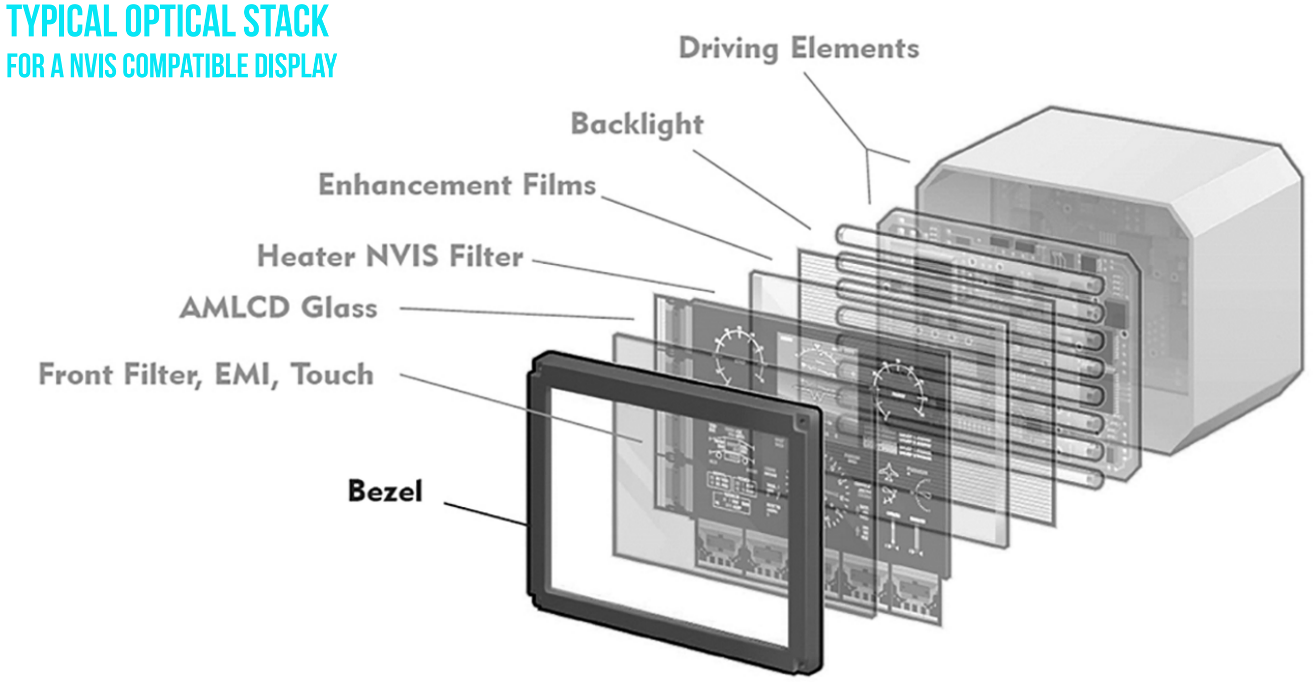
OPTIMIZING MISSION
DISPLAY READABILITY & PERFORMANCE

BY KEVIN ROONEY

Modern airborne video surveillance systems enable mission teams to search for objects of interest and observe unfolding events (either overtly or covertly) while recording and reporting what's being observed. Improvements to a helicopter's video surveillance system can significantly improve mission effectiveness. Ways to improve the system include:

- **Making it more intuitive, and thereby easier to use.**
- **Improving the stability of the camera source and the clarity of the picture.**
- **Merging electro-optical (EO) and infrared (IR) video data.**
- **Enhancing its ability to track moving targets.**

TYPICAL OPTICAL STACK
FOR A NVIS COMPATIBLE DISPLAY



Still, a fundamental problem remains: the human factor. All of the above system enhancements won't add much value if the operator is unable to view the display. That's why the primary goal of an LCD display designed for use in harsh airborne environments is readability. Whether operated during bright daylight hours or at night by crew members wearing night vision goggles (NVG), display readability can contribute greatly to a mission's successful outcome.

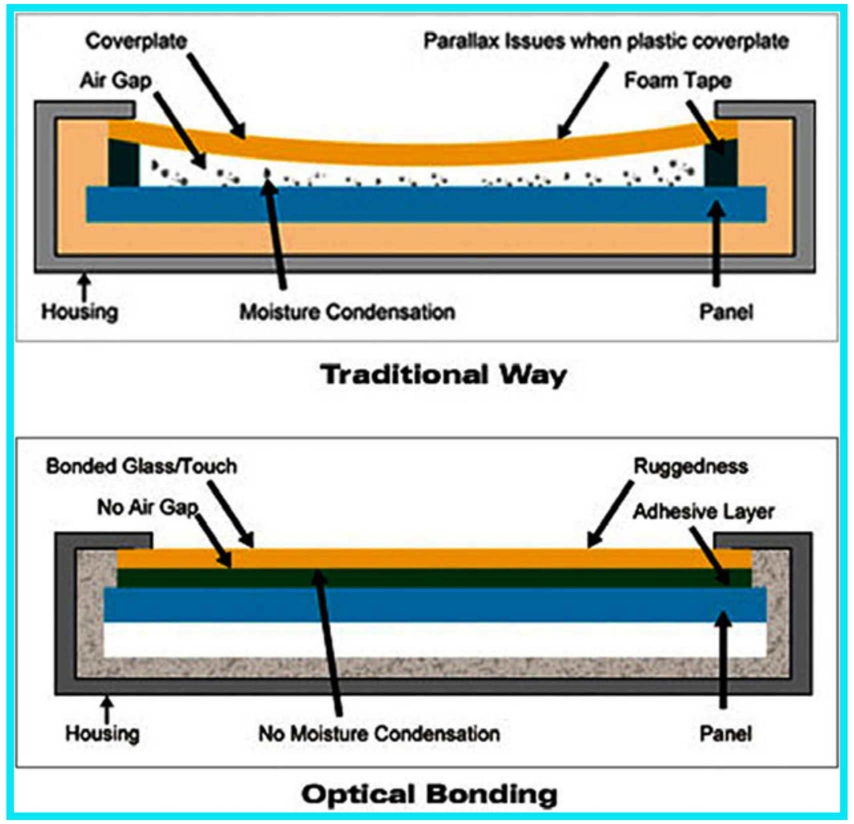
There are several key factors that can affect a mission display's readability—and by extension affect mission effectiveness. The display must support clear, stable video imaging sources and it must deliver clear video images in a high ambient light environment. Display design features that can help optimize image clarity include the display's contrast ratio, how it handles reflectance, and whether it supports a night vision imaging system (NVIS) without filtering. Last but not least, the display must be easy to use and reliable.

FOR DAYTIME MISSIONS, READABILITY IN SUNLIGHT IS A CRITICAL REQUIREMENT FOR DISPLAY EQUIPMENT INSTALLED IN COCKPITS WITH HIGH LEVELS OF INCIDENT LIGHT.

The primary features that can determine the display's brightness include its backlight LED power and efficiency, its LCD transmissivity (IPS vs TN), and color filter saturation. The minimum acceptable level of brightness at the front of the display is 1,000 nits (cd/m2). The display should also comply with MIL-STD-3009 (U.S. Military Standard) requirements to support night vision capability.

In order to optimize readability, the display must be able to defeat any form of light that will reflect off the screen and interfere with the image the operator is trying to view. All forms of LCD, glass, and plastic are susceptible to reflections. Various techniques are used to reduce these reflections. The worst-case scenario is early night/early morning environments, when the sun is very low in the sky and reflects directly off the screen into the operator's eyes. A more typical problem is full daytime sunlight hitting the observer, which turns the observer into a brightly lit object that reflects off the screen. In both environments the issue is light reflecting from the screen.

Frequently, customers will only state a general requirement, such as "very good daylight readability." Unfortunately, nearly all vendors will likely claim they can satisfy that requirement because it's not specific. Some customers will specify a requirement for anti-glare coating. While coating does help, instead of eliminating glare, it diffuses and distributes the reflecting light so less reflection hits the viewer's eyes directly. Furthermore, coatings only affect the outer layer of the display glass. Light also penetrates and reflects off the display's inner layers of glass, and anti-glare coatings do nothing to prevent that.



AIR GAP VERSUS OPTICAL BONDING

In a very simple display there are often three or four layers of glass and plastics, and a more complex display may have seven or eight layers. As light passes through each layer, there will be changes in the refractive index, resulting in some form of reflection.

This is made much worse by displays that have air gaps in their glass stack-up. The best solution is to select a display that optically bonds each layer of glass, directly connecting them to greatly reduce the change in the refractive index between layers. Ideally, a circular polarizer should be employed within the glass stack-up to polarize the light on the way into the screen. It rotates the polarization so that when light reflects off the LCD or the inner layers of glass, the light is out of phase with the polarizer and cannot escape.

CONTROL ELEMENTS OF A TOUCH-SCREEN DISPLAY

In addition to screen reflection, there are a number of important technical features that system designers should understand before they select a rugged LCD display for their rotorcraft platform. These include:

- **Environmental protection.**
- **LCD temperature.**
- **Reliability.**

AN EXAMPLE OF A RUGGED LCD DISPLAY THAT PROVIDES ALL OF THE FEATURES DISCUSSED ABOVE IS CURTISS-WRIGHT'S AVDU5500 21.5 INCH TOUCH-SCREEN MISSION DISPLAY.

First, consider the need for protection from dust, sand, and salt spray. For example, a Coast Guard helicopter is subject to a lot of salt spray. It will also be prone to condensation and water drips. A display that is open to the environment, whether through fans or air holes, will suffer in that environment. What's needed is a display that is sealed or has a pressure relief valve, making it appropriate for different altitudes.

A pressurized hose is often used to wash the floor of a ground vehicle. Displays for ground vehicles should satisfy the IP67 immersion specification, supporting immersion in water down to a meter. Make sure that the display has undergone waterproofing and has actually been tested. Some airborne displays adopt DO160, a standard specification that addresses condensation and water splashing conditions.

Harsh operating temperatures of deployed platforms can also affect the display's operation. Commercial LCDs, particularly in larger sizes, don't support the full MIL range. In order to operate at -40 degrees Celsius, different manufacturers adopt various techniques to overcome the discrepancy between MIL temperature standards and the actual capabilities of the LCD. Some manufacturers will simply provide a display with the hope that it works at -40 C. While commercial LCDs will operate at this low temperature in many cases, their life expectancy will be much lower. Commercial LCD materials semi-solidify at lower temperatures. When switched on in that state, they will be damaged. The damage won't happen right away, and the display might even pass the qualification test, but the issue is the lifetime reliability of the product over the full temperature range. For a rugged display, system designers should look for a pre-heater built inside the display to heat the LCD to its specification level before switching it on. While this approach causes a delay, it does significantly improve reliability.

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