Projection Rules & Tips

computations and formulas

COMPUTATIONS & FORMULAS

Calculate Screen Dimension

The width of the projection screen
should amount to at least 1/6 of the length of the room.
Thus in a 18 meter deep room
the screen should have 3 meter width at least.

Special Format Ratio

For the computation of special formats ratio the following formulas help:

3:4 (1.33 Video)
height = diagonal x 0,6
width = diagonal x 0,8
diagonal = height x 1,67
diagonal = width x 1,25
height x 1.667 = diagonal

1.85 Letterbox
height = diagonal x 0,476
width = diagonal x 0,88
diagonal = height x 2,1
diagonal = width x 1,135
height x 1.85 = width

16:9 (1.78 HDTV)
height = diagonal x 0,491
width = diagonal x 0,872
diagonal = height x 2,039
diagonal = width x 1,146
height x 1,78 = width

1.25 SXGA
height = diagonal x 0,625
width = diagonal x 0,78125
diagonal = height x 1,60
diagonal = width x 1,28
height x 1.25 = width

Room Layout

The foremost seat row should be distant from the screen
1.5 x of the screen widths.
The lower edge of the screen should
have at least 1 meter distance to the floor,
so that also spectators of the rear rows
see good on the screen.

Projection Distance

Helps with the computation of projection distance,
objective focal length or screen size:

External link:

http://www.av-views.de/bildrechner/bildrechner.php

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GAIN & HALF VIEW ANGLE

GAIN

No screen can transmit and/or reflect more light, than the projector delivers, it is accordingly differently distributed only, after the different needs of applications. The term viewing angle does not represent measurable size. It describes only subjectively, in which range a project picture is still more or less visible. Only the criteria Gain + half viewing angles result in together exact explanation about the maximum picture brightness in the optical 0°-axle and the lateral radiation behavior. These two factors stand in dependence to each other. The more highly the Gain, the smaller is the light distribution to the sides. This is an optical law. So we can determine that a high Gain does not represent inevitably an perfect screen, only the connection Gain + to half-viewing angle give information on the quality of a screen.

Half View Angle

Under the different criteria which mark screens falls also the criterion of the so-called half view angle. This only obligatory value results from the Gain and the reflected beam angle. If screen has a Gain of 3 e.g., the half viewing angle results in the case of Gain 1.5. Here the angle is reached where those screen only the half in relation to brightness the optical 0° -axis radiates.
Screens with diffusion characteristic, the half-viewing angle is identical in the horizontal, as well as in the vertical axle. This clarifies a screen with a Gain of 1,0 best.
However extremely different values can occur between horizontal and vertical axis with direct characteristic screens. Direct screens with lenticular structures collect the light in the horizontal axis, and take it from the vertical light distribution.

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Projection Rules & Tips

GAIN and half view angle

Screen Gain - Whoes Loss?

When we come to contemplate a projection device in conjunction with a projection screen, there is considerable irony in the fact that the term "gain" is routinely applied to the screen and hardly ever to the projector. Yet it is the projector, not the surface, which is powered by electricity and it is the projector, not the surface, which comes with a twistable dial marked "Brightness."

Nevertheless screen gain does exist. Although still a misleading misnomer, gain is not purely some shibboleth of the A/V industry. A screen with a gain of 3 is certainly and observably different from a screen with a gain of 1.5. How it is different merits analysis.

Screen gain is measured by pointing the light meter at the center of the screen from a position that is essentially perpendicular and on-axis to that center. Let's be iconoclastic for a moment and examine the assumptions underlying this procedure.

Does it mean that there's anything unique about the particular square foot of fabric which happens to comprise screen center? Of course not. No strip, area, or square foot of screen material is manufactured to be different from any other. Optically they are all fungible; as well they should be.

If indeed there's nothing special about the screen's center, what about the other variable, the viewing angle? Is 0 somehow preferential to all other angles of view? To start with it is quite rare these days to see a projector vertically positioned exactly opposite to screen center. Much, much more frequently the projector is mounted parallel to the top or to the bottom of the screen. And when it is somewhere else, it's still not at 0 but is instead something like 25% down (or up) from the screen's top (or bottom.).

Since it is so unlikely for light reaching the center of the screen to be itself "on-axis", it's a little hard to see what could be the advantage of measuring light from an on-axis position.

The final observation we want to make about Gain is that the number we deduce from our measurements is not a number intrinsic to the screen itself but one which is relative to a fixed, non-screen reference standard - generally a block of magnesium carbonate.

To all intents and purposes a flat expanse of MgC03 will absorb none and re-radiate all of the light incident to its surface. Furthermore, that re-radiated light will be distributed with perfect uniformity throughout all possible viewing angles. This point is subtle and deserves emphasis. Another way of expressing it is to say that light rays incident to such a surface will be re-radiated in such a way that all traces of their incident angles will be lost.

Thus the number displayed by a photometer aimed at an illuminated block of MgC03 will not vary as the instrument is moved through any number of random "viewing" angles. And, to make the experiment really interesting, our number will also remain invariant if we move our light source through an equally large and equally arbitrary range of projection angles.

There is, then, no combination of positions for the projection and measuring device which will yield a greater or lesser amount of "brightness" from this, the common reference standard against which we calculate screen gain.

What is confusing about all this is that the reference standard is itself said to have gain when in fact that's the very thing it most importantly doesn't have. A projection screen has gain when in one way or another it can be measured as being brighter than the reference standard. This is really what screen gain signifies, an increase by some amount over not the low gain, but the no gain MgC03.

There is of course one (but only one) screen surface which also has no gain and which also behaves identically to the reference standard. This is the ubiquitous and extraordinarily useful Matte White. Array an audience before a matte white surface and you can be sure that all of its members, regardless of the projection angle or of their viewing angles, will be assured of a picture that is consistently and equally uniform throughout.

If we could trace a bundle of projected light rays striking a piece of Matte White screen, what we would see is that the rays will bounce off the surface in a pattern that forms a perfect hemisphere. The equator of this hemisphere is flush with the plane of the screen and no matter where on its circumference we choose to look through, we'll always see that it's filled with the same amount of light.

Now let's ask what happens if we vary the intensity of the incoming bundle of light rays. We could do this by fiddling with the brightness knob on our projector or by switching out the projector itself for one with greater or lesser lumen output. Would anything change about our hemisphere?

Yes, one (but only one) thing will change. The radius of the hemisphere will get bigger as we increase the amount of light filling it. So there is a directly proportional relationship between the volume of light (commonly referred to as total luminous flux) available from the projector and the volume of the resultant hemisphere. Varying the amount of flux, however, has no effect whatsoever on the shape of the hemisphere. That, if we are using a matte white screen, remains constant always.

And if the screen is not Matte White, if it has been manufactured to have a gain of 2, for example, what happens to the luminous flux reaching its surface?

As reflective materials are added to the matte white, to increase screen gain, the base of the hemisphere contracts and, as the distance to its "north pole" expands, it starts to adopt the shape of an extending tear drop whose outer surface is still curved but whose diameter grows smaller and smaller as the screen is given higher and higher gain.

Furthermore, the axis of the tear drop (the line from its base which extends through its "north pole") points in a direction that is increasingly dependent on the incident angle of the light rays filling it and will therefore be less and less perpendicular to the surface of the screen. Despite these transformations, however, the volume of the ever lengthening tear drop will always be the same as that of the original hemisphere.

Interestingly, the shape of the lobe of light leaving a rear projection screen is not hemispheric - even when the screen has a gain of 1. And while the volume of the screen's transmitted light remains directly proportional to the amount of luminous flux from the projector, the two are never equal. This is so because all rear projection screens fail to transmit all of the light incident to their back surfaces. Quite a significant percentage of the flux in fact will be reflected by those back surfaces and some additional (but smaller) percentage will be absorbed by whatever medium is comprising the rear projection screens' substrates (typically acrylic or glass).

The gain of a rear projection screen is increased by arranging for the diffusion layer (the scattering medium) to be less and less dense. This results in more and more of the projected light rays being permitted to pass through the screen with their incident angles undisturbed.

The essential behavior, then, of both rear and front projection screens is not created by any direct manipulation of their displayed "brightness." Screens cannot create energy. That's what projectors are for. Screens can (and do!) control the angular distribution of that energy and by that process and that process alone they create what is called their gain.

This mechanism is especially useful to keep in mind when we come to match a screen surface with a specific projector type. Unfortunately not all types of projectors produce luminance (flux) that is uniform across the beam. CRTs, for instance, are notorious for emitting only about 30% of their on-axis luminance at their corners. Alternatively, some new projectors can now deliver imagery whose corners are fully 90% as bright as their centers.

To match a CRT projector with a high gain screen is therefore precarious. If from any given viewing angle we are comfortably to discern all four corners of an image, we'll need to scatter the light reaching them as widely as necessary. If the volume of the flux illuminating those corners is low and the angular distribution from the screen narrow, we inescapably will perceive them to be dim. Sometimes we reverse that observation and say that the center is too bright and that we are looking at a "hotspot," but that is not, strictly speaking, a correct conclusion.

Projectors with greater center-to-edge uniformity of course fare less badly with higher gain screens. But even they will do better still with low gain surfaces.

Does this mean that we should never utilize a high gain screen? Of course not. But we must be careful and even cautious in its selection. Otherwise we may not gain nearly as much as we hoped.