<u>Calculating Projected Image Size</u>

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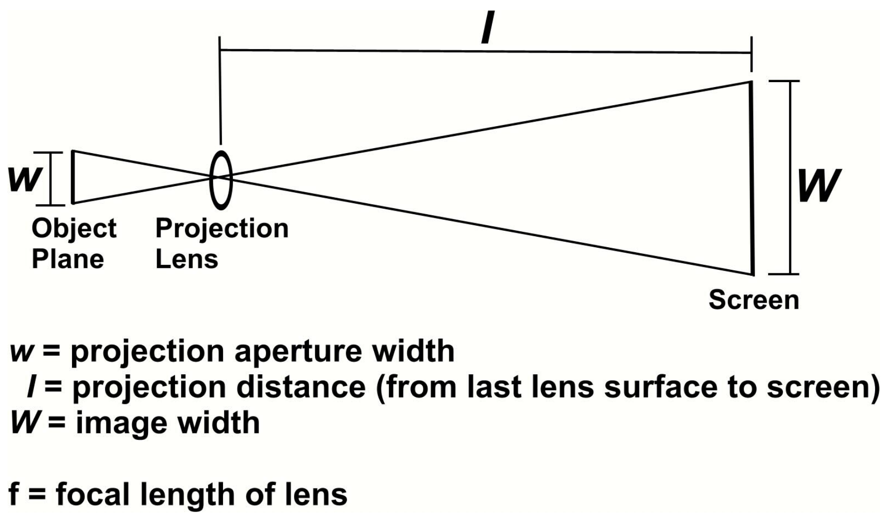
Introduction

Some calculations are required when designing a space that incorporates 35mm slides, film, or overhead projection. Often you are confronted with a situation where you have a given projection distance, you want an image of a particular size, and you need to know what lens to use to achieve this. On the other hand, you may have a given lens and a fixed screen size, and you need to know where to place the projector.

The Formulas

Since projection lenses are compound lenses, very accurate calculations are not practical – you would need detailed optical specifications for the lens. Fortunately, you can calculate with sufficient accuracy for most applications by treating the projection lens as a simple lens. A joint international standard (by ANSI, ISO, and NAPM) has been established for calculating image size and projection distance **independent of the measurement units** (i.e.: works in metric or imperial measure). These are outlined in detail in **ANSI/ISO 11314-1995** and **ANSI/NAPM IT7.206-1996**, and are summarised here. Consider this diagram:



The international standard formulas are as follows:

$$\mathbf{f} = \frac{l}{W/w + 1} \qquad l = \left(\frac{W}{w} + 1\right)\mathbf{f} \qquad W = \left(\frac{l - \mathbf{f}}{\mathbf{f}}\right)w$$

<u>**NOTES**</u>:

If a calculated focal length is non-standard, select the nearest standard focal length and re-calculate projection distance and image size.

These formulas will work in either feet/inches or metric. Just remember that aperture and focal length are in inches or mm, and that projection distance and image width are in feet or metres.
Image height may be used in place of width, providing you substitute the aperture height for the aperture width.

The actual focal length of a lens generally differs from the nominal focal length marked on the lens. Lenses may vary ±5% from this nominal value. In multi-projector set-ups (e.g.: multi-image with several 35mm slide projectors), it is important to specify matched lenses.

To compensate for the use of compound lenses in the "*real world,*" the PD (***I***) should be measured from the centre of the front glass of the lens to the screen. This will result in an error that is short by a few inches. It is wise to allow room in your design to move the projector forward or backward from your calculated distance to overcome both this error and variances in focal lengths (i.e.: an actual lens will not have *precisely* its marked focal length).

For accurate projection distances, use the lens manufacturer's charts and measure projection distance from the film plane to the screen.

Aperture Sizes

Aperture sizes vary considerably from projection format to format. Even within a format, there may be several different apertures in use. For example, 35mm slides can vary depending on the mount used (e.g.: Wess OR1 or OR2). It is critical that you know the exact aperture opening – even a discrepancy of a few millimetres can result in a large error at the screen.

Video Projectors

Video projectors are not as easily approximated. **Consult the manufacturer's lens charts, use the manufacturer's lens calculation software, or use formulas supplied by the video projector manufacturer** – note that these typically only apply to the particular model of projector you are using.

For a zoom lens, ensure that your particular projection geometry falls within the lens range rather than at either limit – this will give you a degree of flexibility to make on-site adjustments. Many projectors have lens options available either from the manufacturer or a third-party such as **Buhl** or **ISCO**.

Note that if you use the lens ratio (e.g.: 7:1, 1.5:1, etc.), you will only get an *approximate* result.

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