

Are You on Track? How Predictive Notification Keeps Production on Track

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Introduction

Introduction

Notifications are all around us. Anyone with a smart phone likely receives regular notifications from their phone “apps,” from informing us of imminent appointments, to telling us that a software update is available, what the latest sports score is, how our stocks are performing, or which of our friends have posted a photo. Notifications are so ubiquitous that the smartphone settings to manage them are high on the menu.

We obviously believe that notifications make our lives better because we have so many of them. So why don't we use them to help us better operate industrial processes? That could be because most notifications are post-facto. That is, they tell us what has already happened. What if we had applications that could accurately predict what is going to happen, and send us a notification in enough time to address the imminent event, so that we can avoid bad things, and, even better, exploit good ones?

This paper presents the state of the art of predictive notification for process industries producers, and how best-in-class technology-enabled services can utilize predictive notification to protect production, and enhance it through improved equipment availability, process performance and product quality.

Predictive in the playbook

Predictive maintenance has long been a part of the standard collection of maintenance strategies that are used by industrial producers everywhere (Figure 1). When regarding these strategies, it appears that Predictive Notification is part of the “predictive maintenance” strategy, and this is largely true.

However, when focused on the right equipment and processes, when employing the best expertise, and when understanding the value delivered, Predictive Notification can be the most important element of a *proactive* maintenance strategy. This may more accurately be characterized as a proactive service strategy, since “maintenance” implies keeping up with the status quo, whereas well-designed Predictive Notification can actually serve equipment and processes in a way that makes them better.

We obviously believe that notifications make our lives better because we have so many of them. So why don't we use them to help us better operate industrial processes?

Maintenance Strategy	Maintenance Approach	Possible Result
Reactive Maintenance	Fix it when broke	High costs, lost production
Preventive Maintenance	Schedule maintenance on a time basis	Effective resource scheduling, but possible failure inducement by regularly touching equipment whether it needs it or not
Predictive Maintenance	Condition-based monitoring	Maintenance based on equipment state
Proactive Maintenance	Detect failure source	Monitoring and correcting root causes

Figure 1. Standard maintenance strategies

The problems with predictive

It is hard to calculate a provable, sustainable return-on-investment on risk avoidance.

The problems with predictive

1. Indicative, not predictive

Technology providers for years have worked to achieve predictable outcomes for improved productivity. In the 1950s and 1960s, engineers took instruments that measured physical properties in the laboratory and mounted them directly on the production process, so properties could be measured on-line and adjustments made to improve production. Bolt-on machinery and control software were developed to automatically adjust properties on-line so that more and better product could be made faster. While these developments were extremely helpful, and still very much in use, they are indicative, not predictive. They measure and control post-facto parameters.

2. Predictive, not practical

In the 1970s and 1980s, companies began developing multi-variable predictive control algorithms, envisioning a scenario where the above-mentioned control technologies would be rendered obsolete through software. While capabilities in these areas can be impressive, they have not yet eliminated other kinds of measurement and control technologies that work in physical space and time. In many instances, their level of sophistication and sensitivity to dynamic processes are too high to be utilized practically. These developments are often relegated to academia, “thought leadership” or production processes with limited parameters.

3. Practical, but pricey

Progress was made in the 1980s and 1990s with condition monitoring that could detect, for instance, impending bearing failures by using technology to discern when frequencies generated by rotating machinery changed, indicating alteration in mechanics that might signal an impending failure. These technologies then sent a notification to personnel so that action could be taken to avoid failure that might result in production loss and maintenance expense. This approach improves upon human faculties for detection, and can concurrently monitor more pieces of equipment and process areas than humans can practically cover. But it can be expensive to deploy detecting technologies (such as tachometers) on all potentially affected process areas, and ensure that all signals are transmitted to a centralized collection device that monitors all inputs, with parameters set to alert humans who can take action.

4. Cost-effective, but incomplete

Many industrial producers contract with companies knowledgeable in predictive technologies to come to site regularly to measure signals to ensure that mechanics operate within established ranges. While this approach follows good time-based preventive maintenance practices (see Figure 1), it is not wholly satisfying as it may still miss catastrophic failures that may occur in the times between visits. This is a popular approach, partly because it avoids difficult-to-justify capital expenditures. It is hard to calculate a provable, sustainable return-on-investment on risk avoidance. It is easier for producers to accommodate the visitation service in an operational budget. Service providers are satisfied with this approach as it gives them predictable, repeatable revenue. Yet these services may not find impending failures, and almost certainly do not actually improve the process so that more of a better product can be made faster.

The problems with predictive

5. Experts are aging

Contracting with an outside service isn't all about capital request avoidance. Cost pressures have led many producers to reduce process engineering staff that might perform this service in-house. Other demographic dynamics limit the availability of this knowledge base. For instance, in many advanced economies, workers in industrial production facilities are getting older, and many years of process expertise is being lost to retirement.

A 2015 study by The Manufacturing Institute¹ showed that 93% of interviewed executives said the retirement of “baby boomers” (those born between 1946 and 1964) would impact the future talent shortage of skilled production workers. Additionally, 89% of these executives said the same applied to a shortage of engineers, researchers and scientists (Figure 2). So talent is getting older and wiser, but not more numerous. Experts are still in high demand; there just aren't enough to go around. This demands fresh thinking on how to propagate this knowledge.

Talent is getting older and wiser, but not more numerous. Experts are still in high demand; there just aren't enough to go around.

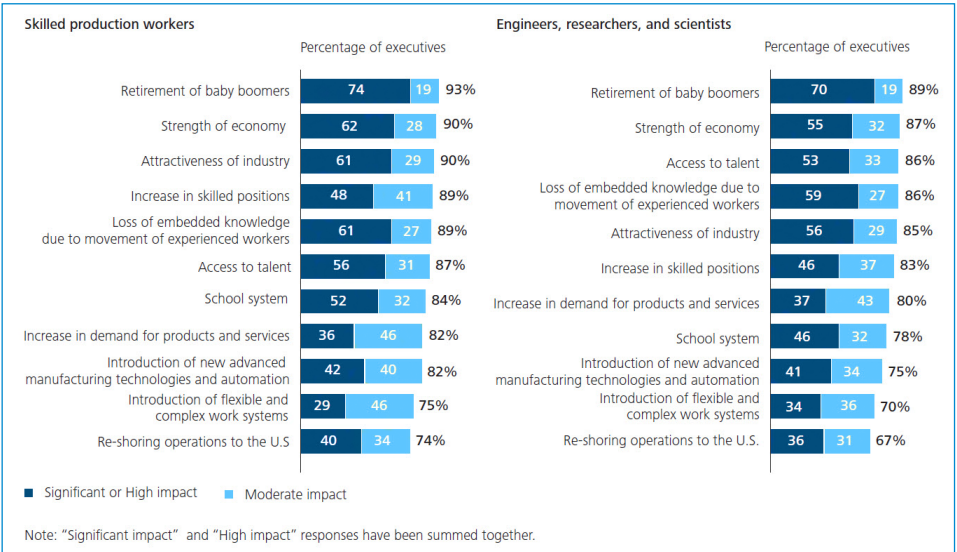


Figure 2. To what extent do the following factors contribute to the future talent shortage

6. Remote is possible, but not always probable

One way to do this is through remote-enabled technologies. Remote interface became practical in the 1970s. But well into the 2000s, almost no industrial producers would consider connecting industrial computers (process control systems) remotely, even over well-protected networks, fearing that someone in the network would, inadvertently or otherwise, take action that would induce failure to the production process. Today, with the continued and steady development of secure communications protocols and cyber security safeguards, producers are less worried about a production failure being induced this way, and supplier experts are helping more producers in a remote-enabled fashion than they previously were able to in strictly physical environments. Yet even with robust cyber security practices, many industrial producers are uncomfortable working with remote-enabled technologies.

¹ T. Morrison, B. Maciejewski, C. Giffi, E.S. DeRocco, J. McNelly, G. Carrick, "Boiling point? The skills gap in U.S. Manufacturing," Deloitte and The Manufacturing Institute, 2011.

The path to predictive

- The path to predictive:
- 1. Pick what to predict
 - 2. Expedite the expertise
 - 3. Validate the value
 - 4. Prove the point

The path to predictive

So there are many problems that hinder the effective application of Predictive Notification. Given these problems, is there a way to develop and deliver technologies that can predict with accuracy what will to happen on industrial production processes, and then notify appropriate personnel so that action can be taken to avoid or exploit the issue? The following presents an effective approach to this accomplish this objective.

1. Pick what to predict

The first thing that must happen is for the producer to select among the facility's equipment and processes those for which to provide Predictive Notification. Choices must be according to the needs of the business, but one effective way to choose would be to perform a criticality analysis in which equipment and processes are analyzed for what would happen if something went wrong, and how that would adversely affect plant performance. A criticality ranking would be applied to each piece of equipment or process, from those with the biggest impact in terms of safety, production or costs, to those with the least (Figure 3). Other considerations could be pieces of equipment for which technology-enabled Predictive Notification exists. These technologies may be expanded to include additional equipment and processes.

2. Expedite the expertise

As mentioned earlier, many producers contract with external suppliers for condition monitoring services, which means the expertise is dependent upon the person providing the service. We also mentioned earlier that industrial producers are rapidly losing expertise as the workforce ages and retires.

So among the considerations is how to capture the knowledge that these experts have in terms of methodologies and analysis, and deploy it in simple, repeatable ways so that initial, time-consuming elements of the job may be completed easily or automatically. Simpler conclusions may also be expedited or automated, such as identifying the source of a potential problem, sorting those problems into categories, and even prioritizing problems so that guidance can be given on what to address. If these critical activities, formerly only possible with the help of an on-site expert, can be technology-automated and automated, then engineers with varying degrees of experience can act.

Level	Effects (Any of the following)
A	Loss of life, body part or lost time accident. Unit shutdown, immediate penalty cost. Regulatory non-compliance. Equipment damage over \$1,00,000
B	Personnel injury. Definite loss of production. Probable penalty cost or personnel injury. Equipment damage > \$10,000 and < \$100,000.
C	Could lead to personnel injury. Possible loss of production. Could lead to penalty cost. Possible equipment damage < \$100,000.
D	No risk of personnel injury. No effect on production. No regulatory non-compliance. Equipment damage < \$10,000.
Minimal	No effect on production. Repair costs < \$1,000.

Figure 3. Sample criticality ranking

The path to predictive

Here's a very simplified way to accomplish this:

- Carefully document methodologies used by experts;
- Employ modern computing capacity to quickly gather inputs;
- Expediently analyze inputs for deviations that indicate departure from design;
- Use these deviations to identify, categorize and prioritize issues for action;
- Proactively notify the appropriate individual to take action.

3. Validate the value

Identifying exactly what to provide in the way of Predictive Notifications for the most critical equipment and processes is one thing; proving the value of doing this is another, more important, thing. In a sample of 111 industrial producers comprising a variety of processes (cement, chemicals, metals, mining, oil & gas and pulp & paper) in North America, South America, Europe, Middle East, Asia and Australia, ABB measured the value delivered by technology-enabled services (including Predictive Notification), and the following primary value areas were identified:

Engineering Efficiency: reducing diagnostic troubleshooting time by expeditiously gathering and processing high volumes of production data. The value is in performing diagnostics faster than previous methods. This value is low complexity (meaning, it is easier for producers to recognize), lower return (meaning, there is a return; just less than what is possible from other values).

Expediting expertise:

- Document methodologies
- Use technology to gather inputs
- Analyze inputs for issues
- Categorize and prioritize issues
- Notify people to act

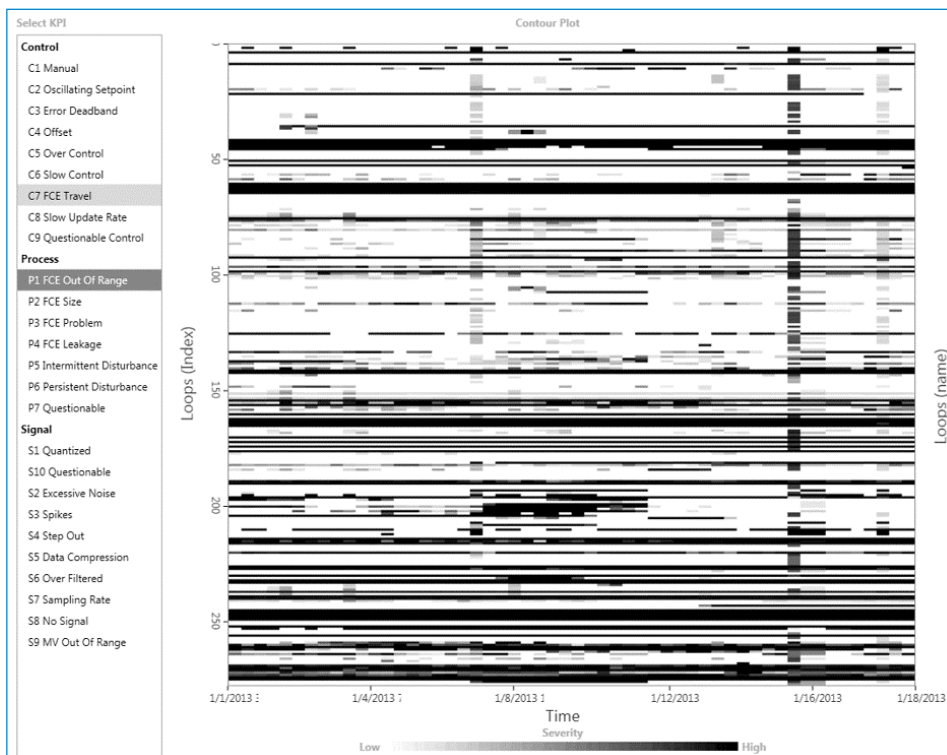


Figure 4. Contour map of data points in a production process

The path to predictive

A contour plot of the data helps increase efficiency because it directs the engineer to seek the cause of deviations.

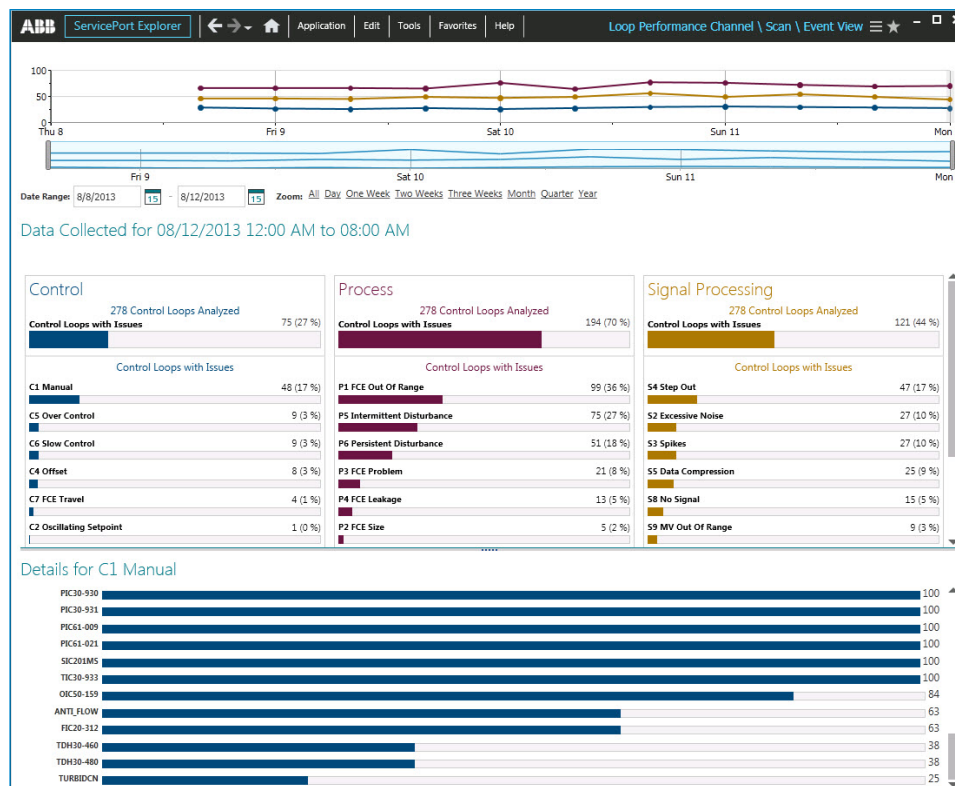


Figure 5. Prioritized display of KPIs to guide corrective actions

An example of engineering efficiency can be seen in Figure 4. Here we have a technology-enabled service application gathering a high volume of production data (more than 15,000 points), and creating a “contour plot” of the data. White spaces indicate a good process; shading represents areas that should be analyzed for possible improvements. This view helps increase the efficiency of process engineers who are working to improve a process, because it directs the engineer to seek the cause of the process deviations represented by the shaded areas. Less time finding data, more time doing something useful.

Incident Identification: quickly identifying incidents such as equipment failures by being able to quickly find discrete events among the high volumes of data being gathered and analyzed by the technology-enabled services. The value is in identifying discrete events faster than former, time-intensive methods. This value is low complexity, moderate return.

A well-designed system can take the data shown in the contour plot in Figure 4 and categorize that data into Key Performance Indicators (KPIs) as represented by the Pareto charts in Figure 5 (from an operator interface). Three KPIs are being tracked in this example, indicated by the three Pareto charts. Each chart has a main indicator bar that increases as the subset bars increase. These subset bars represent collections of discrete events such as those indicated by the vertical shaded lines in Figure 4.

The path to predictive

These collections are prioritized into Pareto charts so that the biggest collection of discrete events always appears at the top of the chart. This automatic prioritization of discrete events guides the engineer to what should be addressed first to fix a potential problem.

Predictive Notification: expeditiously analyzing the identified and categorized discrete events to produce patterns that predict failures, then alerting service personnel so that action can be taken. The value is in predicting and alerting on failures much faster than normal methods. This value is moderate complexity, high return.

An example of Predictive Notification can be seen in Figure 6. Predictive Notifications should be sent in any way that is suitable for a producer; in this case, it is an email that basically states, “You said to notify you when this happened. It has happened.”

Heretofore, services and values described are based on post-facto analyses that are intended to keep production at current state. The values below are produced by improving current state to a level of productivity not yet realized by the producer.

Predictive Notification: analyzing issues to produce patterns that predict failures, then alerting service personnel to take action.



Figure 6. Example of predictive notification

The path to predictive

Focused implementation takes information delivered via a Predictive Notification, and addresses the equipment or process to ensure the event doesn't happen again.

Focused Implementation on equipment: values from improving equipment performance. The value comes from using the above services to identify an improvement opportunity, then performing an upgrade or enhancement quickly and efficiently to improve equipment performance. Value delivered is typically 2 to 4 times the cost to implement the service. These values are high complexity, high return.

Focused Implementation on the process: values from optimizing production, quality, or cost to produce. The value comes from using the above services to identify an improvement opportunity, then assigning the right skill set to deliver services that improve process performance, such as control loop tuning or control modifications that reduce the time between product changes. Value delivered is typically 5 to 10 times the cost to implement. Value is high complexity, high return.

Essentially, these last two values take information delivered via a Predictive Notification, and address the overall equipment or process design, or maintenance trajectory, to ensure that the event doesn't happen again. Ideally, they improve the situation in a way that makes equipment and process availability better.

If these values are plotted as “complexity vs reward” and distributed over the sample population of producers analyzed, Figure 7 shows the distribution of these values and their relevance to the sample population as indicated by the size of the plot points:

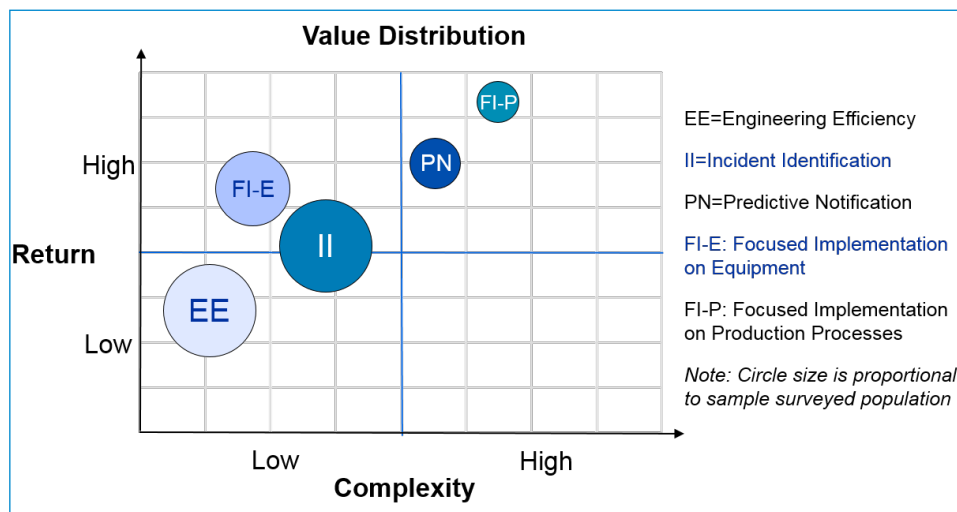


Figure 7. Predictive Notification represents high value opportunity

As you can see, *Engineering Efficiency* is a value that is easily understood and delivered to producers. While this value applies to a plurality of producers in the sample population, the financial returns are lower than those provided by other values.

Next, *Incident Identification* is a value that applies to about the same number of producers as Engineering Efficiency. It is a bit more difficult for producers to understand this value, but it provides slightly better returns if a producer embraces this value.

The path to predictive

Providing a higher return, yet easier for producers to comprehend is *Focused Implementation on equipment*. As many of these advanced services are provided by Original Equipment Manufacturers (OEMs), it is natural that producers would comprehend this value more easily than other values. As the OEM is often uniquely qualified to provide equipment enhancements and upgrades, the relatively high values can more easily be delivered.

Next is *Focused Implementation on the process*. This is the most difficult value for producers to understand, but if they do embrace it, the value produced can be quite high. But because the smallest sample of the assessed population embraces this value, this value is likely to be realized by a smaller population of producers. This value, good though it is, does not command the most important position among values delivered.

Predictive Notification commands this position. Predictive Notification can be, and often is, the linchpin for the other values. Here's why: the ABB assessment shows that providing a Predictive Notification to appropriate personnel, with a recommended action, results in an action taken. Properly designed Predictive Notification induces a response, with high likelihood of that response producing values of Engineering Efficiency, Incident Identification and Focused Implementation on equipment and processes.

Properly designed
Predictive
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4. Prove the point (case study)

The best way to prove the value of Predictive Notification is in application at a real site:

Situation

A plant in the southern United States manufactures products used for food and beverage consumption, so quality is very important. To support their quality objectives, the plant uses Quality Control Systems (QCS) to help operate their machines, and works closely with their QCS supplier to achieve optimum quality. In addition to high quality, objectives for this producer are similar to those for most producers: high availability, stable processes and accelerated problem solving.

To achieve these objectives, the plant employs software and web-based tools to foster best preventive maintenance practices to ensure that service activities drive productivity and increase management visibility. These service tools are used by both plant and OEM personnel to schedule and track maintenance activities, and to ensure fast access to parts information. So this producer employs good asset management practices.

Complementing these preventive maintenance strategies are remote- and technology-enabled advanced services for early detection of potential QCS performance issues, so that they can correct them before quality is compromised. With Predictive Notifications provided via these technology-enabled services, the plant routinely identifies and mitigates problems that could cost millions of dollars in lost production if not addressed.

The path to predictive

With Predictive Notifications, plants routinely mitigate problems that could cost millions of dollars in lost production.

Application

As today's producers know, automating production requires processing large amounts of data. The technology-enabled advanced services utilized by the plant automatically gather and analyze data from the QCS, and provide views of KPIs that help identify variables that may impede productivity, and then provide recommendations to address these variables. These services identify, classify and prioritize opportunities to improve equipment availability, process performance and product quality through visualization and analysis of instrument stability, control utilization and process variability. Identified issues are addressed by experienced service engineers, both on-site and remotely.

Users access information through three data views: **View**, which provides raw data for further analysis (see Figure 4); **Scan**, which presents a summary of KPIs ranked by severity (see Figure 5); and **Track**, which gives users the ability to set parameters for KPIs and create customized displays of each occurrence that falls outside parameters. With **Track**, any KPI that "tracks" outside pre-determined parameters triggers an instant Predictive Notification that is sent to appropriate service professionals for action.

The QCS at the plant includes 31 instruments mounted to eight online scanning platforms, each with an average of 15 standardized variables per instrument. This means that 465 values are updated every 30 minutes, for a total of 22,320 values per day. Although these updates contain the information necessary to identify potential problems, this large data volume makes it extremely difficult to quickly detect trends that indicate imminent failures.

To meet stringent quality standards, the plant requires that no product is shipped unless it has been produced using the QCS. However, the QCS operates in a very hot, challenging environment that can cause instruments to degrade after a few years of use. As instruments age, various components can develop buildup, and electronics can become less sensitive, making reliable readings increasingly difficult to obtain.

Notification

Understanding the importance of accurate instrument readings to the plant's operation, an on-site service engineer uses the Track feature to set Predictive Notification parameters that notify him immediately if an instrument reading exceeds these parameters. One day, before the engineer left home for the plant, he received a Predictive Notification alerting him that the threshold he established for an instrument had been exceeded. This prompted him to take immediate action.

Arriving at the plant, the engineer promptly investigated the issue using data views provided by the technology. A large red bar in a Pareto chart on the Scan display (Figure 8) confirmed that instrument limits had been exceeded. He then studied the raw data views in the View display, and the severity levels seen in the Scan display, to verify the extent of the problem and understand what he had to do to avoid costly downtime. He used the aforementioned preventive maintenance software to ensure that a replacement instrument was in stock, and he scheduled a time to change the instrument during a planned outage.

The path to predictive

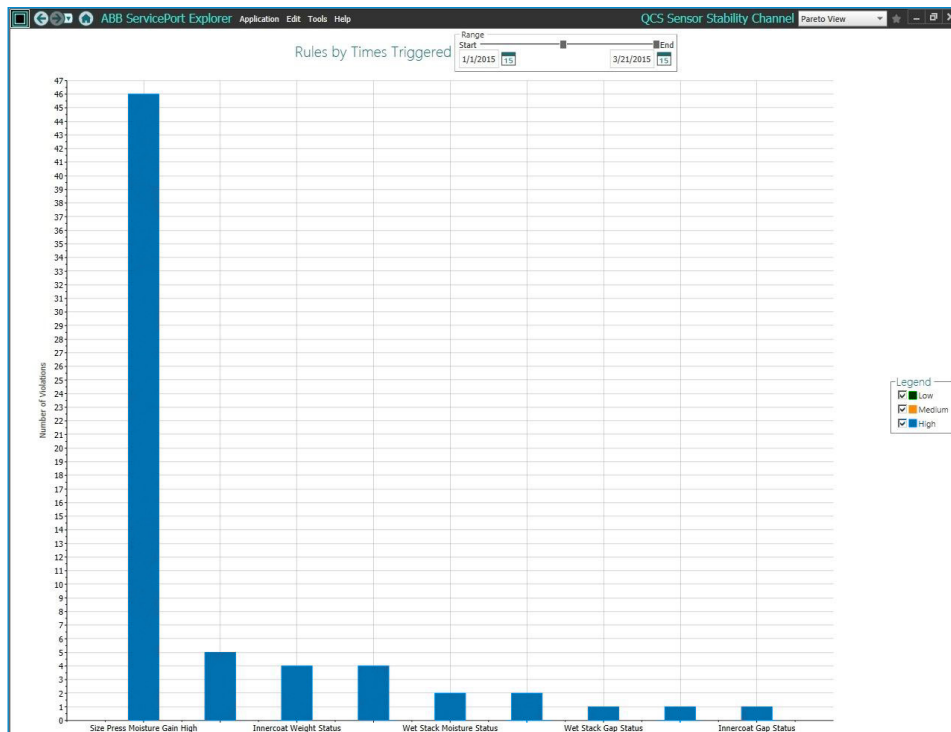


Figure 8. Predictive Notification prompted immediate action on serious issue noted in Pareto

Action taken after receiving a Predictive Notification mitigated quality losses and unscheduled downtime that could have cost more than \$100,000.

Mitigation

An emergency instrument replacement would have meant costly lost production at the plant. With the action taken by the engineer after he received the Predictive Notification, the instrument was replaced cost-effectively during a planned outage. This replacement mitigated quality losses and unscheduled downtime that could have cost more than \$100,000. The benefit of this Predictive Notification was that the plant continued to have high equipment availability, stable processes and maximized product quality.

Many more examples like this can be found among the 111 assessed producers mentioned earlier. Though machinery and processes differ greatly, data volumes and inputs of this magnitude – or greater – can be found in any process industry. The application is similar:

1. Automate the accumulation, amalgamation and analysis of large volumes of data
2. Expediently identify discrete events that indicate possible process interruptions
3. Take what is known about machinery and processes to categorize the events
4. Prioritize the events based on the impact on equipment or processes
5. Notify appropriate personnel on what action to take

With Predictive Notification outlined, evaluated and proven, we now provide an overview of how to prepare a Predictive Notification program for a production facility.

Preparing a predictive program

Preparing a predictive program

What follows is a real-world overview of what it takes to set up a technology-enabled Predictive Notification program for the successful delivery of advanced services that improve equipment availability, process performance and product quality (Figure 9).

Preparing a predictive program:

1. Agree that issues can be avoided
2. Identify, categorize, prioritize issues
3. Involve an expert
4. Agree on actions
5. Create an action plan
6. Set Notification rules

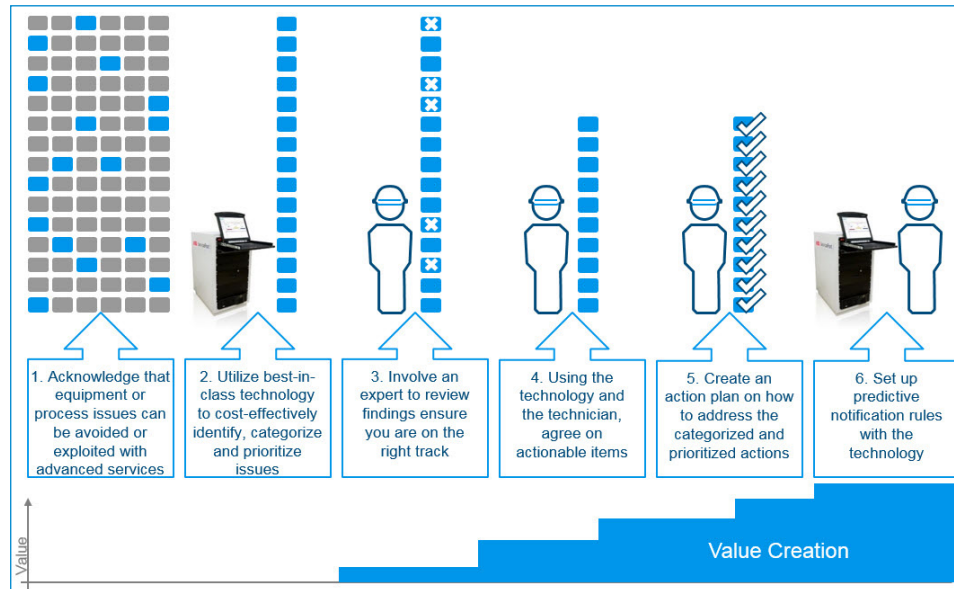


Figure 9. Well-designed Predictive Notification will focus on high-value actions

1. Agree that equipment or process issues can be avoided or exploited accurately and cost-effectively with technology-enabled advanced services

No value can be produced via Predictive Notification if a producer does not believe that equipment or process problems can be mitigated with the help of technology-enabled advanced services. A producer must consider if the values such as those described earlier (Engineering Efficiency, Incident Identification, Predictive Notification and Focused Implementation) can help stabilize and improve equipment availability, process performance and product quality so that more of a better product can be made faster. A producer must agree that these values can benefit the business.

2. Use best-in-class technology to effectively identify, categorize and prioritize issues

Different suppliers have different capabilities. Some specialize in and thus provide high value for specific equipment areas, such as control systems or drives. Some can provide high value for specific production or business processes, such as control loop performance or cyber security. Some can provide value for specific industry equipment, such as hoists in mining, or QCS in paper. Producers must identify suppliers who can provide the best technology and applications designed for the plant's equipment and business processes.

3. Involve an expert to review findings to ensure that preparation is on track

Producers must ensure that they have access to experts who are knowledgeable and experienced in their equipment, process and industry. These experts can guide producers to ensure that the most value-added KPIs are used to develop effective Predictive Notifications. For many, this knowledge base can be found among OEMs.

Preparing a predictive program

4. With the technology and technician, agree on actionable items

With the best available technology selected and the most value-added KPIs chosen, it is time to agree on actions to take when parameters are exceeded. It is best if producers develop and agree on such actions in collaboration with the personnel who will take the actions, to ensure common understanding of the value rationale.

5. Create an action plan on how to address the categorized and prioritized actions

Plans must be developed to ensure that the actions agreed above can be quickly and efficiently taken when parameters are exceeded and the Predictive Notification is sent. Decide who will act; what action will be taken; where the action should be taken; where the appropriate tools and/or parts are located to take the action; when the action should be taken (e.g. immediately, or during a planned outage); and how the action will be taken (e.g. the order of steps in a multi-step process). It is also important to understand why the action is being taken. With a clear understanding of why (e.g. to avoid downtime or maintenance costs), the question of “when” is more easily considered.

6. Set up Predictive Notification “rules” with the technology

After analyzing and understanding the types of issues that equipment or production processes may have, and the KPIs that will be used to monitor these issues, thresholds for what constitute requirements for action must be established, and “rules” set up in the technology whereby Predictive Notifications are sent to appropriate personnel when thresholds are reached. If thresholds are exceeded, a Predictive Notification is sent to the individual who can take immediate action to avoid or exploit an issue (Figure 10).

It is best to develop actions with the personnel who will take them, to ensure common understanding.

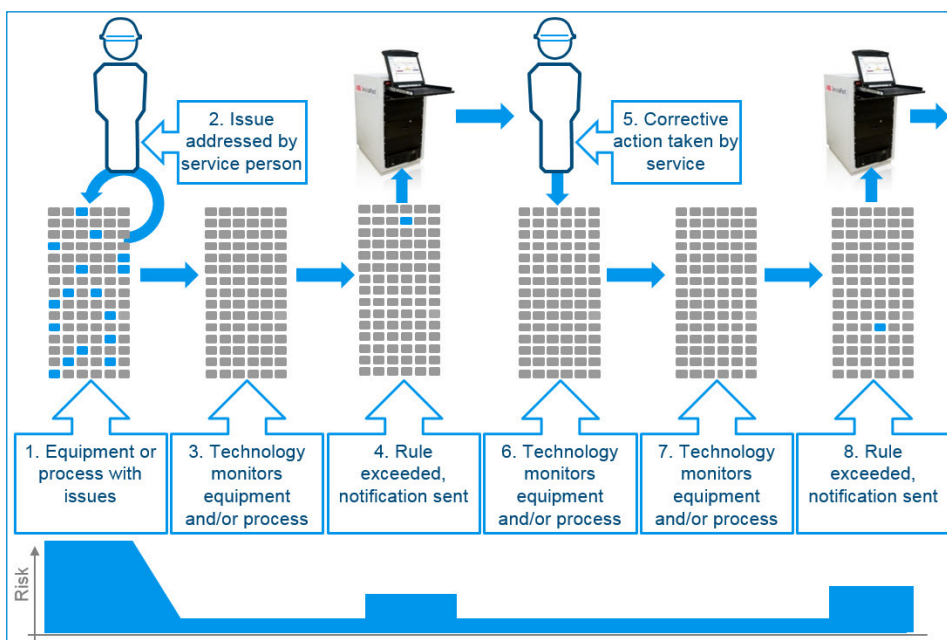


Figure 10. No Predictive Notification can take place until rules are set

The 4 Ts of predictive

The whole point of Predictive Notification is to improve productivity, reliability and sustainability.

The 4 Ts of predictive

For many users, setting up Predictive Notification rules is the most daunting challenge, because parameters that are too tightly selected may produce too many notifications, which can result in them not being taken seriously. Conversely, parameters that are too loosely bracketed may miss important events that should be directed to personnel for action. So it is important to select parameters carefully and accurately. It is helpful to remember these 4 “Ts” when preparing Predictive Notification rules:

1. **Tabulate notifications:** Well-designed technology will have appropriate guidance to tabulate notifications, with selectable menus to assign the notification to a specific piece of equipment or production process. This technology should also assist in assigning a “condition” for the notification, meaning under what circumstances will the notification be sent (e.g. when the threshold has been exceeded, or when the trend toward potential failure reaches a certain rate).
2. **Test notifications:** It is wise to test Predictive Notifications that have been tabulated to ensure that the intended target is able to receive them, and that the recipient knows what to do with notification if and when it is received.
3. **Tune notifications:** in dynamic production environments, some thresholds initially set may be exceeded with no ill effect on equipment or processes, and thus should be adjusted to reduce false positives. Moreover, previously unrecognized dynamics may be discovered that require new rules to be set and tuned. A producer may discover that a Predictive Notification rule set to notify after the threshold has been reached results in nothing bad happening to the equipment or process. The rule should thus be reset to trigger when the most effective response can be applied.
4. **Track notifications:** The whole point of the Predictive Notification discussion is to achieve improved productivity, higher reliability and longer sustainability. A Predictive Notification tracking methodology should be implemented so that management can track Predictive Notification activity to expedite setting up similar protocols for equipment and processes on other lines, or in other plants, and quickly produce the most efficient and effective Predictive Notification program.

Resolving the problems

In the beginning of this paper, we outlined problems with other approaches to Predictive Notification. Now we revisit these problems in the light of what has been presented and show how the approach described resolves them.

1. **Problem: Indicative, not predictive.**

Solution: This approach to Predictive Notification improves upon earlier approaches in its ability to identify, categorize and prioritize actions. By assigning actual actions for appropriate personnel to address, this approach eliminates guesswork and more quickly addresses important issues.

Resolving the problems

2. Problem: Predictive, not practical.

Solution: This approach is far more practical because it focuses on a few highly meaningful KPIs that will quickly produce actionable items to improve production, rather than trying to manage and control myriad variables that are inherent in highly complex multi-variable control approaches.

3. Problem: Predictive, but pricey.

Solution: This approach does not require instruments to be placed on all plant assets. It rather gathers and analyzes signals from already-installed control systems. This approach is less costly than those that require heavy capital investment in highly complex instrumentation.

4. Problem: Cost-effective, but incomplete.

Solution: The incomplete aspect of the problem is in the time-based nature of a periodic condition monitoring. That is, a catastrophic failure may occur in between the times that a periodic service is applied. In this approach, the Predictive Notification provides continuous condition monitoring of parameters, so that there are not time gaps during which a catastrophic failure could occur without warning.

5. Problem: Experts are aging.

Solution: In this approach, the institutional and process knowledge (i.e. methodology) of advanced services experts is documented, distilled, and delivered via remote-enabled technology. This approach does not depend upon the immediate and local availability of increasingly scarce experts.

6. Problem: Remote is possible, but not always probable.

Solution: While remote-enabled technology provides an opportunity for a cadre of experts to gain insight into the equipment and processes being monitored, this approach provides software inherent in the delivery technology that automatically gathers and analyzes data to identify, categorize and prioritize problems and actions. With this “software as a service,” no live or remote expert is needed to take meaningful action to address a problem immediately.

Even with the best Predictive Notification, meaningful actions cannot be taken without the right people in the right place.

Conclusion

This paper has shown that technology-enabled advanced services are the most effective form of delivering advanced expertise in today's production environments, with Predictive Notification of impending issues being the primary value opportunity for improving equipment availability, process performance and product quality.

Yet even with the best advanced services technology and Predictive Notification methodology, one crucial element remains: people. Meaningful actions cannot be taken without the right people in the right place to receive the notifications and act on them.

Only when the right people are in the right place can notifications truly make our lives better.

Contact us

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