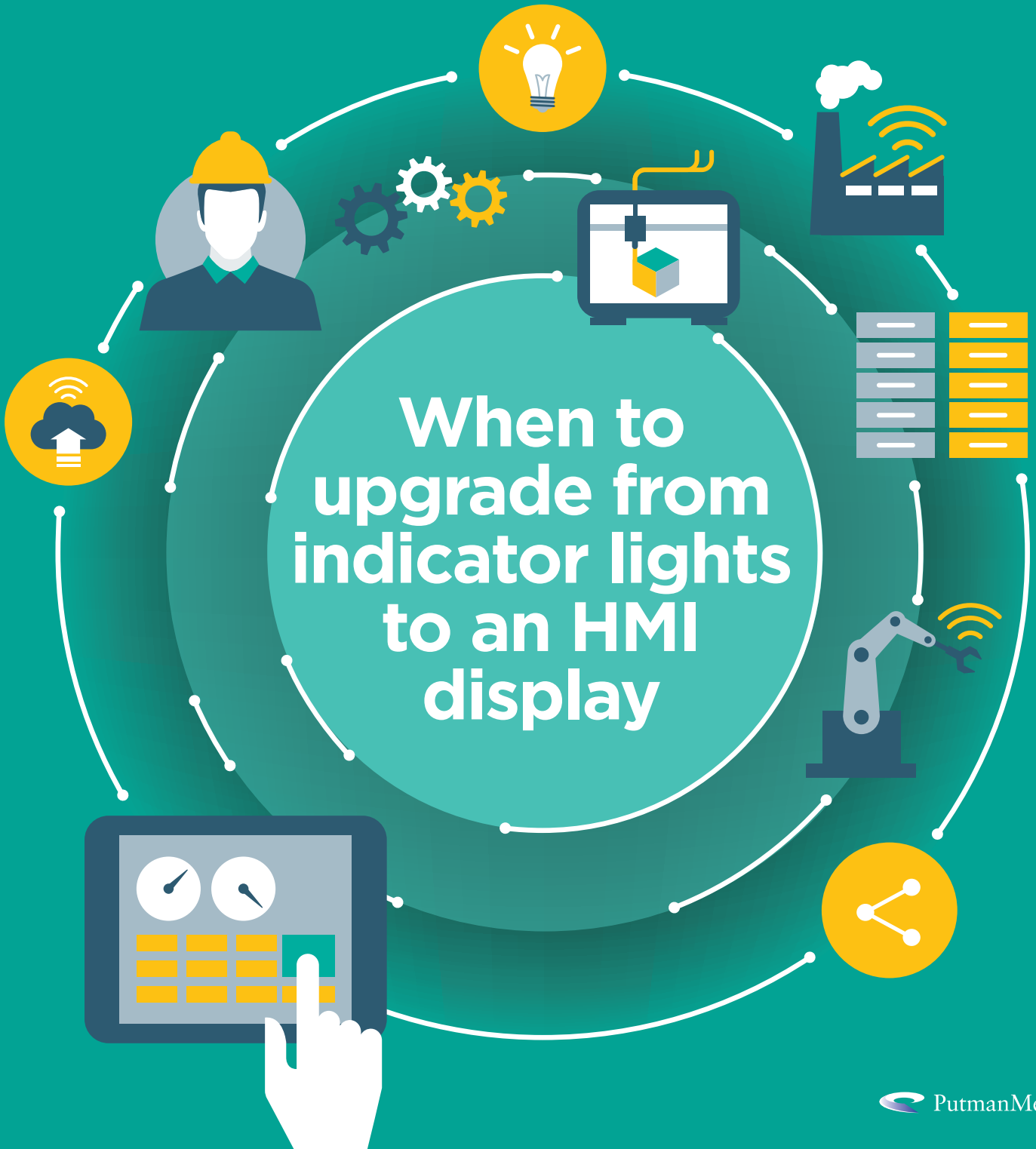
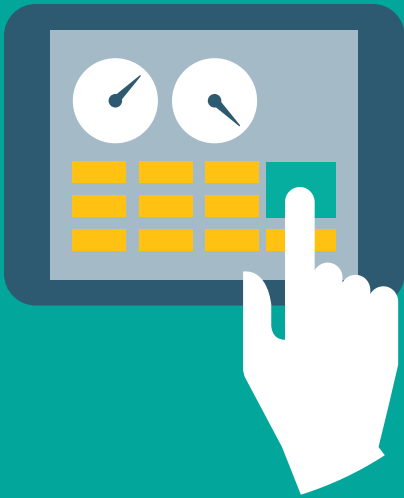


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F O R M A C H I N E B U I L D E R S





# When to upgrade from indicator lights to an HMI display

How to weigh the cost of adding a screen to the machine and why

By Mike Bacidore, editor in chief

A *Control Design* reader asks: I work as a control designer at a packaging equipment OEM, and I think my boss is being cheap. At question is whether to add an HMI or keep the half dozen indicator lights for status and fault annunciation on our box-making machine. It seems like hardware cost is the boss' only concern, where I think integration labor, user experience and functionality are much more important. The addition of an HMI is way beyond just the bottom line cost; it's about machine capabilities and can even help to sell it. What are some pros and cons of adding an HMI to a machine that doesn't currently have one, whether on a new design, existing design or retrofitted? I plan to use this information when presenting my HMI upgrade solution to the boss.

## ANSWERS

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### IMPLEMENT VERY BASIC RULES

If component level fault diagnostics, charts or any diagrams are required on said equipment or systems, you will need an HMI, which cannot be achieved with standard push buttons and indicator lights; an HMI has great advantages for fault recoveries and expendabilities.

Standard operator push-button boxes with indicator lights are more economical when systems have four or fewer motions or eight outputs and a limited number of inputs, of course, not including the above-mentioned, and only basic motions are needed. The HMI becomes more economical when your equipment or system requires five or more motions or 10 or more outputs and a number of inputs.

— Frank A. Loria, vice president, Harry Major Machine, [www.harrymajormachine.com](http://www.harrymajormachine.com), Clinton Township, Michigan

### DEFINE THE STEPS

The choice of operator interface should be based upon the demands of the task and the required level of performance. HMIs have greater potential to present information to improve performance on a complex task. However, if the task is “hit the button when the light comes on,” then a full HMI would not likely be cost-effective. If you want to determine the need, define the steps of how the interface will be used and

the information that the user will need from it to perform correctly. If you can show reduced processing time and/or complexity, then the HMI might be the better solution, particularly if the consequence of error is severe—for example, machine damage.

— David A. Strobhar, chief human factors engineer, Beville Engineering, [www.beville.com](http://www.beville.com), Dayton, Ohio

### PRICE VOLATILITY

This is a very good question and one that we are sure many OEMs ask themselves when designing their equipment. As a software provider that offers an HMI for OEMs, the selfish response would be that you should include an HMI in your solution. But the real answer depends on how your customers use your equipment and the price volatility in your market.

If your equipment is used as the primary point of the line, an HMI is definitely a plus. In this case, you would want to look at an HMI that is not only capable of connecting to your equipment, but also capable of connecting to other systems, and other data sources, such as OPC Classic, OPC UA, ODBC and Modbus. The HMI also needs to be easy to adapt and customize. With such a system, the value of your HMI goes beyond single use and now extends the value across the production line. More importantly, this approach can generate new streams of revenue, such as professional services, software

licensing and maintenance fees. Of course, if your equipment is to be integrated into a larger system which may already have an HMI, your customers would still appreciate having a range of data connectivity options.

If price volatility is a concern, you should look at other options. Instead of offering a traditional HMI, you could offer HMI as a service. Here there is no upfront cost to you or your customer, but a monthly fee that the customer would be charged to access the HMI. The advantage is that you have the benefits of additional revenue streams and can now offer even more services to your customers. Using a SaaS model, you can extend the services to include remote condition monitoring and even performance reporting. For those customers that want the service, they would pay for it on a monthly basis; for those that don't, you have no costs.

— Bob McIlvride, director, communications, Skkynet Cloud Systems, [www.skkynet.com](http://www.skkynet.com), Control System Integrators Association (CSIA, [www.controls.org](http://www.controls.org)) member

## OFFER THE HMI

Push buttons aren't cheap. There should no longer be much difference between the installed cost of a small HMI and push buttons and steam gauges, especially with labor. It shouldn't be too hard to build the cost comparison. Also, have a look at form factors. The micro-PLC on this machine can be replaced by an integrated HMI/PLC for space, labor and cost savings.

Now that HTML5 has come to HMI-based software, HMI development has become really accessible. And with a well-designed HMI, even a 4-in or 7-in touch panel can deliver great computer usability, thanks to the resolution and graphics available.

I know of one builder of pallet stretch wrappers, another highly competitive machine category, that has decided to differentiate its machines with a beautiful but low-cost, full-color HMI. And it worked; sales are up substantially. So perhaps the reader should be talking to the company's vice president of sales instead. You can always offer the HMI as an option, so there is very little risk.

I don't see any cons, aside from some upfront design and programming. For additional pros, look at the HMI's user benefits of diagnostics, operator instructions, troubleshooting videos, languages, recipe-driven changeovers and production-data collection.

Hopefully, this company is using a scalable control platform so that they can reuse software components from their higher-end machines to develop the low-end HMI.

— John Kowal, director, business development, B&R Industrial Automation, [www.br-automation.com](http://www.br-automation.com)

## LOOK BEYOND THE SUNK COST

Weighting initial investment costs is a natural way to measure alternatives, considering this is how most consumers make purchasing decisions. However, when we make big-

ticket purchases, we understandably look at total ownership costs so that we can limit buyer's remorse and fully understand our benefits/risks. When installing HMIs on machines that were previously indicator lights, it is certainly an upsell situation and may need to be justified due to the engineering required and potential issues associated that wouldn't be found with a more passive installation. However, once one looks beyond the initial sunk cost of engineering hours, they'll see the benefits that are available to them, such as remote monitoring, historical logging, user guidance and trending. These fundamental benefits can save OEMs after-sale support dollars, can provide great introspective to one's process and can also be sold as support plans that generate extra revenue to hedge against the initial cost.

— Eric Reichert, product marketing lead specialist—  
industrial PCs and HMIs, Phoenix Contact,  
[www.phoenixcontact.com](http://www.phoenixcontact.com)

## USER IDS AND PASSCODES

Many decision makers have this mindset: If it's not broke, don't fix it. But that is not the approach that should be taken. The landscape of automation is changing, and we are finding ourselves with a new generation of engineers and end users who interact on a daily basis with tablets and touchscreen interfaces. The question machine builders should be asking is: How can we make our machine more efficient and modern? Adding an HMI screen to a

machine that previously used push buttons and switches brings your machine into the 21st century. Not only will your machine be more user friendly, but it may give you the competitive advantage you need in your industry. The addition of an HMI will also open a window to your machine, allowing you or your customer to monitor processes, extract data and set alarms. One could even go so far as to set up user IDs or passcodes that will allow only certain employees access to certain processes of the machine. Another important feature that the HMI adds, that machine builders are finding very appealing, is the ability to create HMI screens in various international languages. The programming behind this is simple, but the feature itself will thrust your machine into the international arena. Many PLC manufacturers have started to integrate HMIs into their PLC hardware, making the relative hardware cost very low and affordable, something frugal bosses cannot ignore.

— Holly Dillon, sales manager, Unitronics,  
[www.unitronics.com](http://www.unitronics.com)

## TOTAL COST OF OWNERSHIP

The controls designer is absolutely correct that he values the integration labor, user experience and overall functionality of the machine. However, being the CEO of a business I can totally relate to his boss' concern about bottom-line costs, as I have to deal with bottom-line material cost and overall P&L statements all the time.

What the boss may not be seeing is the value the HMI brings to the box-making machine and in general the total cost of ownership of the machine.

1. Integration/labor: This cost must definitely not be ignored, as the controls engineer has pointed out. One has to calculate the labor associated to wiring up and installing the six indicator lights vs. the labor of installing one HMI with four DIN clips.
2. The controls designer should look at the cost of the physical indicator lights vs. the cost of an HMI. Even if you get low-cost visual indicators only, it will be approximately \$30/light, so if you have six of them this becomes \$180. With audio/visual indicators, it is 1.5X to 2X, so we are looking at about \$270-\$360.
3. I'm assuming there is some sort of PLC or at minimum relay contacts in the box-making machine. Many of our customers have switched such basic controls with an integrated HMI with onboard I/O that has all PLC functions of your standard PLC. The device can not only act as an HMI, but also does ladder logic and advanced math calculations, if necessary.
4. Now one objection that the boss can bring up, which is definitely accurate, is the engineering time involved in programming an HMI. There is no doubt there is more time programming an HMI compared to just hooking up indicator lights. The way to overcome this is just how you mentioned the flexibility of using an HMI over indicators. You can customize the machine and make it much more user-friendly and advanced, compared to competition, that some customers will even pay more for the machine. And, to top it off, if your bottom-line hardware cost is equivalent, you'll get your ROI from engineering very quickly. If you really want to have a laid-out chart for your boss, I would show the engineering development cost which is a soft cost vs. extra revenue you can get by having an HMI. I know many customers that sell more machines with an HMI compared to simple relay logic controls because it offers many more features to the machine.
5. Another good selling point to the boss is branding of your company. You can put your company logo on each HMI screen, which further promotes your machine.
6. Furthermore, I've even had customers use the HMI as a marketing tool. One example is a large coffee maker that sells high-end coffee machines for homes and offices. With the remote access and control feature, on a weekly basis they are able to promote a different blend on the HMI so that when a user sees the machine and fills his coffee mug, he or she is shown different flavors that can be ordered online. Of course with a box-making ma-

chine it is a little different unless you also sell packaging material. However, it is just some food for thought.

7. One downside I can see the boss bringing up is cabinet space. If that increases in size, it means more dollars to the bottom line. So, here is where one must see what size HMI will suffice for the application to minimize space.
8. Finally, with stack lights as opposed to an HMI, one leaves no room for customization or expansion of features to the machine. With an HMI, you can offer feature upgrades in the future to the customer. You can also give it the 21st-century, latest-technology look, which represents your company as a whole. Everyone must remember the definition of an HMI is human-machine interface. It's the first item the customer goes to on any size machine, small or big, and by having one on your machine it makes your company an innovative, state-of-the-art, advanced packaging company.
9. With regard to total cost of ownership, with an HMI, if your customer allows access remotely, you can train and troubleshoot the machine from the comfort of your office. No need for expensive travel and time away from the office/home. Furthermore with an HMI, one can even have manuals/ instructions on the HMI itself for operation of the ma-

chine, so this will reduce your service expenses, which is also a major cost to the bottom line.

— Vikram Kumar, president and CEO, EZAutomation, [www.ezautomation.net](http://www.ezautomation.net)

## **COSTS CAN BE DECEIVING**

Adding an HMI also makes the machine more modern-looking, which may differentiate a machine builder from the competition. Traditional push buttons are not always low cost either, especially if you factor in the installation and wiring costs. A set of 10 quality push buttons could potentially be about the same cost as a smaller-screen-size HMI operator panel.

— Bjoern Falke, product manager—control systems HMI/IPC, Phoenix Contact, [www.phoenixcontact.com](http://www.phoenixcontact.com)

## **THE RICHER THE EXPERIENCE**

You pose a really good question that can often generate a lot of debate as you yourself are experiencing. One of the challenges with this discussion is that the term HMI is so broad. HMI or human-machine interface is simply the mechanism that allows the human operator to interface with the machine, and so technically the half dozen indicator lights you have are, in fact, an HMI. However, if I read into your question further, I assume that you are thinking of some sort of digital interface that is connected directly to your machine's controller, or another standalone PC where the operator gets a richer interaction with the machine.

To best understand the pros and cons of adding an HMI such as this, we need to understand what is available. First are component-level displays, which are components to a larger system that you can directly integrate into your final mechanical design. These types of displays are typically board-level, connect via serial or USB and are designed to provide more basic functionality such as soft front panel buttons or basic system data. These types of displays are often the lowest cost but are limited in their performance. Another option, and what most people likely think about when considering an HMI, is to use a standalone touch panel computer (TPC) or a standalone PC and monitor that connect via Ethernet to your controller. This type of HMI can drive more complex, graphics-intensive interfaces due to a dedicated processor and therefore provide a richer experience, but they do add cost to your design.

The above options are really good for many applications, especially if you are looking to leverage an existing design or do a retrofit. However, if you are considering new design, then there are some other HMI options to consider, as well. If you are building a new design and you know you want to integrate an HMI into the system, you could choose a machine controller that has the ability to support Web-service-based HMIs or has been specifically designed to integrate the graphics processing

directly into the controller while still maintaining the necessary levels of determinism required, which means you only need a monitor. The first option is called a thin client. Unlike a dedicated TPC or client-installed application, a thin client executes a zero-install user interface (UI) on the client and relies heavily on the server for data retrieval, analytics and logic execution. This type of UI allows you to have even more flexibility on where you access your data, including from a Web browser or a mobile device. If your controller has integrated graphics, you can get the same user experience as a TPC, but without the higher cost and software burden they will have.

There are a lot of options you can pick from when it comes to HMIs, each with its own pros and cons. Overall the richer an experience you provide, the better the interaction. Software-based HMIs provide great amounts of flexibility to you as the designer through feature adaptability, versioning, updatability without mechanical changes and integration simplicity. They also add a lot of value to the end user. However, they do have a higher cost than simple indicator lights and often have a higher software burden. You have to weigh the different options, compare their features and benefits against the cost in order to determine what is right for your specific application.

— Brandon Treece, senior product marketing manager, National Instruments, [www.ni.com](http://www.ni.com)



## HMI VS. INDICATORS

Making a decision between panel indicators and an affordable HMI solution can be challenging. Let's take a look at a few options and compare the pros and cons for each solution. The question asked was specifically for six indicator lights vs. an HMI. Assuming that we are looking at list price for all options, I will try to break this down in the examples below.

Panel mount indicators can vary greatly in price, based on size (22 mm vs. 30 mm) and voltage requirements. So, for this example, we will use the popular 120-V 30-mm indicator lights. The manufacturer's suggested retail price (MSRP) for this part is \$68.03 each. If we need six of these, the total price will be \$408.18 for this project. You may be surprised to see that the small HMI is actually more affordable than the indicator lights. However, price alone may not be the only deciding factor between these options. So, let's take a look at some additional pros and cons for the indicator option.

Indicator pros include:

- more affordable than a larger HMI
- indicators can be easier to see from a distance
- indicator lights will never become obsolete
- indicator lights are easy to maintain
- available with LED bulbs for long service life.

Indicator cons include:

- increased labor for mounting and wiring

- additional PLC I/O will be required to illuminate the indicators
- custom indicator labels may be difficult to order and they might have long lead times from the factory.

Now that we have reviewed the indicator option, we can look at the HMI solutions to see how they compare.

Like the indicators, the HMIs are also available in a variety of sizes and with multiple features. The sizes will usually range from 3.8 inches up to 15 inches in width. In an effort to keep the price comparable to the indicators, we will select a 5.7-in and 4.3-in option from the same supplier.

The 4.3-in display is a great option for small machines where size and budget are a primary concern. This option has the most affordable price at \$289. For applications where the operator is working in close proximity to the control panel, this may be all that you need. If you find that the screen size is too limiting for your application, you will need to look at a mid-sized HMI.

A 5.7-in mid-sized HMI is the most expensive, but the additional screen size will make your graphics much easier to see. Otherwise, the two HMIs are very similar in performance. Below is a list of pros and cons for choosing an HMI solution vs. the indicators.

HMI pros include:

- potentially more affordable than indicators if you select the smaller HMI
- only one hole to cut in your panel
- less wiring required during installation
- multiple indicators, push buttons and switches can be added to the graphics
- multiple screens can be added for additional functions.
- easy-to-program additional indicators or push buttons for future expansion
- no need for custom indicator labels for each device
- less I/O required for your PLC to illuminate the indicators
- alarm messaging can be displayed for detailed fault descriptions
- alarm history can be tracked and monitored to identify reoccurring fault conditions
- secure user accounts can be created to limit access for operators
- engineers can modify PLC parameters from the HMI to improve equipment performance
- Web-server function allows remote monitoring and control capability with PC or smart phone.

HMI cons include:

- more expensive than indicators if you choose a larger panel size
- smaller HMIs can be harder to see from a distance
- an illuminated or flashing HMI indicator might not be as obvious to an operator

- HMI models may become obsolete in the future; replacements may be hard to find
- HMI requires higher technical competency for programming and maintenance
- HMIs will require the additional expense of programming software for setup and maintenance.

To conclude, the argument for the HMI becomes much easier when multiple indicators and panel devices are required for the application. The HMI will give your machine a sophisticated look and additional functionality. Your customers will appreciate the added features that can reduce downtime and increase equipment efficiency. If you are still having trouble with this decision, you might ask your customers if they have a preference.

— Jeff Clonts, product manager, Allied Electronics,  
[www.alliedelec.com](http://www.alliedelec.com)

## MANAGEMENT DECISION

Reading through the question it seems that individual roles are not clearly understood and therefore not properly valued. This is something I have experienced in my career as both an engineer and as an engineering manager. As an engineer, I am not sure that I properly understood the roles and have to admit to being frustrated from time to time when presenting new ideas that were not accepted. As a manager I witnessed the frustrations that others encountered when they presented their ideas, and they were not accepted. Just as I was convinced that my

idea was a sure winner, others have been convinced the same of theirs. When their solution ideas are seemingly overlooked one can believe their ideas are not valued. As a manager, I challenged myself to determine how to resolve this. Every member of my team is valued, and their ideas are valued and do have merit. My task was how to communicate that.

Management bears the ultimate responsibility for the outcomes of the decisions that are made, and it should. Designers, in this case, are to provide information so that management can make a well-informed decision. The manager and management team may or may not share the same level of expertise as a designer or an engineer. You simply cannot know the answer to everything; solutions are too vast and complex; thus the team is made up of different disciplines that managers have to be able to rely on. So, the designer's role is not necessarily to make decisions; although there are a number of decisions made throughout the design process they are responsible for, the role is to research possible solutions, make recommendations, providing quality information so that managers can make well-informed decisions.

I am reminded of a conversation I had with an engineering manager a few years ago. He was the director of engineering for a large packaging OEM, about \$270 million in annual revenue. He had three controls groups

and was working to drive standards across the groups. With every idea someone would stop in his office or send an email, all great ideas. His reply: "I would rather have one wrong way of doing things than 10 right ways. I can fix one wrong way."

It is not that a designer's recommendations are not valued. There are a number of things to consider. Cost is one consideration; "being cheap" I cannot comment on. I have been fortunate enough to work for companies that prefer to compete on value, not price. But you have to understand how you are going to market: is it price or is it value? Regarding cost, the customer is going to bear the end cost and must recognize the value. It has to be competitive, and it has to be profitable. If not, you will not remain in business very long.

"Cheap" is not a good motivation when it comes to making decisions. I recall as a controls manager that vendors would stop in and let me know they could offer me a competitive product at a lower cost than what we were currently paying. However, if I were to approach decisions in that manner that vendor would only be around for a week or so because another would soon follow with the same message. There is a lot to consider, not just component cost. You need to consider the time to redraw your designs, wiring in the shop, support in the field and support in customer service. You can't simply make a decision and assume

it's going to save you money because the component costs less. Component cost is only part of the equation.

Regarding some points to consider in the decision-making process, here are a few to consider.

The cost of a pushbutton and/or pilot roughly equates to about \$200 each. That is the cost of the component and installation. At some point the cost alone can lead to a decision where the HMI is a more attractive solution. At the same time a half dozen push buttons may not justify the cost of an HMI. You also have to consider the time required to develop the screens and any learning curve that may be encountered.

Also consider support after the sale. Do you have the proper skill sets in-house to support the solution after the sale?

Then there is the customer side. What parts do they have to maintain in inventory, or how much will they have to spend if a problem develops? Does the customer have the required skill sets on staff to maintain the solution, or will they depend on the OEM for support? Manufactures like to maintain some level of self-sufficiency, and you should strive to help them achieve that. You don't want your resources tied up providing routine support to customers; they are more valuable than that.

Is this a standalone machine, or is it integrated into a larger production line? If it is a standalone machine, then you have less of a case for an HMI. If the machine is going to be integrated into a larger production line, then you have a better case to promote an HMI. You have the ability to deliver a more integrated solution, displaying things like the communications status, machine interlocks, upstream and downstream equipment status and fault messaging. Enterprise resource planning (ERP) and manufacturing execution system (MES) integration requirements and capabilities lend themselves to a selection of an HMI and will be required in some cases, at some level, to handle the interface to higher-level systems.

Then you have to consider the how the operator interacts with the machine. Does the operator wear gloves? Is it a dirty or abrasive environment? Does the operator press more than one button at a time? This was an interesting one for me. Most HMIs only allow a single input, thus requiring two actions instead of one in some cases, leading to a less efficient process.

HMIs can provide much more detailed feedback to the operator. How much value does that bring? Is it just "neat" technology or does it improve the process? Many times operators become familiar with the placement of a push button, whether they are physical or virtual (HMI), and will be pressing buttons without even looking at the HMI or OI.

I hope this answer helps you to have a better understanding of the roles, the decision-making process and helps you to present information that leads to a well-informed decision. My recommendation for you is to do a proper evaluation yourself, and not just build a case for “your” solution until you are convinced it is the right solution. Present both sides. Allow your manager to make a decision without feeling your input was discarded or seen as being of little value. Communication is a challenge. Just as you are challenged with communicating your ideas, your manager may be challenged in communicating the value seen. It’s not an excuse to settle but a challenge for all of us to do a better job of communicating the value of our employees, of our team members and of our solutions.

— Larry Asher, director of operations, Bachelor Controls, [www.bachelorcontrols.com](http://www.bachelorcontrols.com), Control System Integrators Association (CSIA, [www.controls.org](http://www.controls.org)) member

## THE MODERN LOOK

An HMI can be developed for all types of systems, whether they are new designs or a retrofitting of existing systems for upgrades. Proper planning makes implementation both quick and easy. From a sales standpoint for tool builders, using an HMI just says this tool is a modern-built system, when comparing it to switches and indicators. An HMI is designed to allow easy replacement of controls and status signals on a system. In terms of illustrating system status and faults, the level of detail goes up exponentially. Status lights go from being simply on or off to showing the

exact fault code or alarm message associated with the issue. With the use of the illustrations of the system, the exact location of the faults can also be shown. Another advantage of using an HMI is the ability to store and log data during runtime. From the control side, the space required can be reduced, as well. With the use of different screen objects and even multiple screens, many more controls can be put on a much smaller surface. For example, what used to take a 24-in-by-24-in panel filled with buttons, switches and indicators could be accomplished using an HMI with a diagonal display as small as 4 inches. A major benefit to using an HMI is ease of wiring and reproduction. Machine builders go from having to wire all the controls and indicators to a much simpler solution with as little as a communication cable and a power cable. This reduces both the time to install and failure points in the future. However, one should keep in mind there is upfront design and development time for what goes into an HMI.

— Ramey Miller, HMI marketing manager, Siemens, [www.siemens.com](http://www.siemens.com)

## CONSIDER EFFICIENCY AND EXPERIENCE

There are several benefits related to using an HMI, including increased efficiency, safety, added functionality and less installation time and cost. While a push-button panel is easily understood and simple, it is obviously limited in the functionality it provides. In addition, the efficiency of a push-button panel depends on the experience of the operator.

HMI's are easier to use because you better describe each push button and light function. Push-button panels are used on simple machinery, typically consisting of only one piece of equipment. For example, it may be easier to understand how to run a small motor using a VFD by simply using a start/stop button, assuming you don't need to change motor speed. When you have multiple motors in operation (larger size systems) it is not always clear which motor is running, what the lights are indicating or which button controls which device.

Machine operators will also have a harder time learning how to use the machine. An HMI provides a more intuitive experience. Even maintenance people can benefit from an HMI, particularly when a machine problem needs to be diagnosed. Without an HMI, someone will need to open the control cabinet to access the PLC to troubleshoot the machine. An HMI has built-in diagnostic and troubleshooting screens.

With an HMI, it is easier to add functionality—for example, adding an extra button to a screen takes 2 minutes to download to an HMI. You can charge for adding extra functionality to the system, and it will only take minutes to implement. Installing an additional push button in the panel will cost you much more time and money because of the programming, wiring, installation and labor.

In some cases you can use one operator panel to control two or three systems. You can create multiple screens, and each is responsible to control different equipment. This will bring down overall cost. HMI can track much more information than push button—tracking your box, weight and size of box—all of this information can be logged in the HMI. You can log alarms, events and warnings such as the carton stock is low, so the operator can quickly add a new batch of boxes before machine stops.

You can improve the value delivered by your machine in many powerful ways:

1. change VFD speed or torque
2. monitor servo or VFD parameters
3. manage recipe for machine changeover
4. perform data collection and visualization of that data (how many boxes your customer produced good/bad/reject, machine runtime, downtime, idle, downtime reasons—you can sell this to your end user as an option, and the end user may pay extra for this information; you can do data logging and keep this information on USB or SD card
5. your customer can read alarm messages on the HMI panel and will know immediately how to fix the problem; you can incorporate machine pictures with the location of a faulty sensor or machine fault location (help with maintenance and troubleshooting)
6. installation cost and labor of push

buttons and lights seems to be much higher; with HMI you design project once and use it for all machines that you build (the price for HMIs dropped down and makes it easier for OEMs to incorporate these days)

7. use HMI if you need more than eight push buttons on machine
8. for small systems, start with 3.7-inch or 4.3-inch panel size.

— Aga Zupancic, senior product marketing engineer, Mitsubishi Electric Automation, [us.mitsubishielectric.com/en](http://us.mitsubishielectric.com/en)

## PROS AND CONS

With today's enhanced technology, there are many advantages of using an HMI instead of components such as switches or pilot devices.

### Pros

#### 1. Cost saving

- reduced purchase, installation and wiring cost (Dozens of buttons, pilot devices, panel meters and/or chart recorders can be very expensive.)
- reduced maintenance cost (With the embedded remote monitor/control function found in our and many other HMIs, operators can troubleshoot and maintain the system from anywhere in the world without the time and expense of travel.)

#### 2. Panel space saving

- allows more data to be displayed in a smaller area

- able to view detailed information and error message for operator
- able to provide many more options for operator input.

#### 3. Flexible and powerful

- quickly and easily control, monitor and edit PLC and other controller data
- easy troubleshooting
- easy to modify the operator interface by changing the software programming, as opposed to hardwired devices which are very expensive to add, particularly to an existing panel.

#### 4. Fast response time

- with email alerts, operators can be instantly alerted when a machine malfunctions
- operator can act quickly, minimizing downtime and increasing productivity.

#### 5. Safety

- HMI provides wide range of functionality and communication so operators can control the device or access historical data from anywhere
- operators don't have to be near the panel.

### Cons

- some applications may still require e-stop push buttons for safety and other reasons
- push buttons provide better tactile feedback
- must learn how to use HMI programming software.

— Linda Htay, product manager, IDEC, [www.idec.com](http://www.idec.com)

## GET MOBILE

Besides the obvious benefits of having a visual representation of your machine—real-time statistics, customizable alarms, simple graphics/system modifications, easier troubleshooting—HMIs offer many behind-the-scenes features that no indicator light or push button can provide.

HMI can also provide email capability, where the HMI can email important data to you wherever you are. They offer Web-server functionality so you can log on to the HMI from anywhere in the world to check status or control your machine. They provide data logging so you can record production data for future reference, analysis or troubleshooting efforts. Some HMIs also offer mobile apps

for your smartphone so you can even check on production while on the go (Figure 1).

If you're trying to justify replacement of a half dozen indicator lights, then you should look at basic HMIs, which can provide touchscreen control, and maybe for less than you're paying for those indicator lights when all purchase, installation and wiring costs are taken into account.

The only con I see would be having to run a communications cable to the HMI to achieve the networking capabilities, and making sure the HMI has security built in to keep unwanted users out.

— Bill Dehner, application engineer, AutomationDirect, [www.automationdirect.com](http://www.automationdirect.com)

### MOBILE APPS

**Figure 1: Mobile apps can let remote workers interact directly with a PAC via a window into an HMI through a smartphone or tablet. Given proper security credentials, status can be viewed and changes can be made to alleviate issues.**



(Source: AutomationDirect)



## RETROFIT FOR IMPROVEMENT

There are lots of pros in adding HMI and automation to older technology machines. But as in life there is always a balance to consider between the costs and the benefits that are derived from that endeavor.

The most common thing is to start with questions to be answered, and as you would expect the devil is in the details of this.

Adding HMI to an older design of lights, buttons and fault annunciators at the very least can modernize the look, touch and feel of the end-customer product. But diving a little deeper, the ability to add things like user failsafe (multi-touch with both hands on the screen for startup) and other features is how this is really justified. User feedback such as product count, machine uptime data and a machine maintenance scheduling algorithm based on actual machine usage can become a real way to enhance a product for better competitive edge.

When you look at the end points, the data acquisition (DAQ) for the lights and buttons and annunciators (user I/O), the building blocks from a sensor/DI, DO, AI, AO (digital/analog input/output) are already in place for the basics. So adding a basic HMI panel with entry-level HMI software isn't all that big of a leap and actually isn't also that costly. So the first question to answer is how difficult will this really be to accomplish? That starts with things such as, here

is what it does today. If I only modernize that into an HMI operation, what does that do for me. That starting question has to be answered on multiple levels.

What is the end-user benefit? Will this make this machine better, more modern looking, more competitive in the market place? Usually those questions are subjective but really become the most important long term.

Then the next consideration is what enhancement(s) would I like to do? Answering that is where this really gains momentum. I always paint the mental picture: You start with DAQ, then move to machine control (PLC/PAC or soft versions of that) and then upward to SCADA and enhanced networking and control—being able to measure, manage and report (all on the fly, so to speak). Also, regardless of whether this is a box-making machine or a more complex assembly line, automating manual tasks always brings long-term cost reductions that overcome most if not all objections.

Another very important variable is that there are a wide range of HMI solutions that range from surprisingly low cost to very capable albeit much more expensive solutions. There are a lot of entry-level HMI solutions that have the software/hardware bundled to make it very cost efficient to get into the HMI-enabled product offering. The HMI software (low tag count) lets you get started with relatively low startup costs and

get a solution on your product with some fairly impressive capability.

To site an analogy. Years ago automobiles had buttons, lights and annunciators, just like the box-making machine, so you could effectively drive your car. Today even the economy models are seeing dash-mounted small screens that improve safety, enhance the driver's abilities and overall improve the vehicle operation. One example is the back-up camera, which is becoming a standard option on a large portion of automobiles. The National Highway Traffic Safety Administration (NHTSA) has proposed legislation to mandate that by 2018. According to the NHTSA, the minor cost to enable that is far outweighed by the safety benefit.

When considering retrofit, there is a movement seen in recent years to repurpose and modernize equipment, especially once-expensive equipment with new capabilities. For example, a CNC machine can be retrofitted to bring newer capabilities to older existing machines utilizing new HMI technologies. Vision capabilities might be added to improve quality control and minimize waste. It offers follow-on business, too.

So, one main message in all of this is you can evolve the technology even into existing, older systems if the business case is there. And usually it is.

Are there any cons to this? Overcoming ob-

jections such as “why change?” or “it’s the way we have always done it” or, of course, the fear of the unknown in “how costly and hard is this going to be?”

I wish I could be standing beside the reader as he goes to convince his boss feeding him all the demographic data he needs to persuade his point. Employees who ask, “Why not?” are the ones who drive innovation in our world. And that is a very good thing.

— Tim Stone, North American HMI product manager, Advantech, [www.advantech.com](http://www.advantech.com)

## LIMITLESS COMPONENTS WITH HMI

Deciding to add an HMI to a product design involves much more than simply a line item in a bill of materials. You touched on some of these considerations—assembly cost, user experience, added functionality—in the question. I would add design flexibility and ease of maintenance to the equation. Certainly price is an important consideration, but you may be surprised at the attractiveness of many HMI offerings on the market. After accounting for all of these factors a reasonable decision can be made as to whether it makes economic sense to embark on a system upgrade.

First consider the cost of production. Replacing six indicator lights with one HMI will significantly reduce the complexity of the wiring diagram and hence the time it takes to assemble and test a finished product. Indicator lights consume I/O points on the

PLC. All of these wires can be condensed to a single communication cable; perhaps it becomes as simple as snapping in an Ethernet cable. This may not only save the cost of the indicator lights, but an extra I/O module used to drive them, not to mention the labor required to wire everything together. Maybe there are additional physical switches, such as stop, start, hand off auto (HOA), that can be brought onboard the HMI screen. Anything that can be done to reduce the complexity of the system will reduce the cost of production and have a direct impact on the unit cost, perhaps completely offsetting the additional cost of the HMI.

Let's consider user experience and functionality. Through the HMI project design, you can incorporate your company's brand and aesthetic into the everyday functioning of the product. The experience your customers have using the product every day is the most valuable advertising you can buy. Time and attention spent creating a customized and pleasing user interface can be rewarded with customer loyalty and increased sales. Customization is much easier to achieve using HMI configuration software than in modifying a face plate or modifying hardware.

The next thing to take into account is the flexibility you receive when you move from discrete components to an HMI. Once an HMI is incorporated into the design, you don't merely have six indicator lights, you have the option for an infinite supply of them. And

not only that, but a vast store of all kinds of other useful objects you can add to the system. It is difficult to anticipate exactly what a given customer's needs are going to be in advance. For example, in addition to real-time alarm status a customer may like to see an alarm history to get a sense of how often and why alarms occur. With an HMI, you can easily adapt to such a request with little to no impact on production.

There are many machines out there that do very simple tasks and do them well, but they will never do anything more. If this is the case for your particular product, it may not be worth the effort and expense of a design update. However, customer expectations and competitor capabilities rarely remain static for long. By incorporating an HMI into your machine design you can reduce complexity, while enhancing functionality and future flexibility. This may be the last hardware revision that is made to the system, but it enables continuing expansion of the features and capabilities of the product. The cost of any particular component should be weighed against the benefits it can have throughout the lifecycle of the product, not simply by the upfront cost of the component.

— Mike Sheldon, applications engineer, Maple Systems, [www.maplesystems.com](http://www.maplesystems.com)

## **COMPETITION, INFORMATION, SECURITY, CHANGE, TRANSITION**

You have already stated several of the

many potential advantages to replacing mechanical indicators and controllers with human-machine interface (HMI) software. The packaging industry is one of the largest industries today, utilizing HMIs with well-proven commercial and technological benefits. To help you out further, here are several ideas to discuss with your boss.

**Competitive advantage:** The OEM business is competitive, and demonstrating that your machine is better than the competition's can start with the very first impression, which is visual. Does your machine look outdated or state of the art? Does it look clunky, heavy and hard-to-use or clean, light and highly human-responsive? A bright screen with visually appealing graphics speaks value against bulb-type mechanical lights and stodgy push buttons.

**Information advantage:** HMIs are not just pretty pictures. They can provide a plethora of information that can be used to your advantage, giving your customer an overall better experience over the lifetime of the machine. A simple HMI can log usage statistics, error codes, user ID, date and time of certain events and alarms, as well as communicate this information over a network or WAN even back to you, the OEM manufacturer. How helpful would it be for your customer to monitor the machine for performance and maintenance and for your OEM company to be able to monitor all your machines in the field, gathering usage

data to help to diagnose and predict potential breakdowns and maintenance needs?

**Security advantage:** HMIs can be easily configured to require password-protected logins and track that information. Customers can now be sure that only authorized personnel are able to operate the machine at a particular time and can even assign different levels of authorization such that an operator can enable certain functionality while only a supervisor or maintenance person can enable other higher functionality or support.

**Change advantage:** The only constant is change. Changing the characteristics of an HMI is a simple task, all done within the software. If in the future your machine requires more or fewer lights, switches, toggles, controls, or even changes due to environmental or regulatory requirement changes, making changes to the HMI is dramatically faster, is easier, requires less machine redesign and is more cost-effective than changing mechanical characteristics of a machine. In addition, by using an HMI, the OEM company no longer has to access, stock, ship or install backup and replacement mechanical parts.

**Transition required:** Moving from mechanical interface to an HMI requires a transition, but so did moving from rotary phones to smart phones. Do these types of transitions require some planning, effort and training? Yes. Are they worth it? Of course. Also, be

aware that software itself does change over the years, and it needs its own upgrades.

This is why you want to look to an HMI vendor that excels in simple smooth upgrade paths to minimize the impact to your work.

— Gary Nelson, product marketing manager for Wonderware HMI supervisory engineered solutions, Schneider Electric, [www.schneider-electric.com](http://www.schneider-electric.com)

## SIGNAL TOWERS

A well-designed HMI system can be an incredible tool for machine operators to have both control and machine feedback simultaneously. But hardware cost is just the first step to integrating an HMI solution. The different types of software available allow for many forms of data to be shown on screen, which are dependent on what the operator needs to interface with. The conversion of data can be very complicated, may require a dedicated team of system engineers to integrate this system onto a machine and also may carry a price tag to match. Signal towers on the other hand can be installed quickly, can be seen from a distance when maintaining multiple machine and have fewer moving parts where problems can occur. Towers are also becoming smarter—being PC-programmable, having 21 colors in one unit that can illustrate progress information or including network connectivity so they're enabled for the Internet of Things (IoT). These towers can provide machine feedback similar to an HMI while also utilizing normal tower functions and benefits. Both HMI and signal towers add their own

value to your machine. And if your boss is cost-conscious, you may want to look into some smart signal towers that add more value than standard indication lighting, but at a fraction of the cost of an HMI.

— Sopan Khurana, technical engineer, Patlite, [www.patlite.com](http://www.patlite.com)

## VIRTUALIZATION AND MOBILITY

The primary benefit is that HMIs allow operators to visualize the current state of machines and the ability to control and troubleshoot processes. In addition, teams in the plant gain a view into the automation system in order to track alarms and process variables and changes. When manufacturers lack an HMI solution, they can only react to a machine state after the fact, which often leads to costly downtime.

Today, the benefits of HMIs are extended by their support of virtualization and mobility. The latest graphics engine improves user experience and drives better operator decision-making. These new technologies may require additional effort when deploying the HMI solution; however, the benefits outweigh the cost.

An HMI system will not only provide more in-depth information on downtime events, but also provide more information on critical alarms. To recover from a downtime event, manufacturers can assign corrective actions and detailed instructions for operators. The software also tracks events and changes made to the machine, so you

are aware of who, what, where and when any actions occur.

Information is fueling growth for manufacturers. The HMI is a first step into accessing contextualized, real-time information that helps a manufacturer and the plant-floor teams get the most out of production. The indicator lights provide a status check, but do not provide context or actionable information to operators or engineers. Ultimately, HMI solutions offer increased productivity by providing information to the right users at the right time.

— Chirayu Shah, product marketing manager, Rockwell Automation, [www.rockwellautomation.com](http://www.rockwellautomation.com)

## DYNAMIC USER INPUT

Important considerations that factor into this conversation include complexity of the system, control system infrastructure, what existing products and their costs could be made redundant and eliminated and the machine-specific business case of whether an HMI could facilitate enhanced value.

From your question, it is clear you are looking for an HMI to provide the capacity to enhance the overall system design. To this end, consider whether dynamic user input may be useful for operating or reconfiguring the machine in a more intuitive way. Would enhanced diagnostic information for the operator have the potential to reduce performance bottlenecks or inefficiencies within the design itself?

In determining the impact on overall cost, it may be that other component costs, such as industrial-grade indicators, switches and associated wiring could be reduced or removed. Furthermore, some newer HMI devices are also capable of performing controller (PLC) functions, as well, thus consolidating the cost of a dedicated controller. This device functions as a PLC with fieldbus scanner capabilities for flexibility in collecting I/O signals from throughout your machine.

— Dan Klein, product manager, fieldbus technology, Turck, [www.turck.us](http://www.turck.us)

## COTS SOLUTIONS FOR OI

Have you thought about using off-the-shelf mobile devices to replace your industrial OI? Increasingly, automation engineers and technicians are seeing the value of using commercial, off-the-shelf (COTS) mobile devices for situations such as remotely accessing equipment, commissioning and maintaining systems and providing inexpensive machine operator interfaces.

Most of us have quickly gravitated to smart phones and tablets in our personal lives, emailing and texting, playing games and reading, posting on Facebook and Twitter, watching videos and taking them, even banking and paying bills online.

COTS products are attractive for several reasons. Development costs have been spread out over a broad market, so the product is less expensive to buy. Products

are readily available and can be quickly acquired or replaced. You don't need to wait months or years to get them; nor do you have to keep expensive spare parts in stock. Because products in the general market are used by a wide range of businesses, common standards are often built-in, making interoperability easier. Due to competitive pressures, more frequent product updates add new features and support for the latest technologies. Support and training costs are lower because the product is well-known and familiar to technicians and employees.

These are the same reasons industrial automation experienced its own move to COTS hardware nearly 20 years ago, when PCs first began to infiltrate the factory floor. Off-the-shelf PCs are now an integral part of our industry and used in a variety of settings.

It's no wonder off-the-shelf smart phones and tablets are appealing for industrial HMI and OI applications. They're compact, lightweight, affordable and readily available. They offer powerful processors and high-definition screens with multi-gesture touch. They have built-in wireless networking (IEEE 802.11) and security protocols (Wi-Fi Protected Access II, or WPA2). Lots of developers know how to program for them, so useful Web-based and native apps are appearing quickly. And COTS mobile devices are familiar, especially to younger engineers, so training costs are much lower.

An increasing number of manufacturers are making tools available, so you can create a mobile interface for your equipment or system, or you can adapt an HMI you already have.

— Matt Newton, director of technical marketing, Opto 22, [www.opto22.com](http://www.opto22.com)

## KEEP IT TETHERED

Based on the application and the three scenarios of new design, existing design and retrofits, a graphical pendant station (handheld tethered HMI) would be an ideal simple solution.

The challenge of existing design and retrofit (installed base) is that, with the traditional panel-mounted HMI, the enclosure itself would need to be modified for installation of the HMI or an entire new enclosure be potentially costly and labor-intensive. The ideal placement of a panel-mounted HMI is typically at the operator's eye level, which may also be a challenge for current or retrofit design. A graphical pendant station would be a less-intrusive solution since mounting would only require an easily attachable mounting bracket. For the tethered cable connection to the PLC inside the enclosure, using an existing indicator light panel hole would be an option since that indicator would now be represented on the HMI screen itself. With the graphical pendant station being tethered, an operator can hold the HMI to maximize the viewing experience.

To address your concern and needs for the new design scenario, the graphical pendant stations typically have other features integrated into the product—for example, an integrated e-stop switch and integrated dead-man switch. These integrated features would allow your customers some mobility to operate and/or troubleshoot your machines from different vantage points. Beyond these unique features associated with a handheld HMI solution, the advantages of having an HMI in general would be the ability to have typical HMI functions available such as alarm time stamping and alarm/data logging and improvement for preventive maintenance activities.

— George Caudle, HMI product manager, Pro-face America, [www.profaceamerica.com](http://www.profaceamerica.com)

## HMI-INCLUSIVE

Over the past few years, we've seen our OEM customers wrestle with this issue quite a bit. In certain instances, the lower cost of more traditional components may win the day, but for customers interested in understanding overall operational benefits and total cost of ownership, incorporating HMIs into your equipment can provide ongoing return on an initial investment. So, what are the reasons to include HMIs in your equipment designs?

**Increased productivity:** HMIs can deliver increased productivity from the equipment operators, offsetting the price of a more advanced interface. By delivering a menu-based consistent interface across the equip-

ment with easy-to-follow instructions for each stage in the process, your customer's time to onboard and train operators can be greatly reduced.

Some HMIs offer features like SMS message or email alerts that can be combined with machine-top alert lights to indicate when critical processes are interrupted. Operators are able to tend more cells of more machines since they needn't be in close visual proximity of a machine to receive event notifications.

Further, with features like Web serving and HMI virtualization, your customers can stay connected with their equipment from anywhere and understand which jobs are running, when they will be completed and when the machine will be available for the next job.

**Greater operational efficiency:** Regardless of industry, operations managers and finance teams are constantly looking for ways to output more products with less error, downtime and scrap. An HMI is far more than a display-based push-button replacer, instead providing integrated, customizable data-logging functionality capable of capturing and reporting data to the operator on a screen or in a variety of common formats used by OEE packages in the back office. Once the data is captured and centralized, analysis provides opportunities for improvement that simple lights and buttons just can't offer.



Efficiency also gets a boost when machine operators are able to handle routine troubleshooting independently. HMIs provide an interface for graphic diagnostic messages with step-by-step troubleshooting instructions at the machine, eliminating or reducing the need to contact tech support, maintenance or a manual. And if an issue exceeds the ability of the operator to manage it, the event- and data-logging capabilities of the HMI can greatly simplify the work of your technicians to correct the issue.

HMIs also provide operator guidance when production changes, offering menus to guide an operator through changing parameters relevant to the new project and again lessen your customers' downtime costs. Improved profitability: The ratio between the investment you make as an OEM to incorporate HMIs in your designs and the

value your customers place on the new features is not 1:1. Improved ROI through gains in productivity and efficiency yield ongoing benefits to your customers, and this ongoing use value can enable you to command a higher price for these value-driven features and drive more sales.

Push buttons and indicator lights still have a place in equipment like yours, and we don't see having an HMI as an either/or proposition. Given the features available today, we recommend conducting a thorough voice-of-customer investigation and possibly test your market by offering a mid-range to premium HMI-based version of your product. It could be a great way to build your boss's confidence in an HMI's place in packaging.

— Jeff Thornton, product management—indication & interface, Red Lion Controls, [www.redlion.net](http://www.redlion.net)