PLANAR®

When image experience matters.

Rear Projection Cubes

EXPLORING QUALITY REAR PROJECTION SCREEN DESIGN AND SCREEN ASSEMBLY

This article briefly explores Planar's rear projection screen design and screen assembly from the perspective of the very experienced engineering and manufacturing personnel at Planar who design these high quality screens.

All rear projection display screens are the same, right? Without an image projected on the screen that is correct, they appear very dark and...well…the same. But in reality, not all screens are designed the same and when images are projected on different manufactures' screens, chances are they won't all look the same. Screens are more than just a simple piece of plastic shrouded in a frame; a great deal of engineering is injected into the design of a rear projection screen. Rear projection screens obviously come in different lengths and widths depending on screen size but did you know they come in different thicknesses? Did you know more than one layer, or section of material, is required to project an image and one of those layers is named after a French physicist from the 1800's? Keep reading and find out.

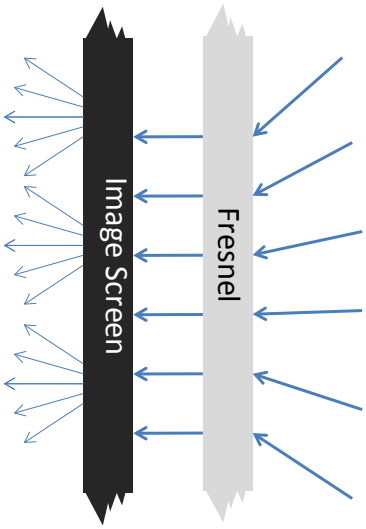
Planar's quest for the optimal screen design was perfected over many years. The Planar PV2 screen shipping on Planar's current LED display cubes is designed differently than a screen 10 years ago. Planar engineers constantly look to improve every aspect of cube design by questioning and evaluating current designs, and today's PV2 screen design is a result of that constant desire to produce the best image experience in the industry. Is the PV2 screen the best screen in the industry? Planar engineers believe so but also believe in developing an even better design if it provides a better customer experience.

Components of a screen

Before getting into the screen design details, it's essential to understand basic screen design. Planar's current LED display cube screen consists of three components: a Fresnel lens, Image Screen and a Screen Frame:

Fresnel: An opaque material designed to redirect the projected light from any angle and send it forward perpendicular to the Image Screen- Named after a French physicist named Augustin-Jean Fresnel.
Image Screen (Lenticular): A dark material designed to dispense the image at designed viewing angles while absorbing and rejecting ambient light.
Screen Frame: A 3.5 inch (8.9 cm) deep shroud surrounding and supporting the fresnel and Image Screen.

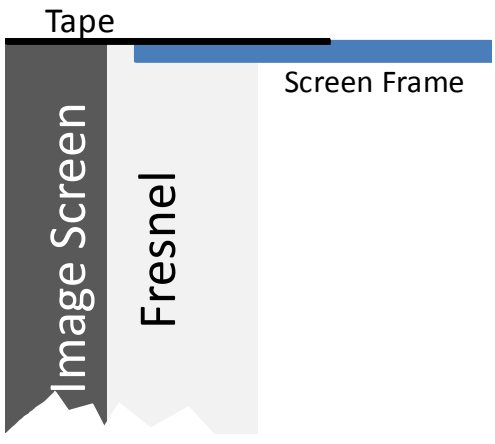
These three elements are carefully designed and assembled forming the rear projection screen we see on the front of a rear projection cube.



Light path entering the Fresnel and exiting the Image screen

Screen Design

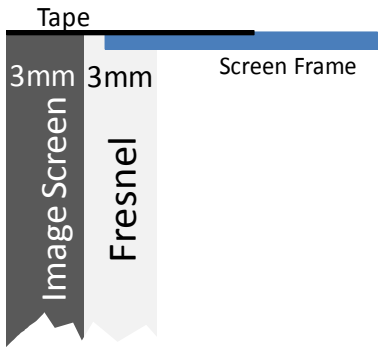
An incredible amount of engineering goes in to Planar'sPV2 screen design. The frame surrounds and secures the fresnel. Placed directly against the front side of the fresnel is the image screen, held in place by, believe it or not, tape. Tape!! Can tape really hold the Image Screen in place providing years of use? Tape is the only material holding the image screen in place, but it's not just any tape. Planar's engineers experimented with different types of tape and chose a material providing extremely high level of adhesion to smooth surfaces along with durability over a wide range of temperature and humidity conditions. This tape is a very thin material enabling Planar to achieve that almost seamless screen gap of less than 0.1mm. But over the years, Planar's engineers qualified a couple other designs before perfecting the screen design on today's LED cubes.



Cross section view of PV2 screen design

1st Generation Screen Design

Through years of experience Planar's engineers discovered screen thickness, weight, and screen material play a very influential role in screen design. The first screens from Planar consisted of a 3mm thick fresnel secured by a metal frame and a 3mm thick Image Screen secured by tape. Over time engineers discover two issues with this design:

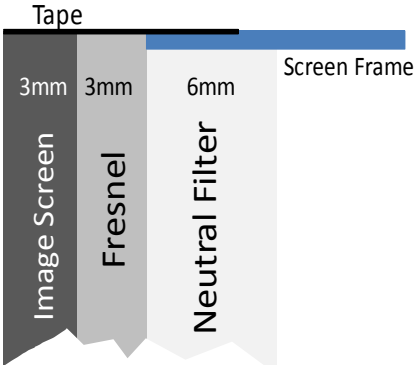


- A 6mm thick fresnel/image screen combination is too thin and could bow in or out over time, especially with larger size screens. Screens must remain flat to produce quality images.
- The metal frame is very heavy and metal expands and contracts at different rates vs. the fresnel's material, causing separation of the frame from the fresnel.

Although these separation issues were rare and present only in extreme environments, cubes are designed to provide quality, consistent images for years.

2nd Generation Screen Design

In the next screen design a 3rd, very clear 6mm layer, called a neutral filter, was added behind the fresnel for greater strength and support-- bowing problem solved! To reduce weight a plastic frame replaced the metal frame. Over time Planar's engineers discovered additional areas for improvement:

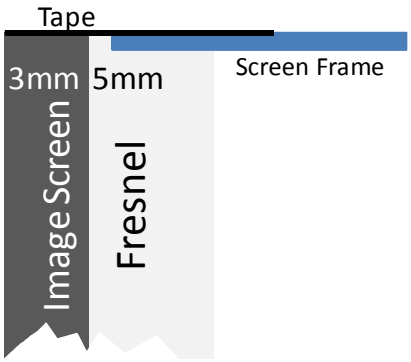


- First, light hitting that extra layer of screen material (the neutral filter) caused a greater portion of light to reflect back into the cube producing a dimmer viewing image.
- Second, the neutral filter material is constructed of a different material vs. the frame and fresnel, resulting in all materials expanding and contracting at different rates.
- Third, the tape previously supporting just the image screen now supports the image screen and the fresnel. Its good tape but not good enough to combat the effects of 2x the weight vs. the 1st generation design.

Obviously, the engineers wanted improvements to overcome these issues.

Current, PV2 Screen Design (3rd Generation)

For today's current PV2 screen design, to reduce weight, increase brightness, improve structural quality and still produce a quality image experience, Planar's engineer's implemented four changes:



- Designed a two layer solution and increased the thickness of the fresnel from 3mm to 5mm. Thick enough to prevent bowing while producing a brighter image by removing one layer.
- Chose a much lighter metal composite for the frame keeping weight at a minimum.
- Designed a unique frame so expansion and contraction between the frame and fresnel is not an issue.
- Designed the image screen and fresnel from the same material so expansion and contraction of the two materials occurs at the same rate.

Screen Preparation

Before the image screen and fresnel are assembled with the frame, both screen components need "prepping". What is involved in the prepping process? Two key steps are soaking and cutting.

Soaking

After the raw, uncut fresnel and image screen material is received in the Planar factory the first preparation process is called "soaking". What is soaking? Soaking involves storing the fresnel and image screen material from 2 to 4 weeks in an environment of 75 degrees F^0 (24 C^0) and 50% humidity. This process ensures the image screen and fresnel are stabilized before screen assembly begins. Why 75 degrees F^0 (24 C^0) and 50% humidity? The specific environment stated above falls in the middle of the operating range specification for the screen. Plus, these conditions emulate a typical end user control room environment so the raw material is acclimated to that environment before it enters the manufacturing process, thus minimizing potential issues at the installation site.

What is the purpose of soaking? Planar engineers discovered that sending the image screen and fresnel raw material to production immediately after delivery resulted in the two materials expanding or shrinking at different rates after the cube is placed in operation. Why does this occur? Unfortunately, Planar cannot control the environmental exposure of raw screen material before it's received in the factory. Until raw screen material hits Planar's manufacturing site this material is possibly exposed to very hot and dry or very wet and cold conditions, and everything in between, for several days.

Cutting

After the fresnel and image screen raw material finishes soaking, they are both cut to screen size specifications with a tolerance of 0.005 inches (0.127 mm). To ensure both screen components are cut to specification and both screen components are cut at exactly the same dimension, two critical steps are followed.

Fresnel and Image Screen on the cutting machine

First, a CNC cutting machine makes a test cut on a sacrificial piece of material before every screen cutting session. The test material is then measured for the accuracy of the cut; length, width and square. Secondly, both pieces of raw material are secured together tightly and the CNC machine cuts both pieces at the same time. These steps guarantee screen material cut to specification and the fresnel and image screen are congruent.

Summary

Eyes are the best judge of image quality and the screen ultimately produces the images we judge. Arguably, the screen is the most important element of the rear projection cube. But designing and manufacturing world-class rear projection screens requires very experienced teams, and with over 20 years in rear projection display cube design Planar produces the industry's best screens.

During the rear projection video wall purchase decision, consider the supplier. Do they have the same high standards and expectations as Planar? Or do they prioritize cost over quality? Unfortunately, it's difficult to determine just by looking at a screen.

Ask the following:

- How much screen design experience does the manufacturer have?
- If the manufacturer has little industry experience, chances are they don't have enough experience to understand what works and what doesn't work.
- Is the screen designed for 24/7 operation for many years?
- Screens can be produced cheaply by using very thin fresnel and image screen material. Over time they may warp and cause poor image quality. Does the manufacturer have long enough installation history to determine the long term effect on screen designs?
- Is the screen designed to withstand extreme environmental conditions without impacting quality? In extreme conditions, all material expands and contracts. The screen should withstand these conditions while still producing a quality image. Planar ensures both the fresnel and image screen are made of similar material to expand and contract at the same rate. In addition, soaking the screens after they arrive at Planar drastically helps minimize quality issues.
- Have other manufacturers improved their screen design over time and are they still evaluating current designs, looking for further improvement? Over years of experience and with an engineering organization focused on optimization, Planar has developed a formula for producing truly world class rear projection screen designs.

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