Technical Article

Keeping people in mind –
For a safe, reliable and ergonomic HMI design.

Human Machine Interfaces (HMI) encompass all the elements a person will use to interact with a machine. The task of the HMI expert is to build innovative, intuitive and reliable interfaces. HMIs play a vital role in machinery design and industrial automation, enabling the efficient operation and monitoring of essential processes.

This article provides an expert viewpoint of those important tactile, electromechanical controls which remain essential for safe, reliable, ergonomic HMI design.

Progress in the industrial machinery sector is synonymous with increasing automation. Here, precision, speed, performance, miniaturisation and networking are the key ingredients to success. However, industrial machinery of every kind is becoming ever more complex, and this leads to greater safety demands in its operation.

The European Agency for Safety and Health at Work makes this clear in their report into the machinery sector: The high proportion of employees working with machines or computers means that proper design of the HMI is essential. Poor design of HMI can give rise to occupational diseases, such as stress or musculoskeletal disorders, as well as to occupational accidents. The potential cost to an employer due to reduced productivity, damaged reputation, or users' dissatisfaction is clear. It goes on to say that given that poor HMI can have serious consequences, its proper design in equipment and the workplace is of utmost importance.

To meet increasing demands, it's been essential to develop specially engineered HMI Components and HMI Systems that will ensure 'safe operation even under the most adverse of conditions' – an EAO philosophy. Because when it comes to keeping people safe, there can be no compromises. EAO has long-standing experience in developing and manufacturing HMI Components and HMI Systems for both basic and complex industrial machinery, thereby ensuring safe and error-free operation.

Human Machine Interfaces play a vital role in machinery design.

CNC controls: EAO developed a tactile, intuitive control surface which could not be achieved through a membrane overlay.

Handheld control unit: The Series 84 E-Stop is ideal as it provides a compact behind-panel depth.

Control panel of a CNC control unit.

HMI components for reliable machine controls.

Machinery HMI design: Precise, efficient and safe

Human Machine Interfaces play a vital role in machinery design and industrial automation, enabling the efficient operation and monitoring of essential processes. While traditionally slower to experiment with new HMI technologies, innovations within SCADA (Supervisory Control and Data Acquisition) systems are pushing industrial companies to generally improve the quality of the interfaces to reflect modern styles. Screen-based master controllers have enhanced capabilities to visualise and display production processes, typically in combination with a tactile control panel for primary system start-up, safety and security functions. Despite this migration of features to screens and visualisation software, illuminated switches such as pushbuttons, indicators, selectors, toggle switches, etc, remain essential for important, primary functions.

EAO is one of the world's leading developers and manufacturers of user-specific HMI Components and Systems for the mechanical engineering industry. We are dedicated to providing safety, high performance, and precision to help drive progress in the industrial sector.

Food and Beverage Manufacturing

Machine and process controls in these food and beverage industry not only have to work efficiently and safely around the clock, but are also frequently subjected to the influences of moisture, dust and cleaning fluids. Considering the great variety of operating requirements, it is therefore extremely important to make the interaction between the operator and the machine safe, intuitive, reliable and repeatable.

Taking into account the long service life, it's essential to develop reliable, high-quality operating concepts for machines in accordance with IP, NEMA, IEC, ADA, ANSI and OSHA.

Semi and Electronics Production

Applications in semiconductor and electronics production require many operator control terminals. These often consist of industrial PCs with touchscreen displays interfaced to production machines, plus a number of discrete electromechanical components. Emergency-stops, for example, are considered to be a discrete function in this market. The system design needs to be made in accordance with the SEMI S2 guidelines.

When developing and designing HMI Systems for semiconductor production systems, intuitive operation, interactivity and full functionality are vital factors. It's critical to design to industry-specific requirements such as clean-room regulations and precision control with flexible, high-quality components.

Advanced HMI Components for demanding Machinery.

Today's advanced HMI Components are precisely crafted devices.

EAO Series 82 leads the industry for combined impact resistance and IP protection.

Precision equipment EAO Series 71.

Series 82 pushbuttons robust and attractive.

EAO has a thorough knowledge of the special requirements in the manufacturing of semiconductors and electronic devices, plus a complete understanding of the functional and regulatory requirements.

Packaging Equipment

Packaging systems, especially those in food and beverage industries, operate in a clean production environment geared towards high work volumes. HMI Systems must comprehensively protect against the ingress of fluids or solids that are found in packaging factories, while still making it easy and safe for users to perform their tasks. Control systems must allow operators to quickly and easily set-up and adjust new production processes.

The goal is to make this essential process easier, faster, and more accurate. To be successful, a HMI manufacturer needs expertise in machine integration and functioning logic, project management, appropriate documentation for line qualification, and testing of centralised advisory services, such as SCADA.

CNC Milling and Machine tools

The ability to quickly visualise and control every aspect of the production environment is critical within both simple and complex machine tools operations such as CNC milling, lathing, forging, stamping and boring equipment. Operator controls must be designed and arranged for maximum user-friendliness to ensure error-free switching between the various production steps.

Advanced HMI Components for demanding Machinery

HMI Component technology has undergone major changes over the years to serve the increasingly specialised needs of machinery. Designers today face a truly astonishing range of choices in electromechanical components that encompass not only the type of device, electrical specifications, environmental sealing, and mounting and termination styles, but also ergonomic considerations such as appearance, configuration, size, illumination and tactile feel.

Today's advanced HMI Components are precisely crafted devices, made to exacting design specifications and very close tolerances from high-grade plastics, metals, and carefully calibrated springs. To achieve reliable, long service lives, they are engineered like fine watches with the performance, feel, and look required in modern HMI Systems.

Bright halo illumination from EAO's Series 84 pushbuttons.

Pushbutton with illumination from Series 84.

Ergonomics play a key role in modern switch design, assuring the right switch for each application – whether it is a flush-mount design to avoid inadvertent actuation, or an emergency-stop switch with an oversized actuator for fast palm-slap shutdown and safe twist or key release to enable re-power of a circuit.

Switch specification

Switches come in a wide variety of shapes, sizes, ratings, and functions. They are built for long life to minimise the need for replacement. High-quality switches are expected to have a mechanical life of 1 million to 10 million operations.

Many switches today are modular, comprised of quickly assembled components including actuators, switching elements, illumination blocks, lenses, marking plates, and mounting systems. This flexible, configurable approach allows for many variations of switches within a singular product series to be used within one application for various required functions.

Industrial water and oil tight switches are designed for front and back-of-panel environmental protection against intrusion of dust, dirt, water, solvents, and other foreign materials and certified to meet various levels of ingress protection as specified by NEMA and the international IP Code.

Designers can simplify their search for the perfect switch by carefully analysing their application requirements first, then, based on their needs, determine the following:

- Electrical ratings – determine the right specifications for the job
- Actuation preferences – choose the most appropriate switch type
- Physical configuration and mounting needs – decide on overall size, style and placement
- Special requirements – select type of illumination, marking, and environmental sealing options

Standard. Diversity. Individuality

EAO develops and manufactures one of the world's largest ranges of industrial HMI products. With decades of experience as a global provider, we have the knowledge and products to satisfy all of our customers' application needs and quality expectations.

Classic HMI Components include pushbuttons, illuminated pushbuttons, indicators, emergency-stop switches, keylock switches, buzzers, joysticks and rotary lever switches. Numerous additional HMI Components complete our comprehensive range.

EAO buttons and switches benefit machinery applications.

Series 84 illuminated Emergency-stop. Always fool proof they can be easily identified by their red lens with a yellow actuator.

Emergency-stop from Series 84.

Illuminated pushbuttons
EAO is the leading pioneer in the field of illuminated pushbuttons. Its universal switch actuators and indicators have been in use all over the world since 1947. They are to be found everywhere in applications that depend on reliable and positive feedback. Typical areas of use are machinery, public and private transport, heavy-duty and special vehicles, the automotive industry and building installations.

EAO illuminated pushbuttons benefit machinery applications:
- Excellent haptic feedback
- Large selection of switch sizes
- Wide range of colours for lenses and illumination
- Wide variety of symbols and markings, also customer-specific
- Very long service life of mechanical and electrical components
- Large range of switching capacities

Mushroom-head pushbuttons
Mushroom-head pushbuttons are used in harsh environments throughout the world as on/off switches. Their large, distinctive operating elements also enable them to be operated with gloves.

EAO mushroom-head pushbuttons benefit machinery applications:
- Excellent haptic feedback
- Operating elements with different diameters
- Large selection of colours and materials
- Illuminated versions

Emergency-stop switches and stop switches
Emergency-stop switches with forced-opening contacts (compliant with DIN EN ISO 13850 and EN 60204-1) are primarily used to enhance personal safety. Emergency-stop switches are always fool proof, and can be easily identified by their red lens with a yellow actuator.

Stop switches do not have to be fool proof. With their snap-action switching element, they are used predominantly around the world as on/off switches in mobile control units, equipment construction and machinery.

Illuminated selector switches
Illuminated selector switches offer ergonomic design as well as reliable visual feedback and status display. EAO selector switches can be equipped with up to three switching positions and up to six electrical contacts. Non-illuminated versions can be equipped with up to 12 switch positions and up to 16 contacts.

EAO selector switches benefit machinery applications:
- Switch position easily visible
- Variety of combinations of momentary and latching switch positions
- Illuminated selector switch
- Full range of base colours for illumination
- Very long service life of mechanical and electrical components
- Supports all commonly used connection systems

“Meeting the requirements of our customers is our benchmark.”

Series 84 can be programmed to change colour and animate.

Series 14 buzzers: Their compact dimensions are optimised for worldwide use in machinery.

Illuminated pushbutton from Series 84.

Buzzer from Series 14.

Keylock switch from Series 71.

Indicators

Indicators are universally popular for applications that depend on clear messages and status indication.

EAO indicators benefit machinery applications:
- Wide range of colours for lenses and illumination
- Wide variety of symbols and markings, also customer-specific
- Bright, uniform, full-face illumination
- Multi-coloured illumination compatible
- Various lighting effects, including flashing and dimming
- Hidden-till-lit capabilities provide quick visual recognition

Buzzers

Buzzers are audible warning devices. They generate tones of a pre-defined volume and frequency. Their compact dimensions ensure that the units are optimised for worldwide use in machinery, medical equipment, lifting and transport equipment, cockpits, driver cabins and building installations.

EAO buzzers benefit machinery applications:
- Large selection of designs
- High sound pressure
- Very long service life of electrical and audio components
- Models with wide voltage range
- IP65 front protection

Keylock switches

Keylock switches are widely used to prevent erroneous or unauthorised operation. They also enable access control systems to be implemented for user groups.

EAO keylock switches benefit machinery applications:
- Large selection of lock systems
- Two or three possible switch positions
- Variety of combinations of momentary latching switch positions
- Supports all commonly used connection systems

Individual, according to customer requirements

By being modular in assembly, EAO products are easily configurable to meet most of the demanding requirements of many applications. However, when those requirements cannot be addressed, EAO can enhance any of its extensive range of industrial HMI Components to meet customer needs, both quickly and cost-effectively.

EAO – Your solution-focused expert and partner.

Series 14 keylock switches prevent erroneous or unauthorised access to control panels.

Keylock switch from Series14.

Modifications to standard products include:
- Altering the shape and size of buttons and bezels
- Adding tactile surface textures and coatings
- Laser engraving and printing text/symbols on lenses, text plates and film inserts
- Lighting colours and animated effects: flashing, pulsing and chasing countdowns
- Changing voltage ranges and adding protective circuits
- Fitting specialised cabling, wiring harnesses and connectors

Your solution-focused expert and partner

We do much more than just manufacture individual control elements. As a solution-focused partner, we provide the option of electro technically and mechanically customising existing HMI Components in line with our customers' individual requirements. From simple control elements through to sophisticated HMI Systems, from serial production through to logistics – we offer the entire range of HMI services and inspire the confidence of our customers.

EAO's HMI Systems competencies include:
- Industrial design and ergonomics
- Component manufacturing expertise
- Component selection – the 'mixed technology' approach
- Software and interface design
- Production, quality assurance and supply chain

HMI Systems design process

At the onset of a project, "defining the requirements" is the most critical and important step for developing a HMI System. The basic concept is – be mindful that the HMI is the user link to all system functions. Failure to consider this can affect the acceptance and usability of the entire machine.

Industrial design and ergonomics

Industrial design refers to the features of shape, configuration, pattern, and ergonomics for a device that is designed for the machinery sector. A definition for much of the design will come from the operational requirements of the application. It can include the user environment, operating temperature range, presence of moisture, and ambient light requirements.

A design should strive for an intuitive presentation of user tasks, i.e. one that is immediately understandable. An intuitive layout with the use of dimensional shapes and well thought out groups of operations, provide for a predictable, consistent and efficient HMI System.

Component manufacturing expertise

When manufacturing HMI Systems that meet the entire spectrum of market requirements, quality is key. Through EAO's high-quality product range, and to the variety and flexibility of our components, the ideal requirements for an effective HMI System are already in place.

Our knowledge is used for selecting the appropriate control technology.

Any EAO product can be fitted with specialised cabling, wiring harnesses and connectors.

An effective HMI System is built on intuitive, reliable and ergonomic components.

Pushbutton from Series 84 with flat ribbon cable.

HMI System panel.

Component selection – the 'mixed technology' approach

Our expertise in HMI System design and manufacturing focuses on providing the necessary components effectively packaged to meet the customer application requirements. After a complete review of the application and the functional requirements and needs of the operator have been completed, selecting the appropriate control technology puts the knowledge gained in this learning process into practical use.

Using 'mixed technologies' can differentiate function, increase usability, and control production costs. Typically, it incorporates a base set electromechanical components or a more complex integration of keyboard, display, touch screen and industrial PC, depending on the required functional sophistication and level of visualisation. The flexible approach to using technology offers customers a real competitive edge.

Typical interfaces designed by EAO include:

- Main operator panel using discrete switches for system start-up and shut down, including emergency-stop functions
- Handheld control units and tethered pendants with displays and short-travel keypads for data entry
- Touch screens and industrial PCs with serial bus interfaces for linking to core system

Software and interface design

Modern HMI solutions feature fieldbus connections for communicating with complex systems. Software adaptations make it possible to configure and control HMI subsystems. EAO has extensive experience with on-board micro-controllers and real-time operating systems. A variety of conventional and new communication protocols are on offer, including:

- ProfiBus, InterBus, DeviceNet
- CANbus, CANopen, CAN-J1939
- USB, Ethernet and variations
- GUI touch screen integration

The CANbus module specially developed by EAO connects buttons, indicators and other components as part of an integrated HMI solution. EAO will preconfigure the module for plug-and-play connectivity.

Standards are the main requirements during the design of machines.

Standards are of the highest level of concern within design considerations.

EAO Headquarters Olten (Switzerland).

Standards

Standards are of the highest level of concern within design considerations. The criteria specified within these general and industry specific requirements dictate features, functional attributes, and design elements. It is usually mandatory to abide by these conditions in order to be approved for participation within the identified market segment. Although it is understood that standards benefit end users by promoting an increase in accuracy, performance, and safety, they sometimes can be a web of details for design engineers involved within the creative process. Without sufficient knowledge of industry standards – design, production, and delivery timelines can be drastically affected.

Standards for Human Factors design within the machinery market includes:

- Ergonomics, design, and materials standards
- Market and application specific: SEMI S2-93/12.4c
- IEC 60947-5-1/5, ISO 13850
- ANSI
- ASTM
- Safety agencies: UL, cUL, CE, VDE

EAO since 1947

EAO AG, a Swiss, family-owned company founded in 1947, has developed into one of the world's leading manufacturers of high-quality switches, keyboards, sophisticated control elements, and complete HMI control units and HMI Systems.

With over 600 dedicated employees, EAO has a global production and distribution network at its disposal. And with production sites in Switzerland, Germany, North America and China, as well as our 11 country sales companies and distributors in over 50 countries, we can guarantee global availability – around the world, around the clock.

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