

WHITEPAPER

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## HMI/SCADA Design Fundamentals - Building for Situational Awareness

Authored by:

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### **Executive summary**

Manage the increasing volume of process data with the proliferation of the IIoT and an increased span of control. Discover a results-driven approach to HMI design with situational awareness as a cornerstone where operators can benefit from superior operational context to help streamline and optimize operations.

# Introduction

The users of modern industrial systems aim for continuous improvement in the availability and maximum efficiency of those systems without compromising the quality of offerings or safety of operations teams. One area where improvements can have significant impacts is quite literally staring them in the face; the human machine interface used to control and operate these systems. By implementing a broader spectrum in the capabilities of software tools used to control and operate industrial systems, operations teams can significantly improve both the business value and the safety of industrial systems with minimal cost investments.

## Continual evolution

The way people have interacted with industrial systems has changed dramatically, as depicted in Figure 1. These changes were driven by operations staff to improve the way that they use, manage, and maintain systems, coupled with advances in technology that facilitated those improvements.



Figure 1: An illustration of industrial operator interface evolution

## Proliferation of IIoT and the increased span of control

The number of components used in modern industrial systems increases as the cost of connected devices fall, improvements in the reliability and bandwidth of networks allows more equipment to be connected, and native communication protocols offer plug-and-play capabilities for integration, while increased demands on industrial systems are driven by the business needs of larger global markets. This rise in expectations is intensified by the exponential growth in the Internet of Things (IoT) and its application to industrial users in

This evolution is organically driven by market requirements combined with advances in technology that address new needs and provide further opportunities for improvement.

That is why a system capable of evolving with industrial requirements can offer significant advantages over proprietary solutions or hardware manufacturer restricted options.

There are several trends in current implementations of industrial automation Human Machine Interface (HMI) systems driven by today's market requirements. The trends currently driving the needs of industrial HMI application design are larger systems, greater volumes of data, increased levels of automation, staffing proficiency issues, and expanded use of remote operations. Each of these industry trends poses new challenges that can severely impact the ability for an operations team to achieve optimal business performance of their systems and safe operations.

Modern operations teams are using fewer resources to staff these systems increasing the responsibilities of an operator, while the techniques to manage these systems lack standards and were not designed for managing an evolving volume of data and equipment.

Another key factor in the growth of systems has been the integration of much larger geographic areas into single systems. These larger systems allow users to make key operational decisions in real time, such as determining which production facility can produce a service or product at the least cost. The expense and reliability of networking systems together continues to improve, and as a result these integrated systems are commonplace today. Regardless of the business driver, the effect of these larger systems can easily overload the operator with much greater volumes of data than they can efficiently manage.

### **Greater volumes of data and the increased operator load**

Even as system complexity grows, the equipment itself is generating more data. In the past, a single transmitter may have generated only a single value connected into the monitoring system, but modern transmitters have additional diagnostics, onboard control, and many tuning parameters all of which increase the data density per component by multiple orders of magnitude. In many cases the user interfaces that contain this data have not been designed to optimize the operator interpretation of this data and further compounds operator overload.

### **Increased levels of automation and the unintended consequences**

To reduce the variability that human operators can introduce, more functions performed in industrial automation systems are automated by control loops and process sequences. These control loops and process sequences do offer the operator some relief from the factors previously discussed that increase their workload but may also have unintended side effects. As operations teams are rarely involved in the design and implementation of industrial control systems, they have little understanding of the actions being taken by the system and may become disconnected from the process.

This generally leads to an over-dependency on the system to drive operator behavior through mechanisms like alarms or process interlocks. It is common to hear that operations teams are reduced to either resolving interlocks or reacting to process alarms. In this type of environment, the operator is performing reactively and therefore cannot prevent disruptions or predict future trends.

### **Staffing issues and the impact on proficiency**

While control systems continue to evolve, user interface design techniques have remained relatively unchanged, increasing the time required to implement new elements and delaying operators in become proficient at utilizing these systems. As a result of deficiencies in system design, it is now commonly expected to take about two years for an operator to become proficient with a system. Further complicating this are conditions in the market that shorten the length of employment for skilled operators. Operations staff have greater opportunities today to seek employment elsewhere or advance through their organizations. These and other factors result in an average term of employment at or just below two years, meaning that operations rarely function at maximum proficiency. Another common concern is the impending retirement of skilled employees who best understand these systems. There is a growing need to replace these experts and bring replacements up to speed quickly. Something must be done to reduce the amount of time taken to achieve both operator proficiency and decrease variability in the quality the process execution from one resource to another.

### **Remote operations and the challenge of distance**

Advances in networking technologies and reduction in costs for these technologies makes it possible to remove the operator from the geophysical location of the process. This is often driven by needs such as safety, optimizing staff utilization through increased span of control, or a need to locate the operations where subject matter experts are available. Whatever the business case, this separation presents further challenges to operations teams. Operators can no longer employ the same observational methods as they can when located near the actual equipment. Many describe their understanding of the equipment and process status through observing sound, vibration and smell alone.

When the operations are remote and these additional senses are no longer available, the operations team becomes even more dependent on the effectiveness of the HMI in communicating the state of the system or process. But too often the user interface has been implemented by recreating and animating the Piping and Instrumentation Diagrams (P&ID). Unfortunately, P&IDs were never designed to overcome these challenges, and this results in operators that poorly understand their systems and how to properly manage them.

## The impact of human error

With control system design trends pushing the limits of operations teams, a common result is interruption and inefficiency due to human error. These errors account for 42% of abnormal situations in industrial systems<sup>1</sup> which unsurprisingly have a direct correlation to economic losses and safety concerns.

### Economic losses

Abnormal situations in industrial processes directly result in economic loss due to a total or partial loss of system availability, reduced efficiency of the industrial process, or reduced quality of the resulting product or service. Studies indicate that loss of system availability costs industrial systems 3-8 percent of capacity.<sup>2</sup> These inefficiencies can result in a great deal of economic loss over the lifetime of a system and are likely much higher due to secondary effects.

However, these losses can be prevented, and if an approach to improve HMI design is not taken, it is highly likely that the amount of loss will continue to increase. Far too often the business value of a process is poorly understood by the operations teams and completely ignored in the development of the HMI design.

### Safety risk

In many industrial processes there is significant potential for bodily injury or loss of life. There are multiple factors to consider for overall system safety including, but not limited to, alarm management, control loop performance and the HMI design. In this document we will limit the discussion to the HMI aspects of safety while recognizing it is a much broader topic. In the investigation of many industrial accidents the HMI design has been cited as a contributing cause.

One of the most common ways that HMIs communicate potential safety issues is through alarm notifications. However, in a recent survey of industrial systems users, nearly 70 percent of respondents indicated that alarm overload impacts their ability to properly operate the production process.<sup>3</sup> The techniques for alarm communication that are commonly employed in HMI design do a poor job of enabling an operator to quickly assess the severity of many alarms and decide on the appropriate action. Without an improvement in how this critical information is being communicated and processed, the overall safety of the system is being compromised.

### Business value model

In just about any industrial process there is a simple model that can be used to describe the business value of the process as depicted in Figure 2. While many processes vary in terms of the product or service they produce, just about any process has raw material and energy inputs and product/service and waste outputs.

The key goal for the process itself is to maximize availability while minimizing the costs (raw materials, energy, and waste) and maximizing the quality and quantity of the products and/or services produced. Unfortunately, the HMIs that are used to operate most of the industrial processes in the world were designed with the main purpose of achieving or maintaining a certain operational state rather than optimizing the performance of the business.

To best drive the business value of these systems the design must take the business values into account. The process needs to be analyzed to determine which decisions the operator should be making to drive the desired business outcome. Once these decisions are known, the user interface should be designed in a manner that facilitates those decisions and drives the operator to action.

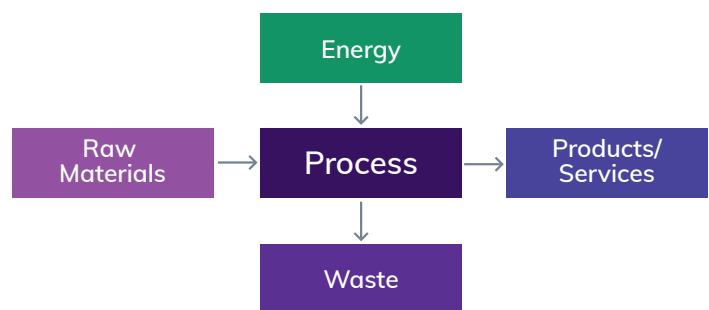


Figure 2: Generic industrial process business value model

# A results-driven approach

The cornerstone of improving the overall HMI design is to deliver situational awareness. Only by achieving situational awareness can the operations team make effective decisions that will deliver overall business success. In Figure 3 situational awareness has been broken into 3 levels; perception, comprehension, and projection. Most HMI applications only assist the operations teams in achieving the first level; perception.<sup>4</sup> HMI applications often only place a numerical value representing a current transmitter signal on the screen in a location that will orient the origin of the signal to the operator. How the operator processes this information will vary greatly based on their experience level.

The HMI should provide information that will facilitate attaining the second level of situational awareness; comprehension. In addition to the current value of the transmitter signal the HMI should provide the operator with a clear indication of the expected value from the transmitter. Typically, the difference between experienced operators and the inexperienced operators is that the experienced have memorized the system parameters and have familiarized themselves with the expected values.

By providing this information up front it is possible to empower an inexperienced operator to behave more like an experienced operator. However, in most cases, even the most experienced operators will inconsistently achieve the highest level of situational awareness; projection. To reach projection, the system must enable operators to determine if an action is required, and understand the consequence of that action or inaction. The good news is that there are tools and techniques available to improve the operations outcomes through goal-oriented design, effective window structure, effective color usage, actionable alarm management, and effective design elements.

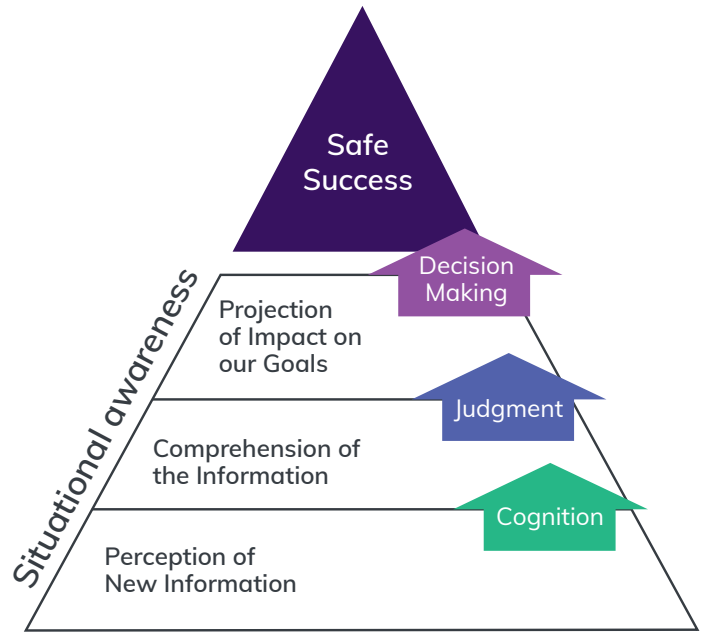


Figure 3: Three levels of situational awareness

## Goal-oriented design

Achieving safety and economic goals are critical to delivering the expected business value. However, if the safety and economic goals of a process are not considered during the design of the control interface and implemented, then it is doubtful those goals will be achieved. To better achieve the benefits of an efficient system, safety and business objectives must be central to the initial design phase of the HMI application.

One method for assisting in designing and identifying the goals of an application is called the Goal Directed Task Analysis (GDTA).<sup>5</sup> As depicted in Figure 4, the GDTA process begins with the major business goals of the system. An example of a business could be to minimize the cost associated with energy.

From these major goals an analysis of the system will be performed to determine sub-goals. The sub goals will be more specific outcomes that are directly related to the process, such as minimizing steam utilization during the cleaning process.



These subgoals need to be actionable. It must be understood what decision the operator is being asked to make and then design the HMI so that an operator can be easily trained on how to make that decision and ultimately achieve the primary goal. For each sub-goal it must be considered how the operator will attain Level 1 perception, Level 2 comprehension, and ultimately Level 3 projection. Only once the business objectives of a system are clearly understood can the system itself be designed to achieve them.

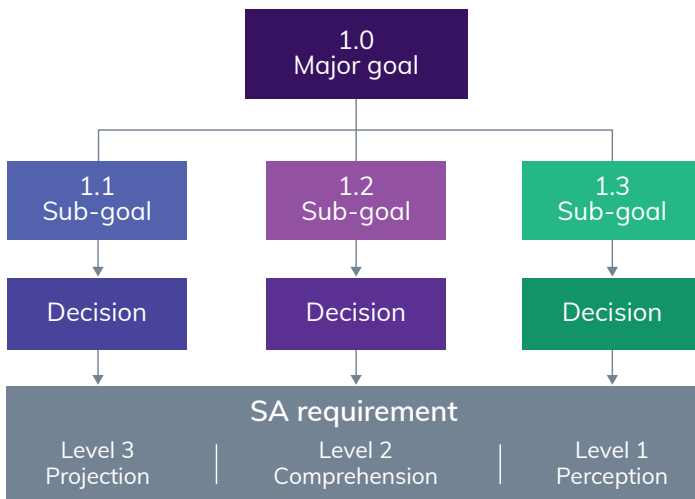


Figure 4: Goal-decision-sa requirement structure

## Effective window structure

An extremely common method of designing the window layouts of an industrial HMI is to simply replicate the P&IDs and then to provide navigational methods to each P&ID representation. By utilizing the P&IDs, the design effort is very low but the issue with this approach is that the P&IDs were not created with the intention of the operations teams achieving key business goals, and this design approach rarely achieves them.

Another common approach taken when there is a great deal of information contained within a system it to pack in the content as densely as possible. At first glance this may seem logical, but this approach only serves to overload the operator. Research has shown that on average a person can only process about four chunks of data at a time.<sup>6</sup>

With this in mind, we must use an approach that will allow an operator to scan as few items as possible to determine if an action must be taken. To best achieve this, the system needs to be modeled in a Level 4 hierarchical nature as depicted in Figure 5. The windows and navigation in this structure will effectively orient the user to awareness, action, or details depending on the window Level being observed.

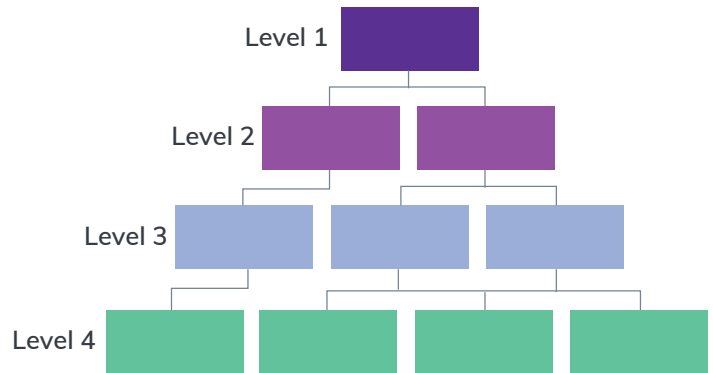


Figure 5: Effective HMI window structure

## Level 1: Area-wide overviews

The top of the structure or Level 1 windows will provide all of the key design elements that will communicate to the operator the information required to attain the projection Level of situational awareness for the key sub-goals identified in the GDTA (performed as part of the Goal-Oriented Design).

Level 1 windows will very rarely look like the actual process but instead will more resemble an information dashboard as illustrated by the example in Figure 6. The most important aspect of the Level 1 windows is to drive operator awareness and facilitate a determination of when action or further investigation is required and guide access to the Level 2 windows.

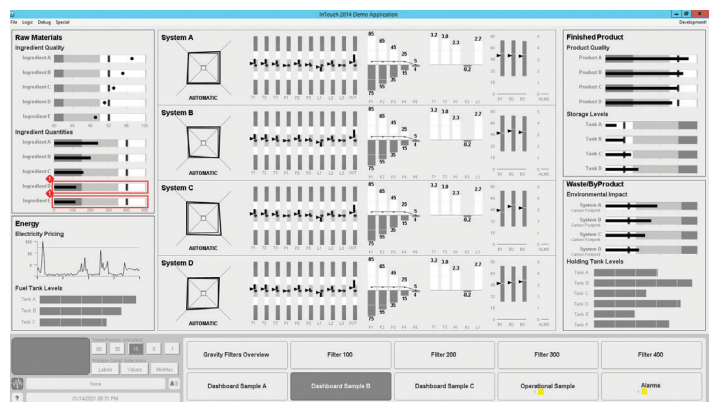


Figure 6: Level 1 Window example

## Level 2: Facility-wide overviews

Once the Level 1 windows have created awareness of a need or prompted investigation, the next step is accessing the Level 2 window, which will enable the operations staff to execute the required action or perform the required investigation. Since the needs of HMI applications vary so widely, the division of awareness and action may be specific to the needs of your system.

A common technique is to design the Level 2 windows as the main operational windows. When designing the Level 2 windows, the operator actions should be strongly considered. As shown in Figure 7 the Level 2 windows may contain elements that are recognized as process elements but are not expected to contain every detail. For example, if an operator is attempting to execute a system wide start-up procedure, then a specialty Level 2 window should be created that will consolidate the information and actions required during start-up on a single window.

Far too often the operator is required to move between many windows to execute a process, which can be slow and prone to error. This technique can dramatically improve the success and efficiency of extensive procedures. There may be more than one Level 2 display for each Level 1 window. When a more detailed analysis of the equipment state and detailed process values is required, the operator will have direct access to the Level 3 windows.

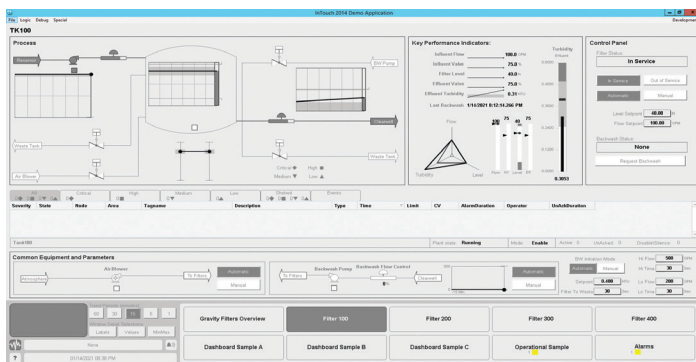


Figure 7: Level 2 window example

## Level 3: Detailed operating information

The Level 3 windows are those that most closely resemble the P&IDs of most systems, and are the most likely to already be present for existing systems. An example of a Level 3 window is shown in Figure 8. Observe that not every physical element (such as piping) needs to be included, as they rarely offer any valuable information.

These windows typically are used in support of the Level 2 displays. For example, if Level 2 displays are where process sequences are initiated, then the Level 3 display may be used to identify and clear process interlocks. The Level 3 windows will provide access to equipment status for all equipment in the scope of the associated Level 2 display. There may be more than one Level 3 display for each Level 2 display.

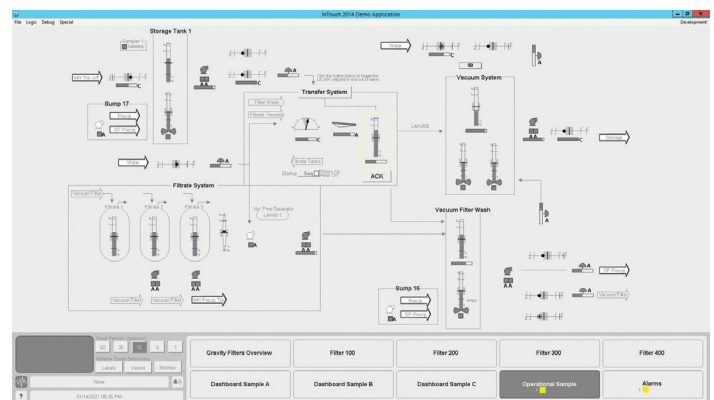


Figure 8: Level 3 window example

## Level 4: Auxiliary information

There are a variety of activities that can be performed from the Level 3 Windows and the windows that provide the supporting information for those tasks are positioned at Level 4. Typically, these windows provide trend analysis, event analysis, alarm analysis, loop tuning, help/procedural information and a variety of other content.

In Figure 9 a Level 4 window example containing a combined Alarm Summary and Alarm History window is shown. There may be more than one Level 4 display for each Level 3 display.

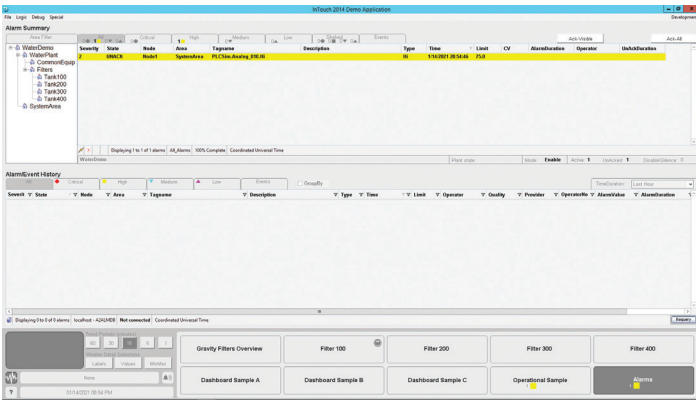


Figure 9: Level 4 window example

## Color and animation usage

When computers were first put into use in industrial processes for the purpose of HMI they had only the most basic graphical capabilities. Eventually the computing systems gained graphical capability and HMI applications also began to leverage these improvements with little thought toward operator efficiency. It has become commonplace for HMI applications to act as a show piece that emulates the process in a very visual manner, and often that visual presentation is used to justify the automation investment to key stakeholders.

However, these very elaborate visual approaches often impair the operator's ability to ascertain the current situation and ultimately make key decisions to maximize the business value of the application. In Figure 10 the process is displayed with three dimensional pipes and flanges that offer the operator no real information, gauges with artificial glare applied, use of the color red to represent several statuses, and a variety of other poor design practices.

The images shown previously in Figure 6, Figure 7, and Figure 8, demonstrate a much better use of color. There is a misconception that graphics designed for better situational awareness are not visually appealing. However, graphics that effectively communicate the state of the process to the operator are highly effective. A limited use of color draws operator attention to the point in the process that has deviated from a normal or expected state. When the system state is within expected norms, the process graphics should not emphasize and draw the operator's attention to these normal conditions, as that only serves to overload the operator's attention.

The utilization of animations should be with the deliberate intent of drawing the operator's attention and not just to make an impressive visualization. If operators are being distracted by spinning pumps or gradient shaded lights when they should be focusing on a process value drifting outside of operational limits, then the HMI is not likely to result in the improved ability to achieve the business goals or safe operation. While color should never be the only method used to communicate a value or state (up to 10% of people are colorblind) it can be a very effective tool for driving the user's attention. To ensure an optimal HMI design it is very important to establish and strictly utilize color standards.



Figure 10: Example of poor color usage

## Effective design elements

When designing and assembling an HMI that delivers effective situational awareness it is important to begin with a standardized set of design elements that will be used throughout the application. These design elements can be symbols or displays that have been optimized for their ability to communicate key information to the operator with minimal training and cognitive load.

These design elements will be optimized to achieve the appropriate Level of situational awareness (perception, comprehension, or projection) to manage the associated process. Trying to cover all the possible design elements is far too large a topic to address here. To illustrate the point, examples of meters with trends will be reviewed.



## Meters with trends

The most common approach to industrial HMI design has been to draw a P&ID style process depiction and to adorn the graphic with numeric values to indicate the current value of transmitters in the field. These numeric values typically are accompanied with the Tagname and units of the transmitter.

This method of presenting information has a large number of deficiencies that hinders an operator's ability to take that data and turn it into actionable information.

As shown in Figure 11, by indicating key alarm points, operational limits, optimal range limits, setpoints, and the current value in context, meters offer a great

deal more information and are much more effective in increasing the operator's situational awareness.

With this representation the operator can identify at a glance if the value is abnormal. When combined with a trend element, not only can the current state be communicated but the directional movement with rate can allow the operator to project where that value will be in the future and determine if an action is appropriate.

Trends are one of the most effective methods of attaining the projection Level of situational awareness for a data value and should be used liberally in industrial HMI applications.



Figure 11: Attaining different situational awareness level with different design elements

## Actionable alarm management

Alarms, by definition, are events that require an action. As such, alarms are a pivotal mechanism for driving operator actions. However, most systems generate a volume of alarms that simply cannot be handled by operators. In a recent survey 52% of respondents said they do not perform an analysis of their alarm systems to identify strengths and deficiencies.<sup>7</sup>

From these results alone, it's clear that most systems have an opportunity to improve alarm management. To begin to address this issue, all configured alarms in the system need to be reviewed to evaluate the alarm's severity. While it has been commonplace to use a very large number of alarm priorities, this practice requires the operator to understand as many as thousands of alarm priorities, which is impractical. Under stressful conditions this lack of understanding can directly lead to errors in judgment.

The best practices in alarm management recommend the use of four severities at most; critical, high, medium, and low. These severities define the maximum response time for the alarms as five minutes, thirty minutes, sixty minutes, and one hundred and twenty minutes respectively, as shown in Figure 12. These times are a starting point and can be adjusted to fit the needs of the process. If the event does not require an action in the time defined for the low alarm severity, then it should be changed to an event and removed from the alarm list.

The configuration of every alarm should be reviewed to ensure that the alarm is only triggered when an operator action is required to minimize the potential for nuisance alarms.

It may still be possible for the volume of alarms to be greater than can be processed by an operator, so methods must be used to allow an operator to identify which alarms must be actioned.

Alarm Severity	Expected Action Time Limit
Critical	5 Minutes
High	30 Minutes
Medium	60 Minutes
Low	120 Minutes

Figure 12: Alarm severities and expected action time limits

## Alarm borders

To ease the process of determining which alarms to action, each of the severities will have a unique mechanism for visual display comprised of unique color, unique shape and a unique identifier. Figure 13 illustrates this concept as alarm borders. In the example of a critical alarm, it displays the color red (and red is used for no other reason), it displays a diamond shape, and it displays the number 1.

This triple coding ensures that the critical alarms are clearly recognized. These borders can be used around any graphical element to draw the operator attention. Since there may be multiple alarms associated with an element these alarm borders also summarize all alarm information on the associated element to identify the most urgent alarm state for that element.

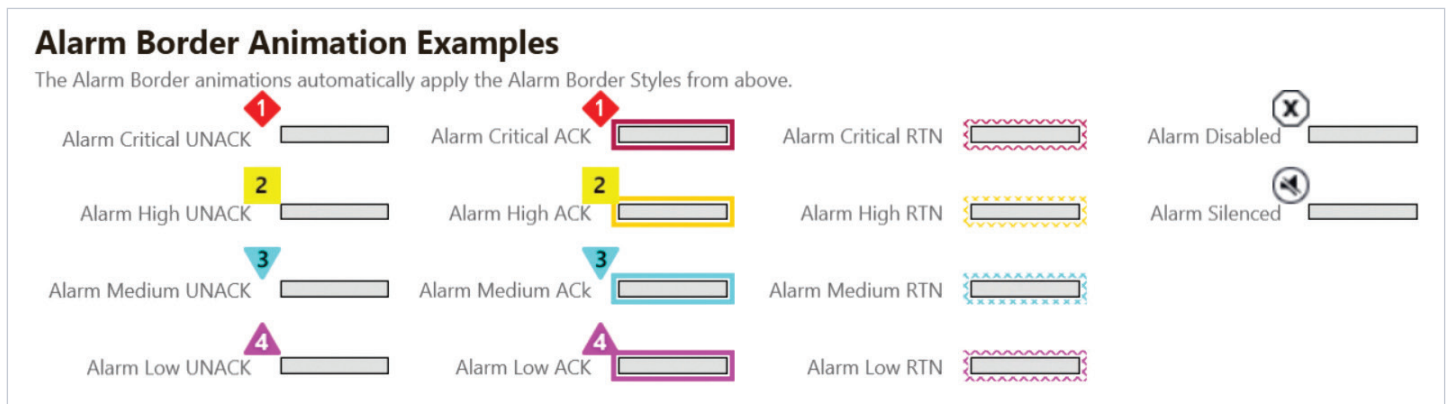


Figure 13: Alarm borders for each alarm severity

## Alarm aggregation

A common practice in HMI design is to display an alarm banner to expose the current alarms to the operators but too often these alarm banners only show a handful of the alarms and alarms of a lesser severity can often obscure alarms of a higher severity. By aggregating all of the alarms in a system in the same hierarchical

manner as the navigation structure it is possible to visually display the overall alarm state as badges right on the navigation element as is illustrated in Figure 14. In this example there are multiple alarms in the system and the operator can easily click on the desired button to navigate directly to the associated graphic to address the alarm.

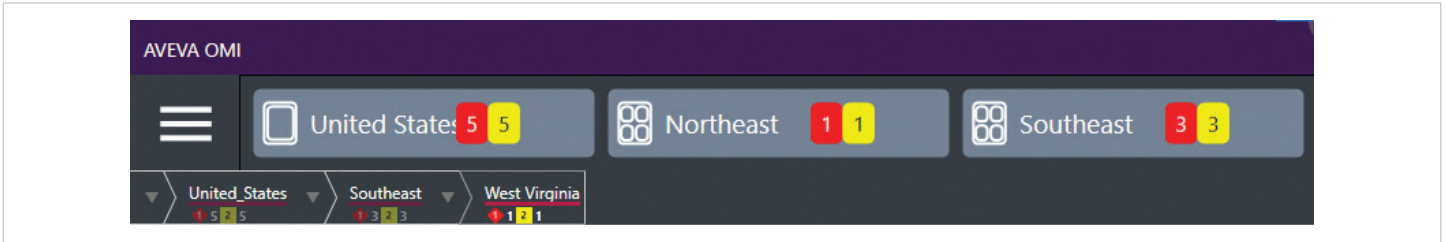


Figure 14: Alarm counts on navigation buttons

## Alarm cause & response

With the increased levels of automation and rising prevalence of staffing issues, operator experience across all areas of the plant is increasingly difficult to achieve. An operator without the necessary expertise, or access to an experienced superior/peer, can be put under immense pressure when tasked with diagnosing and resolving situations they have never seen before.

Especially in cases of alarm floods, inexperienced operators can often focus their attention on the consequential alarms, rather than the root cause, further delaying the necessary steps required to resolve the situation and return the plant to normal operating condition.

By providing a quick-reference guide, as shown in Figure 15, to the potential alarm causes, recommended responses, expected response time, and possible consequences of their inaction, the operator is supported through unfamiliar scenarios so they can respond more effectively.

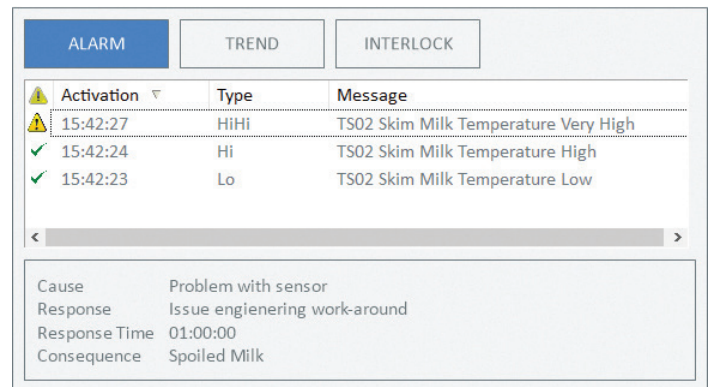
The image shows a window titled 'ALARM' with tabs for 'ALARM', 'TREND', and 'INTERLOCK'. The 'ALARM' tab is active. Below the tabs is a table with columns 'Activation', 'Type', and 'Message'. The table contains three rows of alarm data. Below the table is a scroll bar. At the bottom of the window is a section for 'Cause', 'Response', 'Response Time', and 'Consequence'.

Figure 15: Alarm cause and response information



## Alarm shelving

While regrettable, systems and instruments malfunction from time to time and require maintenance. A malfunctioning instrument often results in alarm conditions constantly being generated within the control system and acknowledging these repeated alarm incidents can quickly overload the operator, or worse, create undesirable learned behavior of automatically acknowledging the alarm.

Providing the ability to quickly shelve these nuisance alarms until they have been properly troubleshooted and fixed, as shown in Figure 16, is a mandatory requirement in alarming systems, and can be enhanced with support for shelving for a defined duration, as well as until a defined end date/time, rather than forcing the operator to separately calculate the shelving duration.

This should also be complemented with direct access to show all shelved alarms as shown in Figure 17, so these alarms can be individually restored after the necessary maintenance activity has been completed.

ALARM	TREND	INTERLOCK	
◇ 07:41:58 PM HH			TS01 Full Milk Temperature High H...
▽ 07:43:29 PM L			Temperature Low
▽ 07:41:48 PM H			Temperature High
△ 07:40:25 PM LL			Temperature Low Low

Acknowledge  
Shelve For...  
Shelve Until...  
Restore

Cause	Problem with sensor	>
Response	Issue engineering work-order	
Response Time	01:00:00	
Consequence	Spoiled Milk	<

Figure 16: Alarm Shelving

Shelved Alarms
User: Systems Engin...
07:41 PM

Wednesday, 16 December 2020

On Date	On Time	Name	State	Cluster	Equipment	Item	Shelved E...	Shelved En...	Shelved Comme...
◇	15/12/2020 09:23:48 PM	TS03 Flavoured Milk Temperature Hi...	OFF	Cluster1	Company.TopMilk.M...	HH	16/12/2020 08:40:29 PM		
△	16/12/2020 07:40:25 PM	TS01 Full Milk Temperature Low Low	ON	Cluster1	Company.TopMilk.M...	LL	16/12/2020 08:40:38 PM		
△	16/12/2020 07:40:18 PM	LS20 Bottle Tops Level High High	OFF	Cluster1	Company.TopMilk.B...	HH	16/12/2020 08:40:52 PM		
▽	16/12/2020 07:40:50 PM	TNK20 Filling Line 1 Tank Level High	ON	Cluster1	Company.TopMilk.B...	H	16/12/2020 08:40:57 PM		

**Cause and Response for selected alarm:**

Cause: Problem with sensor  
 Response: Issue engineering work-order  
 Response Time: 01:00:00  
 Consequence: Spoiled Milk

Figure 17: Display of all shelved alarms



## Dashboard tools

One of the key challenges facing operators is how to take many values and quickly relate them to identify patterns or problems areas as well as associating them to business goals as they are changing in real time. In Figure 18 a table of numeric values is contrasted with the same data in various charts. The tabular form is very ineffective in exposing the key trends in the values. But, by using Dashboard Tools such as charts and graphs this information can readily be processed

because the information can now be pre-attentively processed. This means that instead of having to take in every value and perform mental calculations on the relationships, the relationships can be readily seen by even the least experienced staff member. In contrast, even the most experienced operators will rarely be able to discern this information with traditional HMI visualization techniques.

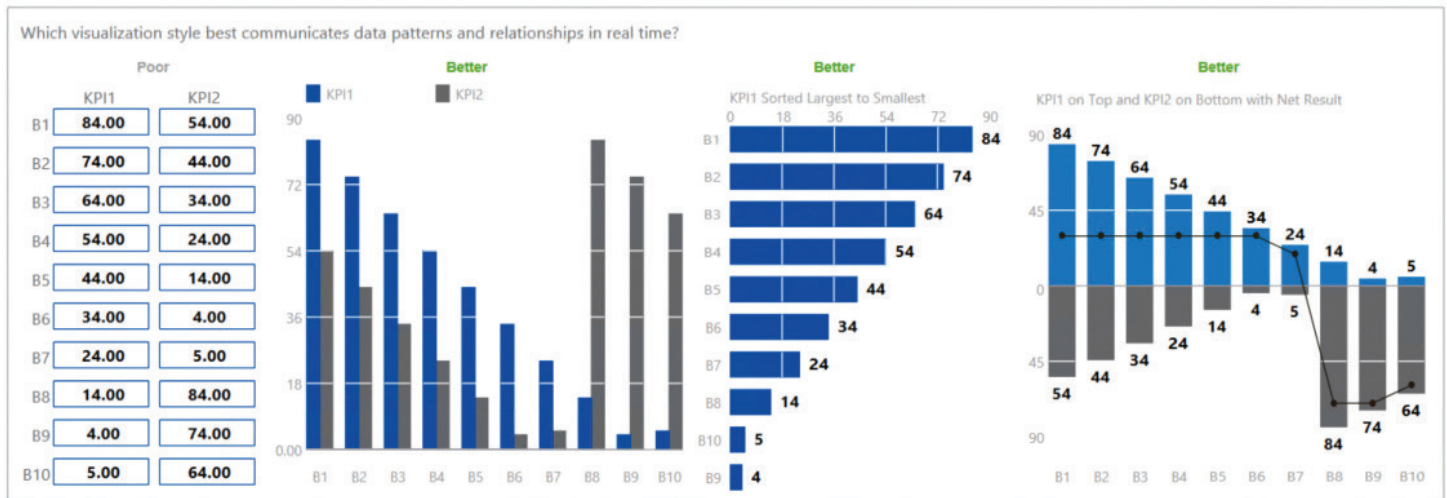


Figure 18: Exposing data relationships with a variety of design elements

## Putting it all together

Modern industrial systems evolve, generate greater volumes of data, have increased levels of automation, suffer staffing issues, and are commonly operated from remote locations. These changes in the industry require a new approach to industrial process visualization. A systematic approach to delivering situational awareness can greatly improve the likelihood of an industrial process achieving its business objective. Research studies have shown that these techniques make it 5 times more likely that an abnormal situation will be recognized before system availability is impacted than traditional techniques.

As industrial processes evolve, so will the design of the HMIs that are used to operate those processes. Figure 19 summarizes the key points of this evolution. Instead of asking the operators to focus on a large volume of process parameters, the data will be placed into context to deliver situational awareness.

Instead of viewing operations staff being viewed as labor resources they will be empowered as information craftspeople that will make key business decisions in real time. Instead of operating in a reactive mode the systems will be proactively managed to extract the maximum business value from those systems. And ultimately the focus of the operations teams will shift from merely operating the process to real time business management.

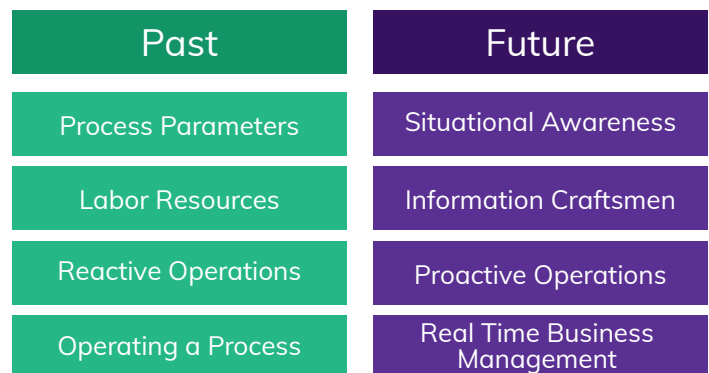


Figure 19: Evolution of industrial process management





## Pima County implementation of situational awareness strategy using AVEVA solutions

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Using an AVEVA HMI SCADA solution based on Situational Awareness and a mobile workforce system, the Pima County Regional Wastewater Reclamation Department provides management and maintenance of the county's sanitary sewer system.

This methodology enables personnel to be aware of the processes and systems in their operating environment, understand the information being presented, and acting on that information when needed.

The Situational Awareness strategy implemented in Pima County's AVEVA-based HMI SCADA uses goal-oriented design, effective window structure, color usage, and actionable alarm management.

The results have been quite dramatic. Operators who previously ignored too many nuisance alarms now take immediate action. Problems are identified and addressed right away before they escalate.

[Read the Success Story](#)

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“The new AVEVA HMI SCADA has enabled our Tres Rios facility to double capacity, while operating using the same number of staff, which is about a 50 percent increase in operational efficiency with a 10 percent reduction in energy consumption.”

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**Rod Graupmann, SCADA Manager,**  
Pima County, Tres Rios Facility

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“We've been able to notice a distinct improvement by operators when things are going wrong and to take suitable response and action.”

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**Larry Sawicki, Control Systems Engineer**  
Pima County, Tres Rios Facility

# About AVEVA

AVEVA is a global leader in engineering and industrial software driving digital transformation across the entire asset and operations life cycle of capital-intensive industries. The company's engineering, planning and operations, asset performance, and monitoring and control solutions deliver proven results to over 16,000 customers across the globe.

Its customers are supported by the largest industrial software ecosystem, including 4,200 partners and 5,700 certified developers. AVEVA is headquartered in Cambridge, UK, with over 4,400 employees at 80 locations in over 40 countries. Learn more about AVEVA at [www.aveva.com](http://www.aveva.com).

## References

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## About the author

**John Krajewski**, Sr. Director Product Management, John has 26+ years of experience in industrial automation and control systems. After acquiring a bachelor's degree in electrical engineering from the University of Delaware, John began his career working as a Control System Engineer in the potable water industry. Subsequently, John worked as an Application Engineer for a System Integrator who primarily focuses on the pharmaceutical and biotech industries.

He joined Invensys Wonderware in April 2000 as a Senior Application Developer in the Product Marketing Department. Shortly thereafter, John assumed the role of Product Marketing's Functional Manager of Infrastructure. John Spent 5 years as a Domain Architect with responsibilities for architectural and functional definition of InTouch and ArchestrA technologies. For the past 10 years John has served in multiple Product Management roles for AVEVA HMI/Supervisory Control products.