



Technical Article

# Human Machine Interface Design *for Public Transportation*

As transportation systems grow more complex, issues of end-product equipment safety, ease of operation, and reducing the risk of human error are becoming extremely important. Designers today know that the operational performance, efficiency, and safety of public transport systems – from buses and coaches to light rail and commuter rail – are closely related to the interaction between humans and machines, the Human Machine Interface (HMI).

The selection and seamless integration of HMI components, such as switch controls and indicators, is critical to the success of equipment designed for human operation. Doing it right provides the “human touch” so desirable in modern passenger and operator interface controls. Design engineers who develop HMI solutions with this in mind will deliver applications with additional transportation market advantage and greater sales potential that exceed customer expectation.

#### **Secrets of HMI success**

The development of a successful HMI solution relies to some extent on a balancing act. Front-end consideration must be given to the engineering and financial constraints placed on a project while the cost rewards to be gained from the investment also must be assessed

Employing high-quality design, best practices, and proven techniques results in reliable HMI Systems. For example, utilizing a philosophy of control panel modularity with intermediate connector termination that reduces end-product assembly costs and extends service life is a good strategy.

Designing and integrating HMI control systems is a task often undertaken by specialized suppliers like EAO to complement the core capabilities of end-product manufacturers. Some manufacturers use an HMI supplier as an extension of their design team, a knowledgeable partner that provides added design capacity and quick turnaround. For example, EAO is working with many transit-related manufacturers and transit authorities to achieve these goals with expert solutions.

# Designing and integrating HMI control systems is a task undertaken by specialized suppliers like EAO. *Manufacturers use an HMI supplier as an extension of their design team, a knowledgeable partner that provides added design capacity and quick turnaround.*

*“An HMI System might include communication and navigation functions, external and internal cockpits, engine room controls, power distribution, lighting and alarm systems, passenger access and egress, as well as peripheral systems like winches.”*

*“Stringent regulations within the public transportation industry require HMI components that meet the highest standards of safety, durability, and functionality.”*



The placement of components, screens, switch configuration, protection guards and other ergonomic factors improve usability and safety.

## **Know industry standards**

The starting point for HMI solutions is a thorough knowledge of technical ergonomic design and manufacturing standards. These include federal human engineering standards such as those set by the Americans With Disabilities Act (ADA), the Department of Transportation Federal Railroad Administration, and HMI guidelines from industry organizations such as ANSI (American National Standards Institute), IEEE, ISO, and others. It is also helpful to be familiar with the Buy America Act, an important advantage for U.S. companies working with non-U.S. manufacturers. Depending on the specific transportation application, observing appropriate standards assures that a new build or retrofit will meet industry criteria. This includes placement of components, legend size and colour, emergency stop switch configuration, protection guards, and other ergonomic factors that improve usability, efficiency, and safety.

## **Standard components**

Stringent regulations within the public transportation industry require HMI components that meet the highest standards of safety, durability, and functionality.

Generally, components must:

- Comply with industry standards for shock, vibration, fire, smoke, and toxicity emissions.
- Provide highly visible illumination with dimming control and long life LED sources that can handle a wide operation voltage tolerance.
- Have large touch surfaces suited for text, symbols, and Braille.
- Meet the needs of disabled users as identified by the ADA.

- Be attractive and functional while vandal resistant, with a positive tactile feedback tailored to specific transportation needs.

Component selection should always be based on cost effectiveness, quality, and reliability according to the requirements of the application, which generally fall into four areas:

- Operator control panels.
- Passenger access – including disabled door access.
- Emergency alert and call systems.
- Interiors functions – including stop request alerts and bathroom controls.

## **Retrofits, and half-life projects**

HMI “plug-and-play” products, used primarily in retrofits, provide functional versatility and time savings in these applications. A range of HMI switch controls, rotary and linear actuators and indicators is available in modular designs that fulfil most requirements. Products can be flush mounted, providing protection against accidental operation, or raised for viewing from all sides.

Additional lens protection can be achieved with extended or sealed rings and lens caps. Lenses are available in a variety of colours together with film inserts for legends or symbols, and can be illuminated with high-intensity LEDs or incandescent lamps. A wide operating voltage tolerance of +25% to -30% insures reliable

**HMI suppliers cannot work in isolation.** *An important consideration in the selection of an HMI supplier is the strength of the relationships that it has with its own suppliers: plastics vendors, toolmakers, electronics engineers, industrial designers, and ergonomics experts.*

*“EAO’s Series 56 and 57 pushbuttons, commonly found as passenger access pushbuttons on light rail, buses, and commuter rail vehicles, meet the latest ADA and Rail Vehicle Accessibility regulations.”*

*“HMI specialists like EAO encourage the consideration of several key areas: ergonomics, health and safety, performance, and the presentation of information.”*



**Attention to detail: the Series 57 Emergency-call button features protective bezel to prevent accidental operation.**

performance.

The latest laser engraving technology makes it possible to incorporate intricate designs, such as symbols and fonts, into products. One of the main advantages of laser engraving over traditional moulding and mechanical engraving methods is the precision and positional control afforded by the laser beam. Characters and images are crisp and sharp, even when reproduced in the smallest sizes, and they are resistant to wear – a significant benefit in applications subject to harsh environments that require service life on the order of 15 to 30 years.

**Working with an HMI supplier**

In today’s difficult environment, improving human performance through ergonomic design enhances safety and operational efficiency. The future development of HMI components and systems therefore necessitates an end-application, solutions-oriented approach. HMI suppliers need to work in full partnership with transportation clients to deliver consultation and an application engineering approach to production.

At the consultation stage, the HMI supplier should be tasked to include full concept, design, and feasibility studies in any proposal. During application engineering, using the latest technologies – such as 360° detailed CAD drawings – the HMI team will help the product manufacturer verify concepts and create prototypes.

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tion in the selection of an HMI supplier is the strength of the relationships that it has with its own suppliers, including plastics vendors, toolmakers, electrical and electronics engineers, industrial designers, and ergonomics experts. All designs must be tested for quality and certification according to applicable standards.

Upon completion of a project, it is important that the HMI supplier fully records details of the project to ensure easy upgrading and remodelling of components for future projects. It is highly desirable to utilize a standard framework, each with a unique configuration for a given program.

**Application consideration**

Today, HMI-based products are used in a broad range of industries in addition to transportation, including machinery, instrumentation, process control, and telecommunications as well as in audio, video, broadcast, and multimedia applications. HMI Systems are particularly important in high-stress and safety-critical operations, such as transportation.

For human engineering purposes, HMI specialists like EAO encourage the consideration of several key areas: ergonomics, health and safety, performance, and the presentation of information. That said, it is essential to look beyond purely ergonomic

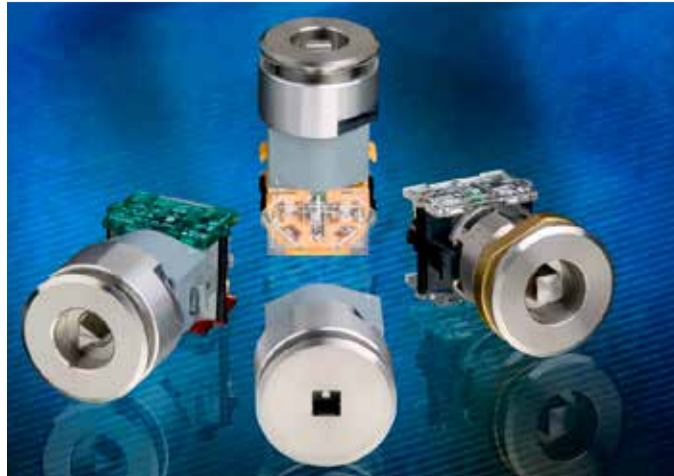


## Time is of the essence for retrofit projects.

*Replacing rocker switches with modern flush-mounted push-buttons in the operator control console is a quick HMI solution with significant advantages.*

*“Crew-key switches protect against unauthorized access. Each switch actuator is comprised of a unique rotor shape identified by the transit authority.”*

*“Vehicles are exposed to extreme weather conditions, vibration, high volume of passengers, and vandalism, so HMI solutions must fulfil the ergonomic and aesthetic requirements of the end-users as well as the technical and cost requirements of vehicle manufacturers.”*



**EAO's crew access keylocks. The selection and seamless integration of HMI components is critical to the success of an HMI System.**

requirements of an application and consider any environmental demands that are likely to be placed upon the end product.

To address the ergonomic risks associated with environmentally harsh applications it is wise to consider stainless steel and durable polymer-based products that operate reliably under demanding conditions. Where required, control products fabricated from these materials offer protection up to IP 67 as well as resistance to heat, shock, vibration, and vandalism. They are designed for minimal maintenance and deliver long-term value in terms of lifecycle cost benefit – a must for most transportation applications. For example, EAO's Series 56 pushbuttons, commonly found as passenger access pushbuttons on light rail, buses, and commuter rail vehicles, meet the latest ADA and Rail Vehicle Accessibility regulations. Featuring a bright front bezel, LED “halo” illumination, and a large touch surface that can be supplied with Braille text for the partially sighted, the pushbutton immediately focuses user attention on the control. Materials utilized in this series are also resistant to the harshest graffiti cleaners available today. The Series 56 is reliable and proven, with an installed base more than 1 million units.

In terms of safety and security, crew key switches protect against unauthorized access and act as additional safety controls. Each switch actuator is comprised of a unique rotor shape identified by the transit authority. Such special purpose keylock switches are ideal for harsh commuter and light rail environments and can be supplied in flush-mount designs for increased protection against

vandalism. Passenger access is a major requirement as well – switches for doors and in toilet areas must be reliable, visible, and easily operated. Wheelchair access requires that pushbuttons are fitted at certain heights and operable by palm.

### **Modern appearance**

Time is of the essence for retrofit projects. Replacing rocker switches with modern flush-mounted push-buttons in the operator control console is a quick HMI solution with significant advantages. Pushbuttons are less susceptible to accidental actuation, improving operational safety. Their large, illuminated lens area has room for more legible markings and clearer indication of status to reduce operator error. In the passenger compartment, new LED information displays add safety and value to many retrofits.

### **Integrating HMI Components**

Once specifications have been approved by both the HMI supplier and the client, they will form the basis for the production and supply of the right solution. Detailed drawings, parts lists, circuit diagrams, and assembly instructions then are completed and production schedules agreed upon before manufacturing commences. Companies that employ modern design-to-manufacturing methods, such as CAD/CAM and concurrent engineering, can shorten product development cycles and cut production time to market.

Harmonious HMI design makes life easier. *The role of the HMI supplier is to develop products and solutions that align equipment and task, to assure that the end user and the technology work in complete symmetry.*

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The role of the HMI supplier is to align equipment and tasks for functionality and ease of use.

The key drivers for the public transportation sector are reliability, longevity, safety, compliance with fire regulations, and adherence to standards. Because these vehicles are constantly exposed to extreme weather conditions, vibration, high volume of passengers, and vandalism, HMI solutions must fulfil the ergonomic and aesthetic requirements of the end users as well as the technical and economic value requirements of vehicle manufacturers.

The role of the HMI supplier is to develop products and solutions that align equipment and task, to assure that the end user and the technology work in complete symmetry. For the user the benefit is clearly defined functionality and comfort of use, a critical key to reducing the likelihood of errors in operation and the dangers associated with poorly designed controls. Overall it is the quality and the reliability of people, products, and processes that combine to deliver the “human touch” that satisfies the demands of modern transportation ergonomics.