DIY Projection Coatings

Improve contrast and gain without the high price tag

BY ANDREW OKERSON

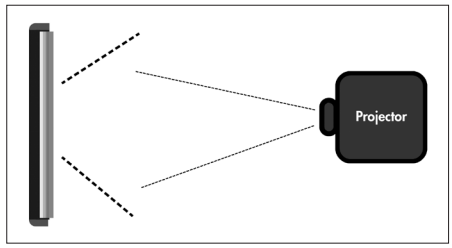
As projection technology advances throughout the theatre world, educational and community theatre organizations are finding the technology more accessible and financially viable. When purchasing a new projector, organizations know to painstakingly review important elements of their projection systems, including projector lumen output, light source types, contrast ratios, and lens throw, yet they often overlook the projection surface itself. Factors like ambient light and projection angle are influential, but the projection surface is also an integral variable when determining the requirements for an effective video projection system. Those variables are more complicated when applied to unconventional surfaces.

In a traditional system, the projector is placed in front of or behind a projection screen that is specifically manufactured for several purposes: create a flat surface, provide a prescribed amount of screen gain (more on that later), and enhance the black levels of the projections in any given environment. These screens are very effective at their job but can cost upwards of $40 per square foot of material. When trying to cover hundreds of square feet, this expense may be out of reach for small performing arts organizations, especially when a cyclorama curtain or a white drywall surface upstage works "well enough."

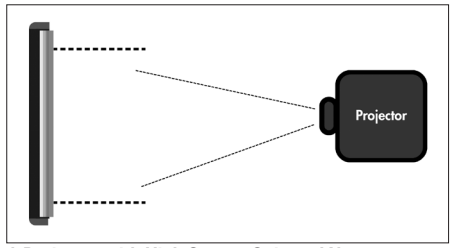
Unconventional projection surfaces offer unique challenges. Perhaps projections are required on the front of a two-story set or onto a large, curved surface. Applying screen material in these circumstances is often unfeasible or cost-prohibitive. What solutions are available in these situations?

Today, projection screen paints—color-optimized mixes from big box stores—help make colors look as accurate as

The Audiovisual and Integrated Experience Association (AVIXA) provides AVIXA standard V201.02.2021: Image System Contrast Ratio. Also known as the ISCR Standard, this standard provides an excellent reference for the lowest acceptable contrast ratio that factors in ambient light, viewing angle, and communication purpose of a display system. This information is critical when creating complex designs. Projector manufacturers provide a projector calculator tool on their websites that uses this standard, and those tools can help estimate the contrast ratio of a system before it is installed. For more information, view the free video at this link: https://tinyurl.com/ja5u2p6r



A Projector with Low Screen Gain and Wide Viewing Angle



A Projector with High Screen Gain and Narrow Viewing Angle

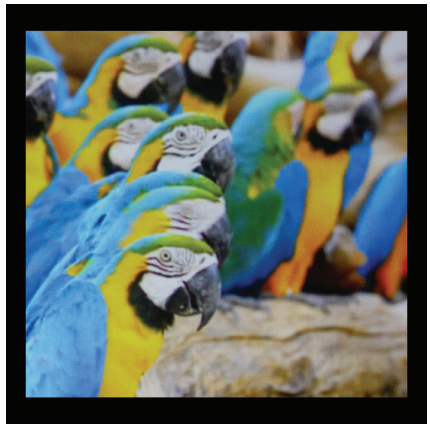
possible. Then there are a couple of commercially available roll-on or spray-on coatings that give any surface the desired projection attributes the substrate lacks. The second category of coatings has additives that adjust the reflectivity and light disbursement properties of the surface. The downside is that these solutions are priced as if they replace the long-term purchase of a projection screen. For one of the coatings, 3.78 liters retails at more than $500. While this expense can make sense on a long-term installation, for theatrical productions that may run for a matter of weeks, the price point is far too high to rationalize. Therefore, it made sense to try to create a coating from supplies that are readily available to average consumers at a reasonable price.

Materials

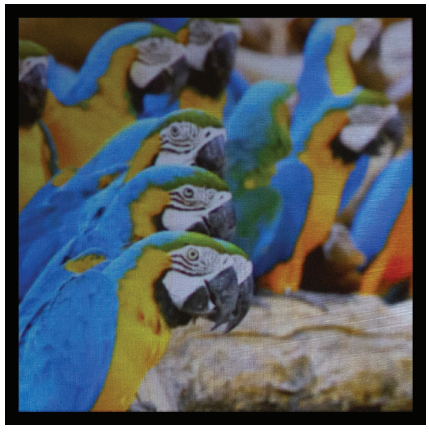
The first step is to identify the desired attributes of a custom coating. The main goal of coating a projection surface differs by use case, but in the theatre environment, brightness is key. No matter what surface one considers projecting onto, access to a projector with adequate lumen output is paramount. Free online lumen calculators will identify the lowest acceptable limit for a given use case, but the standard recommendation is to use a projector that is as bright as possible. Because competing ambient light on stage is always an issue, the average theatrical use-case will require a surface with good black levels, color rendering, and maximum screen gain, which is the amount of reflected light that bounces off a surface, relative to a control surface. It is typically defined by a standard reference material, and the measurement is taken at the center line of the screen at one meter.

The difference between the reference material and the measured surface gives the gain number. If the light measurement is equal, the screen gain is one. If the measured light from the test surface is 80% of the sample, the gain is 0.8. High-gain screens can have measurements of 1.5 or higher because more of the projected light bouncing off surface less diffusely. Therefore, screens with higher gain have a narrower viewing angle. The images on the prior page demonstrate these differences. Always consider the width of a performance space's viewing angle. The greater the screen gain, the faster brightness will drop off as the viewing angle is farther from the center line. It's not an issue in most theatre environments, where the audience sits straight on, but could still be a factor to consider when planning a system in a space with wider seating arrangements.

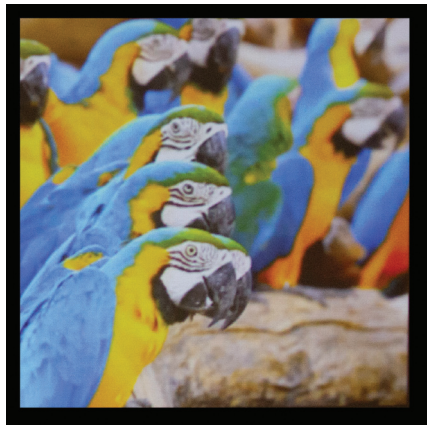
White surface with some ambient light.



White surface with no ambient light



Gray surface with some ambient light.



Gray surface with no ambient light.

With the material requirements defined, the next step is to consider available materials. The Guild of Scenic Artists' online product forum offers a starting point for using mica powder as an additive to flat paint to enhance reflectivity (*ScenicGuild.com*). This is a common practice at The Metropolitan Opera and was used in the scenic treatment for *Big Fish* on Broadway (LiveDesignOnline.com). This mica powder is difficult to source in quantities and refinements that make it useful for a screen coating, and the powder must be handled carefully and with proper personal protective equipment to avoid inhalation.

You'll also find years of discussions from the AVS Online Forum (AVSForum.com) on the topic. Contributors to the forum have put forth a wealth of "homemade" experimental coatings with reviews of their success. These user reports have qualitative information about their experiments but lack empirical data and photographic records of the coatings' effectiveness. My research goal is to use these suggested mixtures as a springboard and provide accurate measurements, detailed photos, and formula records that are specifically tailored for use on stage.

Process

For this research, it is assumed the most common substrates for coating will include muslin, luan, plywood, hardboard, and similar surfaces found in the theatre. It is also assumed the coatings used will be paint-based. Paint color choice is the single-most effective way to improve the appearance of projections. White seems like an obvious choice when attempting to project, especially on irregular surfaces. After all, white will reflect the most

light. However, white tends to wash out the darker portions of an image. This issue is amplified in a theatrical environment where ambient light adds to the effect. The figures on page 7 show how the test image projected onto an all-white surface appears with no ambient light and some ambient light.

Projecting onto a gray surface is a great choice to increase black levels; however, this does result in a reduction of overall brightness. How dark a gray to use will depend on the specific use case and is something to experiment with during the design process. Finding the happy medium between acceptable black level and brightness is worth the investment of time. The figures on page 7 how the results of projecting the test image onto a gray surface, compared with the previous white projection with some ambient light. The ambient light level is consistent between photos.

Finding ways to increase apparent brightness and light distribution are the next aspects to improve upon. The AVS forum provided a starting point for a formula that its users have adjusted over the last 15 years to enhance these aspects. The biggest alteration from the existing formula is the amount of water added and the paint base. The resulting formula to yield about a gallon of silver screen coating is: Rustoleum Metallic Accents - White Pearl, 32 oz.; Rustoleum Metallic Accents - Sterling Silver, 16 oz.; Pittsburgh ULTRA flat base tinted to necessary grey, 10 oz.; Rustoleum Ultimate Polyurethane Satin Finish, 16 oz.; and distilled water, 10 oz.

The mixture requires a great deal of mixing to distribute the mica beads and tint evenly. A paddle mixer or paint shaker would make this process easier. This mixture yields slightly less than one gallon of paint.

Results

After mixing, one can dilute the mixture for the specific needs of a production. For my purposes, I brushed on all the paints. I did not dilute the recipe very much and applied it in a moderately thin coat. It turns out that metallic elements in the mixture reflect light in all directions, which can highlight brushstrokes and uneven surfaces. They are very apparent from several feet away. I would strongly suggest rolling or spraying the silver screen mixture onto any surface. The highlighting effect is amplified on rough surfaces like plywood. It is imperative to start with a smooth surface to achieve a smooth finish. In larger spaces, this may not be as much of an issue. To use this mixture in a sprayer, it must be strained first.

For testing purposes, I painted a swatch of plain white primer, gray tinted flat paint, white pearl metallic paint, and the silver screen mixture onto a two-foot by two-foot piece of hardboard. These swatches are separated by a one-inch section of the white primer. I used a consistent set of test images and videos, one test with a single image covering all the swatches, and another with four small versions of the image covering the swatch. This made it easier to see the differences in apparent brightness and contrast. For the projector, I used a Christie LW650, which has a lumen output of 6500, as the light source. The projector sat six feet away from the test surface straight across on a table in order to avoid any variables with keystone or reflective angles. I took all photos and

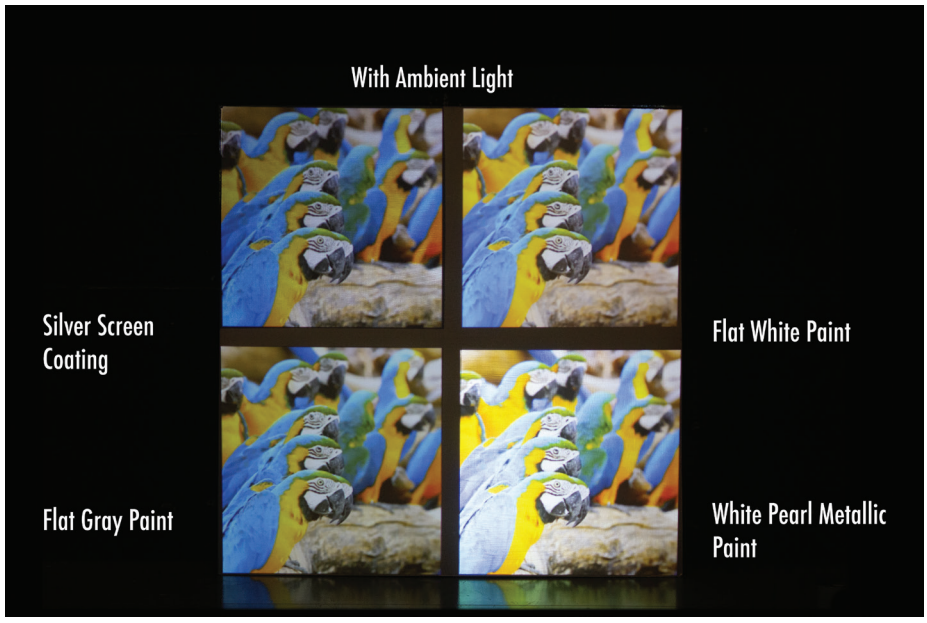
videos from the same location, directly behind the projector at eye level, centered on the test surface. I used a photometer at one meter from the projection surface to measure the brightness.

I first measured the brightness of the projector reflecting off three different test swatches of projector screen material. Furthermore, I used the labeled screen gain of these control materials to see how the test coatings would fare in comparison. Projecting an all-white image onto the white control fabric measured 5,751 lumens. The material data sheet specified a screen gain of 1.3, and I measured 1.4. This could be for a variety of reasons, varying from the use of different measuring instruments to the test pattern used at the screen material factory. The gray projection screen material had a stated gain of one and tested one. The last control material was a darker gray; it had a stated gain of 1.5 and tested at .94.

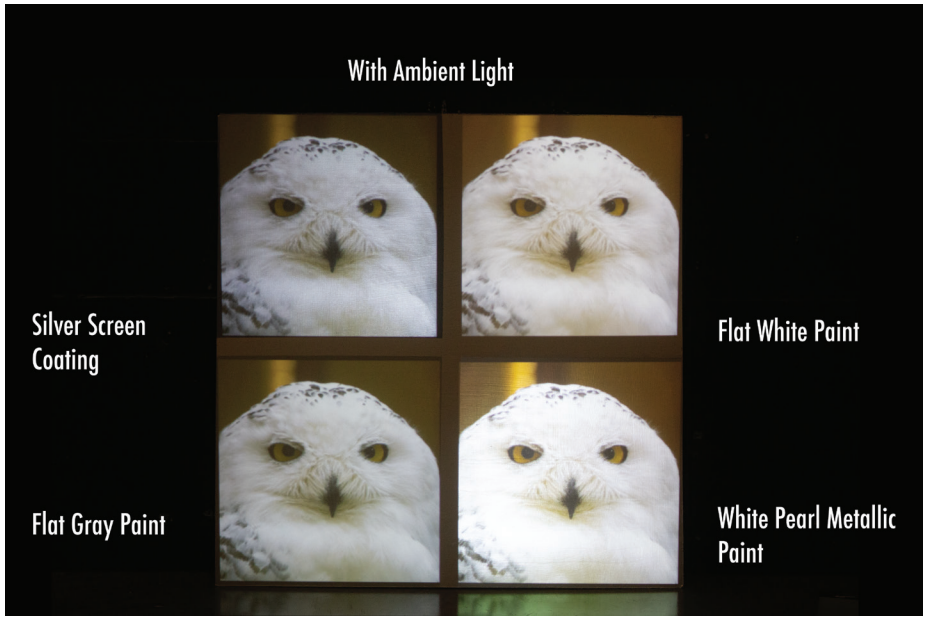
The white pearl metallic paint did not have a direct comparator projection screen swatch, but it did yield the highest screen gain of 1.59. Unfortunately, the surface began to reflect so much that the projector lens hotspot was visible, which is not a viable option for most use cases. As for the rest of the data, I found it very interesting that the white hardboard—a proxy for an average white wall—did not perform as well as the projection screen surface, and yet, the other coatings are very close to emulating the same screen gain as the manufactured option. It is also worth mentioning that the silver screen coating is several shades darker than the Cinegrey 5D Sample material. If the silver screen coating were tinted a bit lighter, the results would be even more impressive.

The silver screen coating also offered more contrast within the projected image in a high ambient light situation. This is the most comparable test to something that would happen on stage. While there is a loss of overall brightness due to the darker paint color, the dramatic improvement in overall contrast is worth the compromise.

Figure above shows all four test surfaces in high ambient light. Notice the shift to warmer tones on the white surface. That is due to the warm ambient light. The cooler image to the left is truer to the source image.



All four test surfaces in ambient light.



All four test surfaces in ambient light with a test image with more white content.

It is also very apparent in this photo that the white pearl is too reflective for this use case. Theatre is all about experimentation, so there could still be a time when a metallic surface could yield the intended result. I also took several videos of projections on the materials, which provided further visual confirmation that the silver screen and gray paint are better projection surfaces when competing with ambient light. Other equipment used to complete these tests included a Mac computer running QLab software with four surfaces mapped to the individual test swatches, overhead pendant lighting measured at 256 lumens to provide consistent ambient light, and a Canon T3i DSLR camera with an 18-55mm Lens. The test images were sourced from an image library in online photo editing software Canva. They are licensed for use in an educational setting. I am also happy to provide the test videos upon request.

In conclusion, a white projection surface is ideal in perfect conditions where ambient light is not a concern, but darker tinted bases and reflective additives are an economical and efficient way to increase the screen gain of any projection surface, as well as enhance the apparent contrast of an image at the same

time. Reflective additives on their own may prove too bright and end up creating distracting hot spots on a surface. These additives will also highlight uneven surfaces and brush strokes. The different components for these coatings are available at the average hardware store and require no special tools or skills to mix and cost a quarter of the commercially available mixes. These findings should serve as a solid foundation when looking for surface coatings to improve projection surfaces. This data, along with some experimentation in the paint shop, will yield a quality result for any production.

Andrew Okerson is the technical director and resident scenic designer for the nationally recognized performing arts department at Carmel High School in Carmel, Indiana. He also offers theatrical design services to school, community, and regional theatres across the Midwest. Okerson is an active member of USITT and EdTA. Find out more at AndrewOkerson.com.

Works Cited

Eddy 1, Michael S. December 5, 2013. "Big Fish on Broadway, Part 2: Scenic." *Live Design Online*. www.livedesignonline.com/theatre/big-fish-broadway-part-2-scenic

MississippiMan, et al. March 2025 "The Official Silver Fire V.2 Thread." *AVS Forum*, 15, www.avsforum.com/threads/the-official-silver-fire-v-2-thread.1311989/

Powers, Angelique, et al. August 9, 2019. "Mica Powder Discussion." *Guild of Scenic Artists*. www.scenicguild.org/forums/search/?bbp_search=projection&bbp_search_forum_id=14718 Accessed 30 Apr. 2025.

Organizations

www.avsforum.com
www.avixa.org/en
www.livedesignonline.com
www.scenicguild.org