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HMI: Selecting a user interface based on user requirements

When creating a human-machine interface (HMI) for a given product, the type of HMI you choose should be based on the end user's requirements. Therefore, product developers need to consider some of the following questions when designing a new HMI product:

- Do users need a tactile response?

- Will users be wearing gloves?

- How often does the product need to be cleaned?

- What is the operating environment (outdoor vs. indoor, extreme temperatures, etc.)?

- What colors or lighting does the intended user experience require?

There are three main types of HMIs to choose from: membrane switches with graphic overlays, elastomer keypads and capacitive touch switches. Each offers its own advantages and customization options. To help guide decision-making in the product development process, this whitepaper will explore each type of HMI, their characteristics and why each may be appropriate for various conditions and use cases.

3M adhesives. The top layer is the printed overlay with all the graphics the user will see. The next layer would be a selective adhesive from 3M, which connects to a circuit layer with metal domes. This is connected to the printed circuit, which Boyd prints in-house using conductive inks. Then, another layer of 3M adhesive is added to bond the product to the application. The result is a thin but extremely durable product that is ideal for applications with space limitations or where total product weight is a concern.

TACTILE FEEDBACK OPTIONS

Metal domes can be integrated within membrane switch stackups to provide tactile feedback. Boyd creates tactile responses in a range of actuation forces and switch heights. We can also add fully embossed keys for situations where product designers want users to be able to easily feel and distinguish individual buttons.

DESIGN FLEXIBILITY

Graphic overlays can be screen or digitally printed to display nearly any color or graphics. Combined with a membrane switch, that makes this type of HMI ideal for applications that require complex graphics or unique designs.

EMI/RFI SHIELDING

Boyd incorporates EMI/RFI shielding materials into membrane switch stackups. This may be necessary for some applications to protect signal integrity when sensitive internal components require added protection.

DISPLAY WINDOWS AND BACKLIGHTING

Boyd creates membrane switches with windows for digital displays, as well as integrates backlighting systems using LEDs or other types of illumination. These design options make membrane switches well suited for low-light environments and products that require both digital displays and tactile user controls.

Membrane switches and graphic overlays

Membrane switches are typically screenprinted on thin polyester using silver or carbon conductive ink. They are often combined with printed graphic overlays to create aesthetically pleasing HMIs. Membrane switches offer easy cleanability and are typically resistant to moisture, chemicals and abrasion. With custom colors, textures, backlighting and tactile response options, membrane switches offer a wide range of design configurations. Their versatility and low cost are the main reasons why membrane switches are used across nearly every industry, for applications like medical devices, control panels in aerospace and industrial equipment, consumer electronics and more.

THIN CONSTRUCTION

The stackup for a membrane switch product features multiple layers all bonded together with

Elastomers

[Elastomer keypads](#) are also known as silicone keypads. The distinctive feature of this type of HMI product is that they are very flexible and an ideal choice when you need a switch with high-tactile feel and customizable feedback. Boyd creates compression molded elastomers with a variety of durometers and colors. Because they are generally made from silicone materials, elastomers are soft to the touch, durable, and ideal for rugged applications where OEMs need a physically responsive user experience. Elastomers provide excellent weatherability in ruggedized environments. Elastomer keypads are resistant to moisture and chemicals, and can endure temperatures ranging between -40° C to +85° C. The tooling is also generally very inexpensive, creating a cost-effective solution for a range of applications. Elastomers are used in aerospace applications, defense vehicles, medical devices and equipment, and eMobility applications.
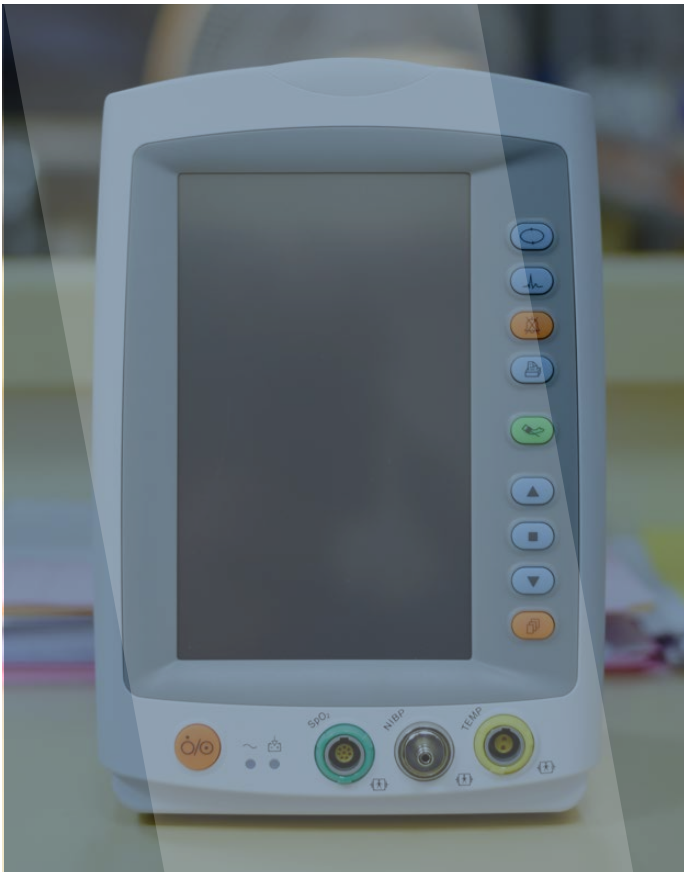
LIGHTWEIGHT

Typically made from silicone materials, elastomers are lightweight and can be a valuable addition when overall product weight is a concern. For example, if a piece of industrial equipment requires a durable HMI and to keep weight at a minimum to help control transportation costs, elastomers are a good choice.

SEALED SURFACE

Molded elastomer keypad products come as a single piece with a sealed surface that prevents ingress from dust, dirt, debris or other contaminants. This is why product developers often choose elastomers for outdoor environments or applications where ingress protection and ease of cleaning are important.

SIMULATES FULL TRAVEL OF TACTILE KEYPAD

Boyd designs tactile feedback — or snap action feedback — in our compression-molded elastomer products. These solutions don't need metal domes like graphic overlay membrane switches. Instead, they feature a web design, and users press and release the molded buttons and they pop back up. Compression-molded elastomer keypads have that snap action to travel up and down, and this functionality is molded into the elastomer itself. This is also known as an active elastomer, or active web elastomer keypad.

VARYING ACTUATION PRESSURES

Elastomers are customized to require different amounts of force to actuate buttons. For example, in a military program where product designers wanted users to experience true positive engagement when pushing a button, Boyd integrated 480-gram metal domes that are fairly stiff. For a medical device program to be used in a doctor's office, 280-gram metal domes can be used that are much softer and easier to push.

Elastomers can be customized to provide optimal user experiences across a range of applications.

OPTIMAL LIGHT DIFFUSION AND BACKLIGHTING OPTIONS

Raw silicone has a milky white color that makes it ideal for backlighting and dispersion of light. With simple backlighting, the raw silicone color is easily illuminated for a soft white light. Boyd also provides a wide range of other backlighting solutions for full-color experiences.

For example, once we mold a product, we can print colors on the raw silicone and then cover everything with a top color, which is often black. We then go back with a laser and ablade into that top black color layer, exposing the first color layer to create icons or other graphics. This process allows OEMS to achieve a crisp legend with a variety of illumination options for varied user experiences.

ARRAY OF COLOR OPTIONS

While raw silicone is milky in color, elastomers can be produced in any color. Boyd has the capabilities to color match and create elastomer keypads in multiple colors to identify important controls and enhance the user experience. Color variety and durability is why elastomers are sometimes used for industrial equipment controls and other manufacturing applications.

ONE-PIECE CONSTRUCTION THAT SIMPLIFIES ASSEMBLY AND TOOLING

Because an elastomer keypad is a single, one-piece construction, it helps speed up downstream assembly processes and saves on further tooling. This provides operational benefits for any application, but is especially useful for high-volume projects with tight deadlines.

Capacitive touch switches

Capacitive touch HMIs can be similar to touch screens and are being used more and more commonly across industries. The process to create a capacitive touch switch involves printing a graphic overlay and then attaching that with a 3M adhesive layer to a capacitive touch circuit. The result is a very thin stackup construction of capacitive sensors that offers numerous benefits including excellent durability, sleek, modern design options, easy cleanability and more. Capacitive touch HMIs are used in consumer electronics, medical devices, and many other industries.

LONG SWITCH LIFE

Because there are no moving parts in a capacitive touch HMI, the switch life is essentially infinite. By eliminating metal domes, springs or other parts that need to move to create the tactile response, the mean time between failure (MTBF) of the supporting electronics makes these solutions ideal for products with a long lifespan.

EASY CLEANABILITY

The finished product appears as a single flat surface without cavities that can trap dust, dirt or other contaminants. The materials typically used for the top layer are also chemical resistant. This makes capacitive touch HMIs well suited for applications that require frequent, thorough cleaning, such as medical devices.

NO MOVING OR MECHANICAL PARTS

As mentioned above, capacitive touch solutions have no moving or mechanical parts. This not only prolongs the switch life, but makes these HMIs a good choice for applications where durability is paramount. With no parts to break, users feel confident the product will last, even under challenging conditions that require ruggedization.

BACKLIGHTING CAPABILITY

Boyd backlights through capacitive switches by using reverse printing and clear polymer conductive inks. This process allows light to travel through the capacitive touch switch and backlight icons on the top surface. Boyd creates dead front (viewable only when backlit) looks for additional design options. These backlighting capabilities can be useful for low-light environments or when a dead-front experience is desired.

THINNER MATERIAL STACKUP

As mentioned above, capacitive touch HMIs can be incredibly thin and are ideal for applications where space is at a premium or product designers are looking to create a sleek, modern user experience.

Working with HMI experts

Ultimately, deciding what type of HMI to use depends on what an OEM is trying to achieve, what the user wants to touch and feel, and the intended reaction they want to get out of the interface. But the best way to achieve that optimal user experience is to work with experts who can work through project requirements to identify and develop custom solutions for complex challenges.

Industry innovators work with Boyd time and again for their HMI solutions because we are experts with the experience and capabilities to enhance a wide range of HMI applications.

We offer comprehensive converting capabilities and manufacturing expertise to create robust HMI solutions that meet strict requirements with tight tolerances. Boyd is also a 3M Preferred Converter, which gives us priority access to 3M adhesives and other display materials. Our engineers and production specialists have unparalleled materials expertise which allows them to help clients develop new, effective solutions with the latest material innovation.

What really sets Boyd apart in the world of HMI development is our integration capabilities and value-added subassembly services. For example, we integrate different switch technologies, different input devices, backlighting elements, metal domes, molded plastic enclosure bezels, EMI shields, protective lens coatings and more, all in a single product. The result is a tested plug-and-play subassembly for our clients.

By working with Boyd to concept, develop and produce HMI solutions, industry leaders spanning a wide variety of applications can create the optimal user experience while improving manufacturing speed and efficiency.

Ready to start your next project?

Contact Boyd today to see how our converting capabilities and materials science expertise will help you develop outstanding HMI solutions

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3M Preferred Converter *Preferred*

Boyd is the trusted global innovator of sustainable solutions that make our customers' products better, safer, faster and more reliable. Our innovative engineered materials and thermal solutions advance our customers' technology to maximize performance in 5G infrastructure and the world's most advanced data centers; enhance reliability and extend range for electric and autonomous vehicles; advance the accuracy of cutting-edge personal healthcare and diagnostic systems; enable performance-critical aircraft and defense technologies; and accelerate innovation in next-generation electronics and human-machine interface. Core to Boyd's global manufacturing is a deep commitment to protect the environment with sustainable, scalable, lean, strategically located regional operations that reduce waste and minimize carbon footprint. We empower our employees, develop their potential and inspire them to do the right things with integrity and accountability to champion our customers' success.