WHITE PAPER

A New Path to Operations Visualization

Why touch technology won't eliminate physical controls

ADVANTECH

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Preface

For nearly all enterprises, the rise of Industry 4.0 and IIoT has transformed automation, leading to a global intelligent manufacturing revolution that shifts the paradigm from "automation" to "intelligent automation."

Industrial human machine interfaces (HMI) that can handle bulk data exchanges are essential for field data visualization. Thus, in order to better visualize the equipment status and production workflow, HMIs must evolve to become more intelligent.

With the advantages of a growing computer and electronics industry and the continually declining cost of developing new technologies, HMI design is entering a new stage. Each upgrade enables users to better operate machines and control applications using ever-more simple and accurate methods, thereby improving productivity.

Despite the recent advancements of industrial HMIs, including expanded displays, accelerated communication speeds, and other powerful features, their designs and interactivity can still be improved to better satisfy consumer demands. So what types of HMI designs and functionalities do consumers require/are likely to become mainstream? And what are the reasons they will become mainstream? These issues will be discussed in this article to provide a projection of future market trends.

The History of Industrial HMIs

HMIs, as an interface that allows users to interact with the system and exchange information, are widely used in today's society. In fact, HMIs have become indispensable to the development of many industries, such as the automobile, entertainment, electronics, medical equipment, banking, and service industries, which have long been major markets for HMIs.

HMIs typically comprise hardware integrated with software. Just like other HMI applications, industrial applications of HMIs have matured. Their primary functions are real-time information exchanges between humans and production equipment via programmable logic controllers (PLCs), variable-frequency drives (VFDs), and meters, displaying data and providing visual feedback, and executing operating commands via an input unit (such as a touchscreen, keyboard, or mouse).

Following the infiltration of IIoT into factory floors, HMI technology has become essential to the fulfillment of intelligent production and the integration of system functions. To better display machine performance parameters and production workflow, over the past three decades computer technology has continually evolved to match ever-changing production requirements. This has also driven improvements in HMI designs to maintain pace with the development of intelligent manufacturing.

1946
Operational interfaces comprising indicators and mechanical switches

1980s
Character user interfaces (CUIs) comprising terminals and keyboards

1990s
Graphical user interfaces (GUIs) such as PCs and workstations comprising multiple input devices and a dot-matrix display

Now
New development trends that include augmented reality (AR) and virtual reality (VR) technologies

As early as three or four decades ago, when PC-based HMIs had not yet emerged, screen-based interfaces played a minor role in automation. At that time, most HMI products were controlled using physical features such as buttons, knobs, and indicators and connected via serial ports or proprietary protocols. However, their control capabilities were rather limited, often only allowing users to start or stop machine operations or implement certain settings or adjustments.

With the introduction of the Microsoft Windows operating system, HMIs started to go through drastic changes in visual functions: industrial technology experts combined graphics with data acquisition features and created a new breed of automation software to be implemented on the Windows platform.

Accordingly, more advanced PC-based HMI terminals started to pervade factories.

Compared to earlier solutions, PC-based HMIs deliver greater value as they support additional functions such as data processing and programming at production lines, which optimizes the flexibility of the machines.

However, with the ever-increasing machine functions and rapid development of IoT technology, HMIs must be upgraded and enhanced.

Particularly for cloud servers collecting big data, how can HMIs be improved to realize more effective data feedback? This is a crucial issue that contemporary users hope to solve. In addition, the increasing prevalence of consumer electronics in recent years has sparked a demand for more intuitive machine communication interfaces. Moreover, users also desire more powerful features that allow easy and convenient access to diverse data.

In response to trends in the consumer electronics market, most of the industrial sector has begun equipping traditional control equipment with touchscreen technology to better integrate HMIs into the control workflow. And the realization of intelligence continues to evolve. In a number of high-end industrial sectors, cutting-edge AR and VR technologies have been integrated into the manufacturing process to enable remote monitoring and machine control through virtual operations.

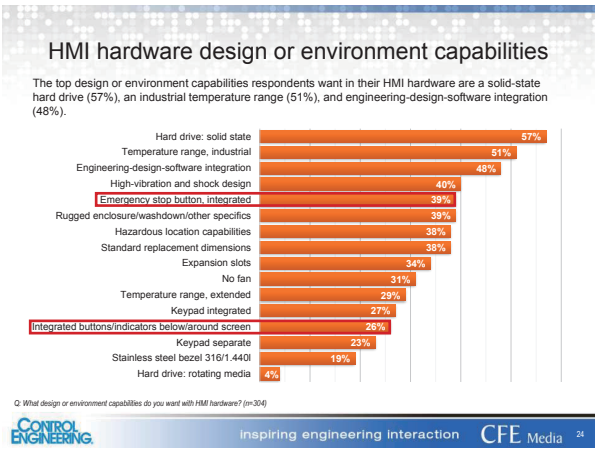
Although emerging technologies like AR and VR have endless potential for industrial applications, to optimize and streamline the processing workflow, most factories still prefer using HMIs with physical control units for human-machine interaction.

HMI Development

- Manual operations: Conducted by emerging computers
- Command processing: Adopted by the DOS operating system
- Graphical user interface: Enabled by the Windows operating system
- Multimedia human-machine dialogue mode

The Evolution of Buttons on HMIs

Considering recent development trends, it's clear that traditional HMIs that feature physical buttons are being gradually replaced with touchscreen HMIs. But even in 2019, we can still see buttons on machines and equipment everywhere in factories. That is to say, the transition from traditional HMIs to touchscreen HMIs does not make physical buttons obsolete. In the arena of industrial manufacturing, physical buttons remain desirable.



Source:The survey on consumer demand for HMI hardware design or functionality

In 2018, Control Engineering, a trade publication and website that covers automation technologies, conducted a study of end-user demands for industrial control HMIs[1]. The results revealed that most users want HMIs that have physical buttons as well as touchscreen technology. As high as 39% of surveyed users wanted to retain emergency-stop buttons on machines, while 26% wanted buttons built into the HMI panel bezel—either directly below the screen or in the surrounding area. Obviously, although intelligent digitalization has driven industrial development for many years now, people are still strongly attached to having physical means of interaction.

To satisfy user demands, three main types of industrial HMIs are typically produced: touchscreen-only HMIs, touchscreen HMIs with a few pushbuttons, and touchscreen HMIs equipped with multiple pushbuttons or a physical keyboard. In regards to which type is most commonly deployed, the following paragraphs will provide real-world stories that provide insight.

Touch Technology Overtakes Physical Buttons

Undoubtedly, implementing touchscreen technology into HMI designs will provide increased convenience. Compared to a traditional keyboard and mouse, touchscreen HMIs offer greater operation flexibility and more intuitive data visualization, eliminating many workplace difficulties. However, is incorporating all HMI functions into a touchscreen-only design the best solution for users?

Obviously, unlike button-based HMIs, touchscreen HMIs do not provide tactile feedback. Without tactile feedback, users lack keypress confirmation of touch commands, which is particularly important for those with visual impairments.

In response to enduring demand for tactile feedback, most modern electronic products still feature a variety of buttons—even though some may be purely decorative. According an article published in The Wall Street Journal in 2003[2], 90% of office HVAC (heating, ventilation, and air conditioning) thermostats are dummies. Some companies have even gone so far as to install white-noise generators to mimic the hum of air conditioners, which actually successfully reduced employee complaints. This demonstrates that people rely on the physical sensation of administering a control action. Pushbuttons are considered the ideal for providing tactile feedback because it gives a physical confirmation of the key press.

That is why the iPhone, after years of development, still retains a physical Home button. The advantage of the Home button is not merely allowing users to return to the home screen. As the only physical button, the Home button allows users—once familiar with its location—to navigate the phone without needing to look down at the screen. The physical button allows for instinctive navigation, giving users a sense of functional familiarity and safety.

This “sense of safety” in the form of tactile feedback is an advantage that virtual buttons cannot provide. Virtual buttons do not have a fixed position and may be deployed too close to other onscreen menus, making input errors commonplace. Thus, if physical buttons are replaced with virtual buttons on industrial production lines, the error incidence rate will definitely increase. As of today, this issue can only be remedied with the use of physical buttons.

In the consumer electronics market, physical buttons are provided for user convenience and familiarity. But for industrial applications, there exists continuing demand for products such as pumps or gate switches that provide tactile feedback. Because these single-purpose devices are often aimed at data acquisition or equipment control, the ability to display data is not necessary despite the tendency to use physical HMIs. Such devices are employed to not only reduce costs but also shorten the action confirmation time and improve reliability. Thus, physical buttons are still required for industrial HMI designs.

Physical buttons are also helpful for eliminating the following issues encountered when using touchscreen HMIs: difficulty distinguishing graphical onscreen changes under sunlight, shifting and unclear targets, and the need to look at the screen when performing important tasks. The existence of physical buttons allows users to quickly and accurately complete tasks.

Therefore, even today, although touch technology dominates the global market, physical buttons still offer usage advantages that cannot be ignored. In terms of the future, we believe that human-machine interaction supported by tactile feedback will not be sacrificed with the emergence of new technologies.

Physical Buttons Move Toward Integration

Although HMIs that offer tactile feedback have penetrated the market, in this era of big data and the IoT, the use of touchscreen technology for industrial HMIs continues to grow. Looking at the consumer electronics industry, which is often a pioneer of market developments, we can see that although most HMIs still feature physical buttons, the number of physical buttons is declining. Indeed, many of the buttons have been integrated with touchscreen functions. Moreover, most electronic products are controlled using the touchscreen as the interface.

There are reasons driving this trend for integration. Successful HMI designers consider both the user experience and product features to attract consumers. That is why touchscreen HMIs with a reduced number of physical buttons are widely popular. Such integrative designs not only reduce the product's weight, for a more fashionable aesthetic, but also increase the usage flexibility. The touchscreen HMI enables users to navigate the device using a single screen instead of numerous pre-configured buttons that take up space.

The history of Nokia's Eseries phones supports this perspective. When it hit the market, the Eseries was the first range of mobile phones with touchscreen technology, eventually becoming a long-term best seller. However, despite featuring the latest technology and Nokia's powerful branding, the Eseries still fell out of popularity. This was because although the phones incorporated touch technology, all the old keys and buttons were retained. This design of a touchscreen HMI with full keyboard became redundant in the quest for larger screen sizes. That is why the Eseries was finally overtaken by the iPhone in terms of popularity.

Thereafter, most mobile phone manufacturers have followed the same path and used touchscreens as the primary human-machine interface. Using software to integrate button functions that enable users to navigate the phone via the touchscreen, the 20 buttons on the Eseries have been reduced to 3 or 4 buttons. This has increased the usage convenience and efficiency, while streamlining the form factor. The iPhone ushered in a new era where touchscreen became the mains user interface for mobile phones.

Returning to industrial applications, digitalizing HMI buttons helps factories simplify operational workflows and track production data collected by intelligent devices in order to facilitate remote centralized management of large-scale production activities. Consider the automobile industry for example. In the old days, the central control panel of a vehicle featured physical buttons and switches for controlling the air-conditioning, radio, and other functions. Whereas in recent years, emerging in-vehicle HMIs have incorporated function buttons and switches into the touchscreen. Moreover, touchscreen HMIs have even been integrated with intelligent driver assistance systems for automated navigation and parking assistance. This not only enhances the driving experience and overall safety but also indicates the extent to which technology will guide our future.

The above examples clearly demonstrate that customers prefer HMIs that feature a touchscreen and a few physical buttons. Such interfaces combine the advantages of touchscreens with the benefits of physical buttons – the physical buttons provide tactile feedback and enable instinctive operation once users familiarize themselves with their locations; the touchscreen offers the latest cutting-edge intelligent technology, satisfying their desire to remain on trend. From this, we can rationally infer that in the next 5 to 10 years, integrated HMI designs will dominate the industrial HMI market.

Future-Proof Expandability

Advantech, a leading provider of advanced industrial HMI solutions, has developed a new HMI product – SPC-800 – that addresses consumer preferences as well as the limitations of touchscreen HMIs. We expect the SPC-800 to drive another burst of innovation for industrial HMI designs.

Advantech's SPC-800 is an industrial HMI that follows recent trends for a touchscreen interface combined with a few physical buttons. The SPC-800 accommodates user preferences for physical buttons while providing a touchscreen for more efficient operation, integrating the two interface types to optimize operational safety and ensure efficient processing.

Advantech SPC-800 series

However, as the development history of HMIs shows, blindly following trends will not yield success; instead, innovating existing mainstream trends creates real opportunities for success. With SPC-800, Advantech has tried to provide unique value through flexibility and versatility. Additionally, because physical buttons are generally only configured to perform a single function, functional scalability is quite limited. Advantech's SPC-800 overcomes this disadvantage with the inclusion of an integrated customizable expansion unit for configuring physical buttons according to usage requirements.

With this modular function expansion unit, most physical buttons and electronic components can be custom configured. Moreover, to accommodate the expansion unit's flexible scalability, Advantech modified the SPC-800 base with holes for easy installation and incorporated an internal terminal board for simplified wiring. Overall, all these modifications and innovations were aimed at increasing convenience for HMI users.

Although flexible expandability is the most notable advantage, the environmentally friendly and ergonomic design is also a key merit of SPC-800.

Featuring an integrated support arm system mount adapter, the SPC-800 can be deployed outside the control cabinet and directly mounted on machinery. Cables are routed through the swing arm to an I/O wiring area that can be accessed without dismounting the device. This not only ensures easy access to the power supply, Ethernet, and USB ports, but also enables the use of standard connectors. The achievement of IP66-rated protection from water and dust as well as IEC 61131-2/61010 certification verifies the system's robustness and suitability for operation in a wide range of challenging industrial environments.

Conclusion

Regarding the long-term development of HMIs, in order to stand out from all the rapidly developing technologies in today's highly competitive market, product designers must consider customers' ever-changing demands. Advantech's SPC-800 HMI solution is the ideal solution for industrial applications. The system's high flexibility and unrivaled expandability have sparked new innovations, providing customers with cutting-edge technologies and an optimized usage experience. The SPC-800 is a flagship of next-generation integrated HMIs.

Moving forward, we believe that Advantech's HMI products will incorporate more technologies that will enable endless possibilities in terms of human-machine interaction. Perhaps one day, when people are no longer reliant on sensorial feedback from machinery, HMI development will expand into new areas, beyond people's wildest imagination.

References

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About Advantech

Founded in 1983, Advantech is a leading provider of trusted, innovative products, services, and solutions. Advantech offers comprehensive system integration, hardware, software, customer-centric design services, embedded systems, automation products, and global logistics support. We cooperate closely with our partners to provide complete solutions for a wide range of applications in diverse industries. Our mission is to enable an intelligent planet by developing automated and embedded computing products and solutions that facilitate smarter working and living. With Advantech products, the application and innovation potential becomes unlimited.
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