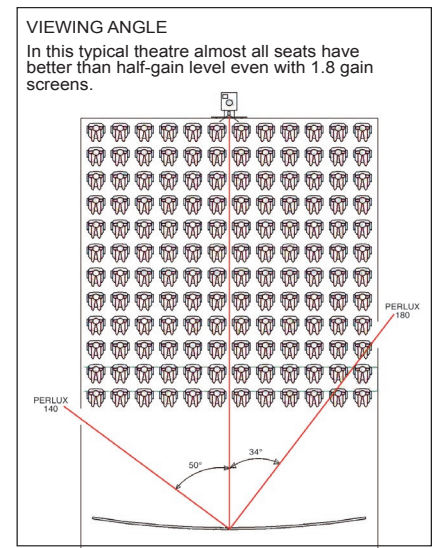
However, there is a consequence of the increased directionality that gain screens have. Viewed from the side seats of the cinema, the screen will appear less bright than from the centre seats of the cinema.

These effects are measurable, and can be minimised by curving the screen frame. It is recommended that curved frames should be used with gain screens.



Theatre shape is also a factor in the satisfactory use of gain screens. The desirable theatre shape is where the throw distance is at least 1.5 times the width of the screen (on the assumption that the screen occupies most of the theatre width). This brightness variation of gain screens occurs equally with film projectors. However, the intrinsic light distribution from a digital projector is more even than from a film projector, so the

adverse light distribution consequence of gain screens is reduced with digital projection. It is acceptable with DCI compliant projectors to use mid-gain screens (1.4 / 1.5) on flat frames, in replacement situations.



SUMMARY

As there are many digital projectors installed already, there will be some knowledge of actual operating costs. It may be possible to reduce lamp power, and consequent operating costs, by upgrading the screen for a higher gain. If the screen is already of some age, it may well have been damaged or be dirty, and so changing it will be beneficial anyway. For new installations, it will be important to consider together the projector model and lamp size with the screen selection, to optimise screen brightness and theatre operating costs. As stated above, converting to 3D introduces other factors as well.

Harkness Screens are the largest manufacturer of cinema screens in the world.

For more information or advice on this subject, please contact Andrew Robinson at Harkness Screens (UK) Ltd.

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