Smart mirrors vs. heads-up displays (HUDs)

Understanding key differences in design, materials and manufacturing

Advances in display technologies have enabled new user experiences for a wide range of industries. As a result, more companies are looking to create smart mirrors and heads-up displays (HUDs) as standalone products, or as part of larger applications—like smart displays in car windshields. Although they are similar, there are some key differences in their design, materials and manufacturing process. Fully understanding those differences will allow brands to increase speed and efficiency when creating these products. Although we do not make smart displays from scratch, Boyd has a wealth of experience improving display applications with custom solutions that make displays better, lighter and more reliable, and which feature greater contrast to improve usability. This whitepaper will explore the main differences between smart mirrors and HUDs as well as some key considerations engineers should keep in mind to improve the performance of these products.

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What is a smart mirror?

Smart mirrors often involve complex stack-ups of glass, optically clear adhesives (OCAs), LCD modules, backlighting components, films for light management and other materials. In a normal state, smart mirrors provide a reflective surface just like traditional mirrors. But when switched into LCD mode, they can display images just like a TV screen. One of the most common applications today occurs in vehicle displays where rearview or side mirrors are reflective in a normal state, but then show a rear-view camera display when operational. They can also be used in augmented reality-type applications to display both the image of the user and additional digital elements projected via the underlying screen.

For example, bathroom mirrors that can display information like the weather report or a user's daily schedule are starting to become more popular in hotels and new home construction. In the fitness industry, smart mirrors are being used to provide direction for workouts and display statistics like heart rate and oxygen levels. In the beauty market, brands are using smart mirrors to show shoppers what they would look like with different types of makeup and provide product recommendations. And even in the medical space, smart mirrors are being used for diagnostic and physical therapy applications, like learning how to do stretches properly.

With new use cases and applications being developed seemingly every day, smart mirror technology represents a significant opportunity for brands that can deliver great user experiences via an efficient and cost-effective manufacturing process.

What is a heads-up display (HUD)?

Heads-up displays differ from smart mirrors in that they are rarely used to reflect images. Rather, HUDs are see-through displays that project images onto a piece of glass and are often positioned to be directly in a user's line of sight. HUDs provide both transparency in the overall application, but also the image brightness to see what's being displayed. One of the most common applications today is in vehicles where windshields can display the vehicle's speed and safety warnings when the vehicle is on, but the image disappears when the vehicle is turned off, and the vast majority of the windshield remains transparent. The key is finding ways to effectively balance the two primary needs—transparency and image brightness—and that primarily comes down to materials.

Heads-up display stack-ups typically include primary and cold mirrors, OCAs, light diffusing films, LED modules, thermal management materials and more. When developing and manufacturing such complex products, it's important for brands to create streamlined, low-profile designs and maintain tight tolerance control to ensure products operate reliably and accurately.

Design, materials and manufacturing considerations

Both smart mirrors and HUDs involve complex stack-ups and require precision and efficiency in the production process to achieve project goals. Here are some of the most important materials and manufacturing processes to consider when working to improve display products.

Light management films

Effective light management is key for achieving optimal performance for any smart mirror or HUD application. There are actually a number of different types of light management films commonly used in both types of products, including light control films, brightness enhancing films, visible-light reflective films and light diffusing films.

Light control films constrain the light exiting from displays to minimize reflections on the outer glass. Brightness enhancing films manage the angular output of light from displays, using a prism structure to focus light toward viewers. Visible-light reflective films are used in HUD applications to provide high image brightness while reducing undesired visible light. Similarly, reflector films help maximize the recycling efficiency of displays and can reflect close to 99% of the visible spectrum.

All of these films are often used in combination with one another to provide the best user experience in both smart mirrors and HUD applications. The key is not only choosing the right light management materials, but determining how they fit within the product design and stack-up construction to achieve performance goals.

Bonding

For both smart mirrors and HUDs, different bonding options help ensure structural integrity and product performance while also allowing for additional design flexibility. In both types of products, optically clear adhesives (OCAs) are often a critical component of the overall design and functionality.

OCAs are virtually invisible, reduce ambient reflections and can improve contrast for better readability while still providing high-strength bonds for solid adhesion. OCAs come in a variety of forms, including double-coated tapes and adhesive transfer tapes that are easy to work with for better manufacturability. One important thing to note about using OCAs is that precision and cleanliness in the manufacturing process are paramount to avoid bubbles or contaminants in the material that could compromise optical clarity.

In smart mirrors, VHB tapes are often used to bond the housing or structural components of the mirror. Many manufacturers prefer 3M VHB tapes in particular because they provide excellent adhesion strength and heat resistance while also helping to ensure ingress protection from moisture and other contaminants because of their closed-cell construction. Where smart mirrors need to be more durable—such as in vehicles—these tapes also provide good shock and vibration protection along with additional impact resistance.

Polyethylene foam tapes and other thin tapes are also used frequently in HUD applications because of their high bond strength, excellent thermal management characteristics and resistance to moisture and UV rays.

The importance of tight tolerance material converting

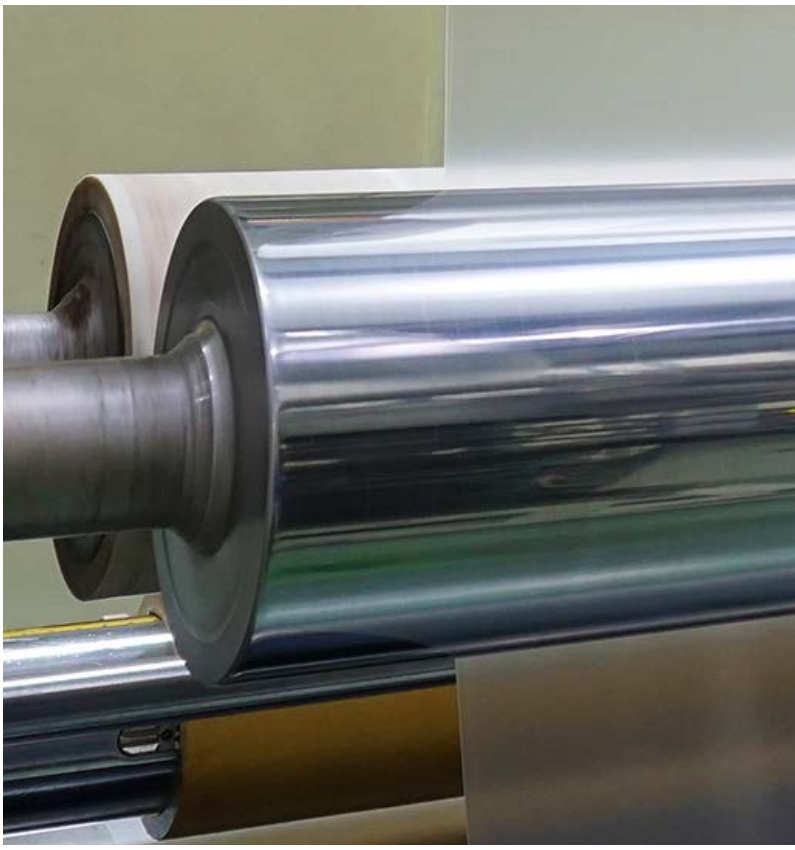
It seems most consumer electronics products are getting smaller and lighter as technology advances. But with smart mirrors and HUDs, it's not about the size of the overall product (windshields and bathroom mirrors can be quite large), but maximizing the available display surface with thinner and thinner borders and bond lines. All of these applications, therefore, require tight tolerances and the ability to convert tapes, films, foams and other materials to precise specifications.

This means brands should consider partnering with a converter like Boyd that has the capabilities to ensure precise die cuts, rotary cuts or waterjet cuts in every run. Precision die cutting can become more challenging for high-volume projects, and some applications require cleanroom processing to ensure displays don't become contaminated. So, it's important for brands to choose their partners carefully, looking for converters who can provide precise, high-volume converting with cleanroom capabilities and have the experience to create exceptional display stack-ups quickly and efficiently.

Screen printing and digital printing

When most people think about mirrors or floating digital displays, they don't often think about printing. But various printing techniques can actually enhance the user experience for smart mirror and HUD products.

Depending on the application, digital printing can be done directly on glass to create a permanent image that is still semi-transparent. In other cases, printed circuit boards are created by screen printing conductive ink and then using a face stock, liner and adhesive to create a full stack-up. This is why it's so important for manufacturers to partner with truly full-service converters who not only have diverse printing capabilities, but who can also cut or otherwise convert those materials for faster, easier assembly.



Backlighting and deadfront applications

In smart mirrors, a deadfront look simply means there are images on the display that are invisible until they are illuminated. That illumination is typically provided by a backlighting unit that is included within the interior of a smart mirror stack-up. These images may be icons or other graphics that convey meaning in their own right, or they may be used in conjunction with membrane switches to provide an interactive, touchscreen experience for users.

Therefore, design engineers need to not only consider the aesthetics of deadfront applications, but also how those displayed images might impact the entire product design and user experience. As with any light emitting module, thermal management is a key consideration when incorporating backlighting units. This is why thermally conductive tapes, pads and heat sink materials are often used in both HUDs and smart mirrors to ensure effective heat transfer.

Achieving project goals

The challenges involved in enhancing and producing new smart mirror and HUD products can be daunting, to say the least. Beyond design and engineering challenges, brands and OEMs need to be able to manufacture products precisely and efficiently to control costs, timelines and ensure product quality.

The surest path to success is to work with an experienced partner like Boyd that has the display expertise and manufacturing capabilities to drive new innovations. We can assist with materials selection and provide design engineering and converting services to enhance efficiency and speed in the go-to-market process. By working with a trusted partner who can offer insights on the most important aspects of smart mirrors and HUD applications, manufacturers can overcome design and production challenges to achieve project goals.

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About Boyd

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