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Building Defense Grade

HMI Solutions for Military Vehicles

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Defense contractors face tremendous challenges when designing and manufacturing land vehicles for military applications.

Demanding field requirements call for more durable equipment that exceeds the standards found in consumer and commercial-grade products. Defense manufacturers require the utmost reliability; sub-optimal performance or failure costs time and money and puts military lives and national security at risk.

Military land vehicle design uses human machine interfaces (HMI) to convey information quickly and accurately. Displays, labels, and control interfaces must also withstand demanding usage since military vehicle HMI systems routinely operate in harsh conditions, extreme temperatures, and extraordinary use environments. These vital components need solutions designed and manufactured using robust methodologies tested and proven to maintain prime performance in any scenario.

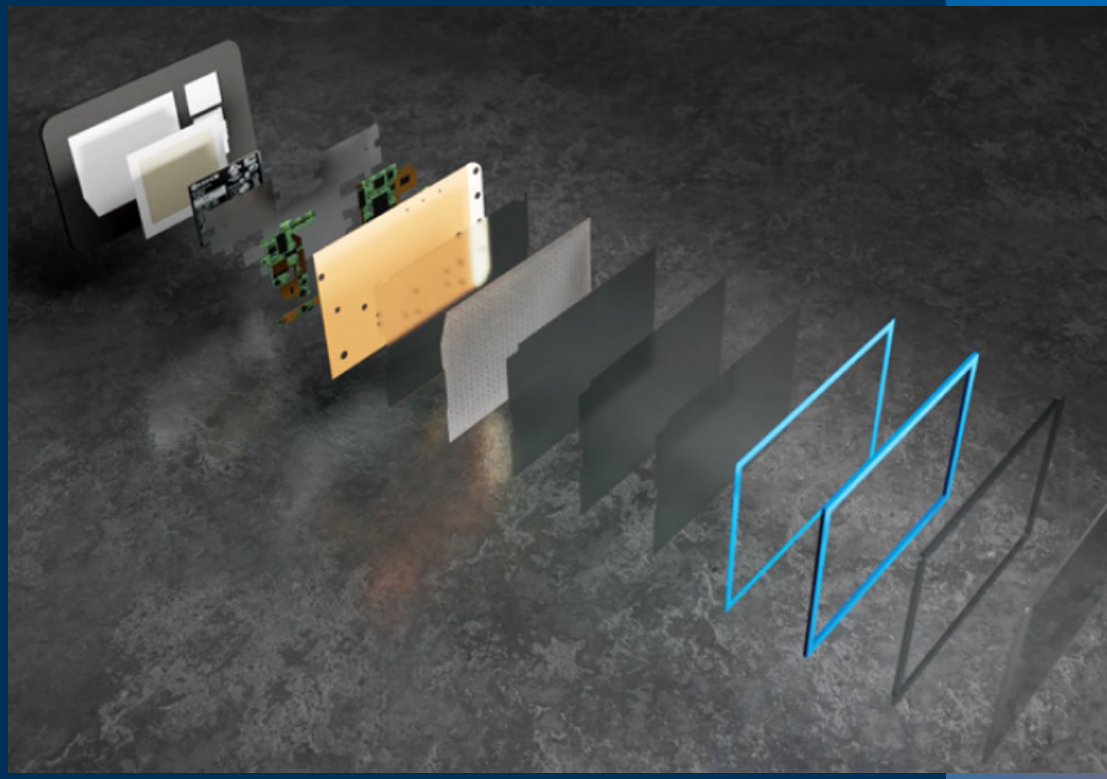
Boyd's experienced engineers collaborate with defense industry leaders to design customized HMI components and assemblies that exceed exacting defense specifications.

Our durable, adaptable HMI solutions utilize the highest quality materials to ensure lasting operational performance.

Display Assemblies

Modern vehicle displays provide essential operational data to military personnel. Engineers must design these screens to ensure readability under multiple lighting conditions while providing intuitive controls that display dynamic information and menus for a broad range of functionality. Cracked or shattered displays compromise operational performance and increase maintenance costs, so display modules need to be rugged enough to withstand impacts, vibrations, and extreme temperatures.

Boyd provides defense industry leaders with multiple HMI display technologies that enhance performance and reliability. Our Design for Manufacturing (DFM) approach ensures that display components for military vehicles integrate seamlessly with existing and newly engineered HMI systems. We have decades of experience designing and building display stacks, which allows us to select materials that balance performance, durability, and usability while optimizing cost and complexity.



Enhanced Visibility

We utilize anti-fingerprint (AF) and anti-smudge (AS) coating to enhance touch screen visibility and usability. Mitigating reflection and glare is critical for military vehicle displays. By applying anti-reflective (AR) and anti-glare (AG) coating to the front surface of the display (or integrating reflector films into its construction), we boost apparent luminance and contrast to provide more vibrant images across multiple use environments and lighting conditions — including direct sunlight and harsh artificial lighting.

Screen Protection

Long-term display protection films provide an optically transparent barrier that protects screens from scratching and cracking during frequent, repeated use over the module's lifetime. Anti-shatter and other reinforcement solutions combine with tempering processes to increase impact resistance by altering the compression and tension of the glass.

Assembly Backlighting

Conventional display module designs incorporate a strip of light emitting diodes (LEDs) that surround the screen to illuminate the display. Based on visibility requirements, we install brighter or dimmer LEDs along this light rail. Integrated dual-mode light rails can also alternate LED types based on user needs. By combining assembly backlighting with brightness enhancement films — and recycling light generated by the backlighting toward the viewer — our display solutions improve viewing angles and improve screen visibility and vivacity.

Graphic Overlays and Labels

Graphic overlays form a critical interface layer in HMI systems. They serve the dual function of creating a user-friendly interface and isolating electronic components that could create interference. Custom manufactured overlays can fit into any space to convey important military vehicle information to operators and passengers.

Boyd offers the widest array of overlay options in the industry, allowing defense manufacturers to choose the best combination of materials for functionality, durability, and cost. We use polyester (PET) and polycarbonate (also known as Lexan) for graphic overlay components. While polycarbonate is easy to print, texture, and die cut, polyester offers superior resistance to chemicals and harsh elements.

LED Deadfronts and Diffusers

Deadfront overlays feature a series of symbols and graphics that communicate important information to users when lit by an LED backlight assembly. Commonly used for instrumentation panels, they call attention to indicators or warnings during vehicle operation. Deadfront labels frequently incorporate diffusers to eliminate LED hotspots and maintain consistent backlighting. Boyd's state-of-the-art color and light lab works with defense industry leaders to identify the perfect combination of materials and coloring for military vehicle HMI applications.

Screen Display Overlays

Adding a decorative cover lens to a display highlights areas of the screen to provide important device information. Screen display overlays commonly incorporate colored graphics, text, and symbols. Printing markings directly onto the rear surface of the screen ensures they won't wear away with repeated use.

Keypad and Button Overlays

Printed text on elastomeric buttons often wears away quickly from repeated usage, forcing military personnel to replace otherwise functional buttons. By shifting button labeling to precision cut graphic overlays, defense manufacturers can minimize waste and save costs by ensuring that buttons only need to be replaced when they break or deteriorate.

Precision Injection Molding

Military vehicles utilize custom HMI modules that conform to the characteristics and dimensions of the vehicle's design. Plastic injection molding accommodates engineering requirements without compromising efficiency, performance, or manufacturing budgets. These molding techniques utilize a variety of materials, including commodity plastics, acrylonitrile butadiene styrene (ABS), polycarbonate (PC), and engineered polymers such as Ultem (polyetherimide – PEI), Radel (polyphenylsulfone – PPSU), and Polyetheretherketone (PEEK).

Boyd uses advanced statistical process control (SPC) tools to refine the manufacturing process by minimizing unwanted variations, reduce molding costs, and improve product performance. Our engineers consistently leverage actionable data to enhance production flexibility and strengthen quality controls.

Display Bezels

We incorporate multiple plastics into our manufacturing process to increase display housing and enclosure durability. Both ABS and PPSU plastics provide excellent impact resistance and strength for military ground vehicle HMI applications. We can also add colorants during the injection process to match existing colors or increase contrasts within a design.

Improved Durability

Although conventional plastics and polymers are quite rugged, military applications require extra resilience. Boyd uses a variety of materials additives to enhance the mechanical properties of HMI displays, including glass and carbon for improved rigidity, UV stabilizers or protection against ultraviolet light, fire retardants for lower flammability risks, and Teflon for greater durability.

Over-molding

Many HMI applications call for materials that combine the rigidity of hard plastics with the rubberized qualities of softer plastics. The over-molding process combines the best qualities of both, providing increased protection against moisture, increasing aesthetics without compromising durability, and improving vibration resistance. Over-molding also streamlines the manufacturing process by allowing multiple parts to be formed into a single part.

Seals and Gaskets

Military vehicle HMI systems must maintain operational integrity in hostile environments featuring dirt, dust, and moisture. Sealants, die-cut gaskets, adhesives, and O-rings play a critical role in preventing liquid and particle ingress, minimizing wear and friction between surfaces, and reducing noise, vibration, and harshness (NVH) impacts. Materials must be customized to the exact specifications of HMI applications to prevent leakage paths, reduce excessive surface wear, and minimize contamination from surface grinding.

Boyd combines decades of experience with precision manufacturing methodologies to create reliable and cost-effective seals and gaskets for HMI systems deployed in military vehicles. We use custom selected materials to create seals that conform to less-than-perfect mating surface finishes or to create a pliable, elastic layer between two hard substrates.

Bonding Seals

Our optically clear adhesive (OCA) and liquid optically clear adhesive (LOCA) display bonding and sealing solutions protect display assemblies over the lifetime of the device with “zero gap” tolerances that provide unmatched protection against dust and liquids. We manufacture optical display HMI components in clean room environments starting from Class 100 to 100K. Our highly controlled processes help keep screen assemblies contaminant- and particulate-free over the lifetime of the display.

Integrated Display Gaskets

Dust, moisture, shock, and vibration pose a constant threat to electronic display modules. Integrated display gaskets, composed of bonding systems, vibration management, optically clear adhesives (OCA), window tapes, barrier films, and thermal management, provide ultra-tight tolerance against environmental and contaminant factors to improve the longevity of display devices. Boyd uses rotary die cutting and advanced processes like segmented frame technology to deliver cost-effective, high-performance display gaskets for LED, LCD, and OLED screens.

O-Rings

A common, but critical, component of HMI assemblies, O-rings provide a static seal that prevents leakage and cushions opposing compressed surfaces. O-rings are typically made from elastomers such as rubber or silicone and come in a variety of formats, including square rings, X-rings, U-rings, and V-rings. Boyd’s library of over 600 elastomeric compounds, including silicone, fluorocarbon, nitrile (Buna-N), and ethylene propylene diene monomer (EPDM), offers versatile sealing solutions for HMI systems.

Integrated HMI Controls

Military vehicle control systems must be intuitive and provide appropriate feedback while pivoting users towards correct device usage in high-pressure environments. They also require switches, sensors, and other components that are durable enough to withstand the rigors of the battlefield. Since defense manufacturers design unique HMI systems for their vehicles, they need customized interfaces engineered to precise specifications rather than generic, “off the shelf” components.

Boyd supports the complete interface design cycle for defense industry leaders — from initial prototyping to volume production. Our extensive experience developing innovative switch and interface technology allows us to reduce costs and complexity while delivering elegant, functional HMI solutions.

Elastomer Keypads

Three-dimensional elastomer keypads offer a high-profile, tactile feel with an underlying switch layer that can be customized to support active web or dead web feedback designs. Made from a flexible polymer, our ruggedized keypads are durable, resistant to moisture and chemicals, and can withstand temperatures between -30° C and 80° C. Although elastomer arrives as an off-white color, we can customize its visual appearance with multiple color options, color text, symbols, or iconography. Silicone or polyurethane coating further alters the look and feel of keypads, and laser etching can accommodate LED backlighting. Elastomer keypads are compression molded and completely sealed, making them less expensive and easier to clean than plastic keys and buttons.

Membrane Switches

A membrane switch is a micro-motion, momentary contact, flexible circuit with a printed graphic overlay. The self-contained design provides excellent resistance to moisture, chemicals, and abrasion. We offer extensive customization options for membrane switches including colors, textures, backlighting, and tactile response to meet a variety of design configurations. Our design and manufacturing expertise also includes printed circuit boards (PCBs), which minimize the complexity and cost of military vehicle HMI solutions involving membrane switches.

Capacitive Touch Sensors

Frequently incorporated into touchscreen displays, capacitive touch sensors streamline traditional circuitry by eliminating several design layers and components. A capacitive switch is a thin, non-mechanical sensor applied to curved surfaces and mounted behind glass or decorative plastic. The design lacks any moving components or seams, making it highly durable, easily cleanable, and resistant to moisture and dust. For touchscreen displays, haptics technology provides valuable user feedback. We also design capacitive touch circuits for non-touchscreen interfaces using backlighting techniques, selective overlay printing, clear, conductive inks (usually polymer-based, such as PEDOT ink) that ensure translucency, and alternate stack-up assemblies.

Boyd is the Leader in Defense HMI Solutions

Boyd is a leading innovator in the defense sector with a decades-long track record of developing and combining technologies that exceed the demanding performance requirements of military applications.

We combine our experience with market-leading, customer-first service and proprietary-design engineering modeling tools to quickly iterate designs and accelerate concept to production timelines so defense industry leaders can deploy mission-critical technologies faster.

Our ITAR compliant defense manufacturing facilities adhere to AS9100D quality management systems to provide the highest level of quality throughout the design, prototyping, and mass production process. Boyd validates defense HMI solutions by product- and application-specific qualification to ensure consistency and reliability. Our fully redundant operations can easily accommodate sudden demand surges or critical stop events.

As a 3M Preferred Convertor, Boyd has earned priority access to the world's most advanced materials when designing custom HMI solutions for military vehicles. By working with Boyd, defense industry leaders can ensure their products meet the demanding performance, durability, and usability requirements of military applications.