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Personal Electronics are Shaping Tomorrow's Industrial Human Machine Interfaces

User experience with today's personal electronics and consumer websites are driving the development and use of industrial automation human machine interfaces.

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Daily smartphone and tablet use by consumers is raising expectations for improved human machine interface (HMI) interactions everywhere, and with good reason. Any type of consumer electronics technology used regularly—including handhelds, appliances, vehicles, gaming systems and more—can benefit from enhanced operator interface and interaction. In fact, progressive operator interface features are often a major selling point for these products, as with Apple's iPhone and iPad.

Users become accustomed to the advanced operator interface features of their favorite consumer electronics products, and in fact any electronic products with an attractive interface, and they want to see the same level of convenience and ease-of-use in the products they use at work.

Industrial manufacturers have historically focused more on their core equipment competencies, such as providing real-time control and monitoring, and less on the user experience. However, the proliferation of "smart" devices, and especially the increasing availability of Internet of Things (IoT) and industrial IoT (IIoT) devices, is changing this emphasis.

The underlying automation systems must still work reliably, but the interface to these systems must offer operational status and diagnostic information which can be quickly and easily harnessed to improve the user experience, and ultimately the overall equipment effectiveness (OEE).

Simply overloading users with raw data is not the answer, and is counterproductive in most instances. Instead, modern HMIs must transform this data into useful information, and present it to users in a simple and effective manner. The HMI must also provide straightforward ways for users to operate the underlying automation systems and the equipment they control, and to quickly respond to any abnormal events.

The latest HMI hardware, software and best practices have positioned manufacturers to respond to end user expectations by providing new features and benefits. This white paper will describe some of the ways in which the future of HMI is available today, and will show how there is an expanding need for advanced HMIs in the industrial and commercial markets.

HMI Market Drivers

End users are surrounded by ever increasing numbers of HMI applications in all aspects of their personal and work lives, and it would be interesting to study exactly how many touchscreen touches a typical person performs each day. Even ignoring PC and smartphone interactions, there are HMIs on our computer accessories, in our cars, and at the retail stores we visit. Parents are routinely entertaining their children with touchscreen tablets, so youngsters are exposed to the HMI experience almost as soon as they can sit up.

Even though the industrial sector typically lags consumer electronics trends in many ways, automated equipment and system vendors have adopted many aspects of consumer HMIs rather quickly. This has often been done by modifying consumer electronic HMIs to meet industrial needs, such as with the 4.3-inch display popularized by gaming systems becoming a de facto industrial HMI standard for small screens.

These and other HMIs offer a much more cost-effective and flexible way to add functionality to equipment compared to expensive hardwired buttons and lights. Programmable HMIs are also far more adaptable to making changes than other hardwired interface methods, since additional hardware and costly field modifications are avoided.

Not only does this help "future proof" the operator interface experience system, it also provides opportunities for manufacturers to add new and improved features down the road. For end users, properly implemented HMIs can provide a very attractive user-facing display, and act as a differentiating feature.

Beyond visualization, HMIs can perform many important control and communication functions. As *Control Engineering Europe* puts it, "today's HMIs can be much more than this and are no longer simply display devices with fancy graphics. Now, they can display all the real-time information needed to control a system, and can also carry out monitoring operations for the machine" (Reference 1).

With technical and economic reasons clearly favoring incorporation of HMIs, industrial automation manufacturers will continue to increase their use. This is already evident as smaller standalone machines which were formerly provided with simple hardwired controls now regularly come with touchscreen HMIs. Even larger systems already designed around HMI platforms are improved the operator interface experience by providing additional distributed HMIs throughout various operational areas, especially in support locations such as maintenance offices.

Commercial-grade devices such as building HVAC controls, monitoring systems and instruments, appliances, and consumer-facing kiosks represent another category of HMI growth. Small HMIs are often the best way for these products to provide the required operator interface to users.

The growing availability of IoT and IIoT devices will also drive the need for more HMI options. While IoT devices are often smart home-type and other commercial sensors, their more robust IIoT cousins are typically deployed throughout an industrial organization as an additional layer to provide additional points of measurement. This IIoT data is used to provide and improve predictive maintenance, condition monitoring and safety systems—and to offer visibility for increasing operational efficiencies.

HMIs are a fundamental technology to support many markets and industries. Factories continue to become smarter, and the transportation, energy, mining and other sectors continue to increase incorporation of HMIs. HMI technology can be applied in more situations as products improve, and the variety of "smart" devices needing an HMI continues to expand. These developments will drive the development of advanced HMIs.

Meeting End User Expectations

Over the years, the underlying technology platforms for HMIs has evolved. Initially they were proprietary systems and text-based. Large scale proliferation began in the late 1980s when PC-based computing was robust enough to serve as an HMI platform. These PC-based HMIs could offer far more advanced graphical and computing features than their proprietary predecessors, and at lower price points as PC and display prices rapidly declined.

Other incremental improvements have included the transition from bulky and power-hungry cathode ray tubes to LCD displays and LED backlighting, the availability of cheap memory and solid-state storage, and the increasing communication speed of wired and wireless Ethernet. These advancements were primarily leveraged from commercial off-the-shelf (COTS) technologies developed for mass consumer markets, so end users were already familiar with many of the underlying technologies such as PCs, Ethernet, Windows-based operating systems, etc.

The first HMIs were a technical solution for providing more capabilities at reduced cost. However, achieving basic functionality often trumped the user experience, both during initial configuration and subsequent operation. Sometimes this was because hardware and software limits were reached. Other times it was due to a lack of focus on what the end users might want. Systems were relatively slow and clunky in many cases, but so long as they worked they were considered a success compared to what had come before. End users really had relatively few alternatives to serve as a reference.

Today's end users, on the other hand, have many more data point as to what an HMI can and should be. They can look back over many years of significant change and progress in terms of consumer HMIs due to their personal and everyday experiences. With nearly every consumer carrying a smartphone HMI right in their pocket, expectations are far higher than ever before. As another example, the automotive industry has been and will continue to pursue touch integration of controls,

infotainment systems and virtual personal assistants as the “next big thing” for operator interface in their vehicles (Reference 2).

With this newly provided power comes some concerns, however. Media attention of various hacking efforts has certainly made its way into consumer consciousness, and must be addressed with any electronic networked product. Fortunately, there are methods to provide the required levels of cyber security with modern industrial HMIs.

Extreme familiarity with advanced consumer HMIs and end user sophistication are now considerations for how industry develops their HMI products. Suppliers must evaluate how their customers will view their new HMI products, and how they will make their purchasing decisions. There is now a strong demand for workplace industrial automation technology offering the same types of intuitive and convenient features seen in consumer products, combined with comprehensive security.

Leading HMI Requirements

To understand what HMI features are most in demand, a great starting place is to review what any smartphone offers in terms of operator interface, and then add other industrial-specific requirements. Table 1 lists leading HMI requirements for current and future industrial products, with each requirement explained in greater detail in subsequent paragraphs.

Table 1, Leading HMI Requirements

- Image-based visualization
- Intuitive touch control
- Home key and navigation links
- Wireless integration, especially near field communication (NFC), Bluetooth, and Wi-Fi
- Trusted platform module (TPM) for security
- Software support for web-based SCADA and HMI
- Logo and branding for end user recognition
- Modular capabilities.

One of the most striking features of any modern smartphone, tablet or computer is vivid visuals. The icon-based touch device environment, and rich graphic content of web pages, has shaped the way users interact with electronics, and therefore sets operator interface expectations.

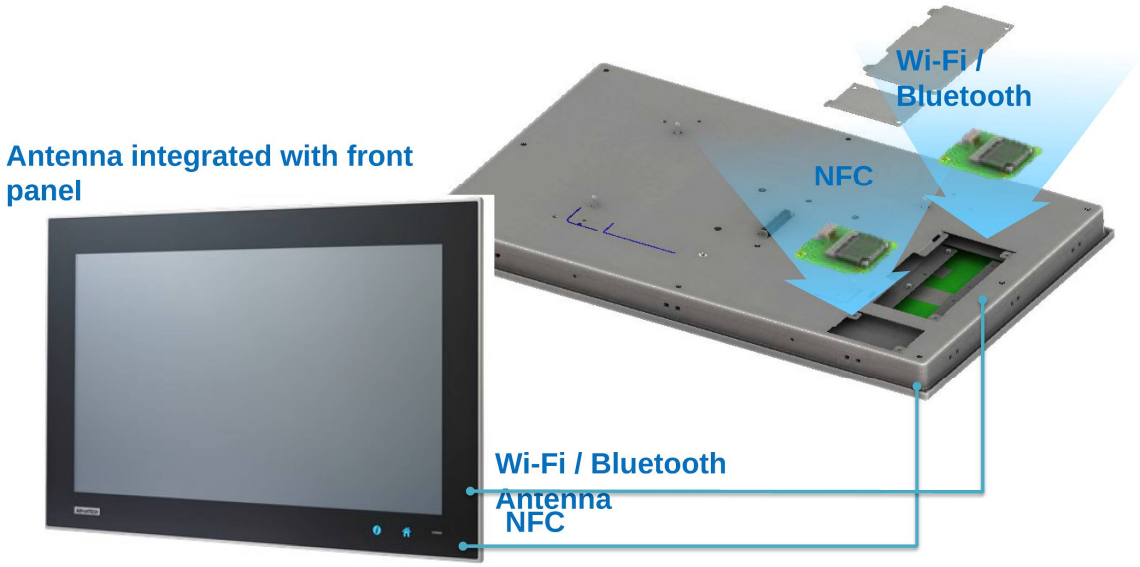
Suppliers look for HMIs with the right processing power, display specifications, and supporting software to provide the displays their customers will need. Sometimes this could be a clear and simple display, while in other case it would be a more detailed schematic representation of an operation. In some instances, the best method is to use actual equipment and system photos and images with information superimposed on them.

Visualization is only half of the formula; users must be able to initiate control through the HMI. While there is still a place for keyboards and pointing devices such as a mouse, it is much more natural in many cases to offer touch and multi-touch screens. A properly configured HMI should be intuitive for users, allowing them to easily select exactly what is needed.

Furthermore, there must be streamlined navigation methods for moving among the various display screens quickly graphics. A fundamental control is the “home key”, which quickly and repeatedly brings the user back to a known starting point and facilitates reliable navigation. For instance, industrial automation leader Advantech offers the TPC touchpanel computer and touchscreen monitor product lines with these features.

Networking capabilities allow the HMI to communicate with other equipment. Wired Ethernet is a possibility, but many newer systems rely on wireless Ethernet (Wi-Fi) to communicate with other control elements and computers. This is especially beneficial to reduce field wiring and support mobile equipment. Two other wireless technologies, NFC and Bluetooth, are becoming more important as a means for operators to use phones or other devices to uniquely identify themselves, and even log into the HMI. The HMI can also use this information to provide relevant data for that user, and to restrict access as required.

Wireless capabilities can be built-in or add-in modules, but antennas which are integrated into the HMI front panel are essential to ensure easy installation with fewer cabinet penetrations. The Advantech TPC products shown here support these features.



Security is always a concern, especially for any HMI involved with factory automation or infrastructure projects. It is critical that the devices in these types of service be compliant with trusted platform module (TPM) security standards. TPM is an integrated hardware module which can be configured with the HMI programming software to ensure proper user authority and access control.

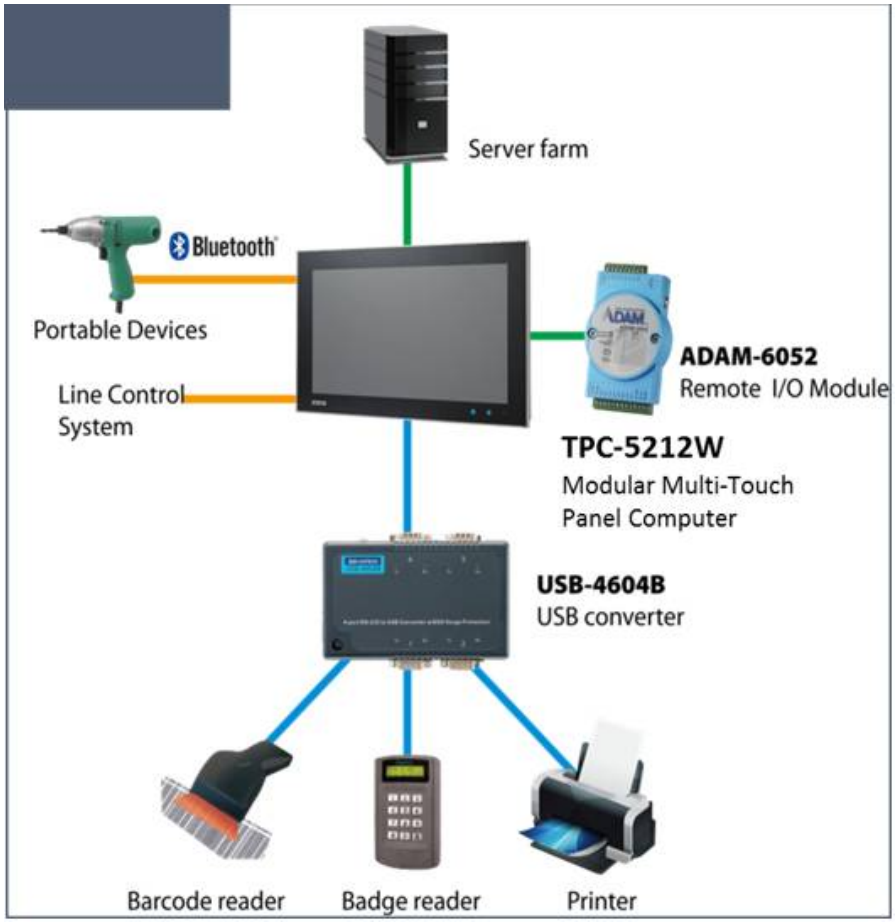
Many of the HMIs discussed in this whitepaper are basically industrialized PCs with automation specific features. As such they can fulfill many roles, although this whitepaper has mostly focused on visualization. For visualization applications, the HMI software can be a dedicated program, or could be web-based, or perhaps even a virtualized solution.

PC-based HMIs may even be tasked with more advanced functions. These might include running native control programming, communicating with local hardwired I/O, interfacing with other smart devices via serial or Ethernet for fieldbus communications, or other advanced features.

A final requirement is a bit simpler, but no less important to some, and revolves around that fact that oftentimes HMIs are implemented by original equipment manufacturers (OEMs). In many cases, these OEMs need to provide their HMIs with logos and branding, so any HMI supplier should be able to private-label their products.

Application Example, Automotive MES Solution
Modern HMIs meeting the requirements listed above can do far more than just show pretty pictures. Properly provisioned and configured, they can tie together various manufacturing execution system (MES) elements to make operators more efficient.

For example, the below figure shows a diagram of a typical automotive MES application. Starting at the right side of the diagram, it is possible to connect Ethernet-capable I/O directly to the HMI for local control processing. An example might be the HMI monitoring a proximity switch indicating a car body is in position on the production line and ready to be worked on.



The bottom of the diagram shows how more complex communication devices such as barcode readers, badge readers, and printers can be integrated with the HMI. An operator may need to scan in their badge to identify themselves, then scan the car body on the production line, then print out an assembly barcode sticker to be applied on the car body.

The HMI could interact with a database located on a server farm to display the proper components to select and install. Using Bluetooth-enabled tools (which provide usage and performance data to the system), the operator would proceed to install the parts. Once the work is complete, the HMI could signal the line control system to advance.

The right HMI is well positioned to act as the centerpiece of a smart manufacturing cell, centralizing functionality and reducing costs.

Conclusion and Outlook

Consumer electronics have achieved astounding sophistication in the last decade or so, with an emphasis on usability powered by improved operator interfaces. The power, attractive interface and ease-of-use provided by HMIs in handhelds, vehicles, and other common commercial products has elevated consumer familiarity and expectations for all their operator interface experiences.

In the commercial and industrial world, there are many sectors such as smart factories, transportation, energy, mining and others which regularly make use of HMIs. The same COTS hardware and software technologies used in commercial application will continue to be leveraged for industrial HMI platforms.

Integration of HMIs into equipment and larger systems will increase since they are the most economical and flexible method for manufacturers to provide required visualization and control. Additionally, the expanding use of IoT and IIoT devices is another market driver increasing demand for more HMIs.

Moving forward, successful industrial HMI platforms will need to deliver the powerful visualization and touch navigation features common to personal electronics, vehicle interfaces and other commercial operator interface experiences. Additionally, industrial HMIs must provide the latest wireless technologies to make them convenient to install and interoperable with user electronics. Finally, since HMIs are often used in critical applications, they need to comply with the TPM and other security standards, and reliably run the latest SCADA and HMI software.

References:

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