Process Analytics Finds Process Problems

By Jack Wilkins, Canary Labs

Process analytical software can help companies gain great insight into how their process operates, find problems, and improve quality.

Process Analytics and Intelligence—sometimes called Manufacturing Intelligence—has transformed the way companies produce goods, understand their manufacturing processes, and ensure a quality product in ways we could not have foreseen ten years ago.

Real-time Analytics have replaced the legacy concept of running reports. Reports that represent a static picture of a process at a fixed point in time are great tools for compliance audits and long term warranty analysis. However, they may not accurately represent the "as-is" state of a process. Reports showing large amounts of data can be difficult to interpret. There are often limitations in how the report data can be drilled-down and viewed.

With today's large volumes of data, there's a wealth of information that can be gained about the process. But how can this data be captured, managed and retrieved in a way that presents the information in an up-to-the-minute easy to understand format? Real-time Analytics provides the techniques and solutions that address this problem. Instead of users having to interpret the data, it's presented in a graphical form enabling them to easily drill down to explore the data in real-time.

This white paper discusses how Process Analytics is implemented and utilized. Ways of managing and distributing Process Analytics to the organization are presented.

Obtaining the Data – The Process Historian

Cutting edge manufacturers today use large volumes of real-time process data stored in a process historian. This is the data foundation that is required to drive the Real-time Analytics and dashboards that improve their ability to quickly detect and react to process problems or quality issues.

Data is generated from a multitude of sources, from devices as simple as a weigh scale to as complex as a PLC controlling a high speed bottling line. To interface with such a large range of data sources, it's important to look towards standards. In manufacturing, such a standard already exists and is widely used. OPC from the OPC Foundation is the standard that simplifies integration of manufacturing devices to a process historian.

Process historians are specifically designed to handle the high speed, high volume data generated by manufacturing processes. Process historians capture the data and store it in a highly efficient format. Some historians compress the data, resulting in gaps or voids, while others capture and store it using lossless compression.

Capturing data with a high degree of fidelity directly affects an organization's ability to rapidly filter and drill down through huge volumes of data. To ensure optimal performance when selecting an historian, look for high end performance characteristics such as 500,000 samples (consisting of Time, Value and Quality data - referred to as TVQs) stored per second, the ability to extract 1,000,000 or more samples per second for display in client applications, and the ability to support large numbers of concurrent users.

Real -Time Process Analytics

The trending of process data is a quick and effective way to see what's happening. Figure 1 shows how trending can quickly display the results of a large amount of data in a format that is easy to understand. This display can be brought up while the process is running using the latest real-time data.

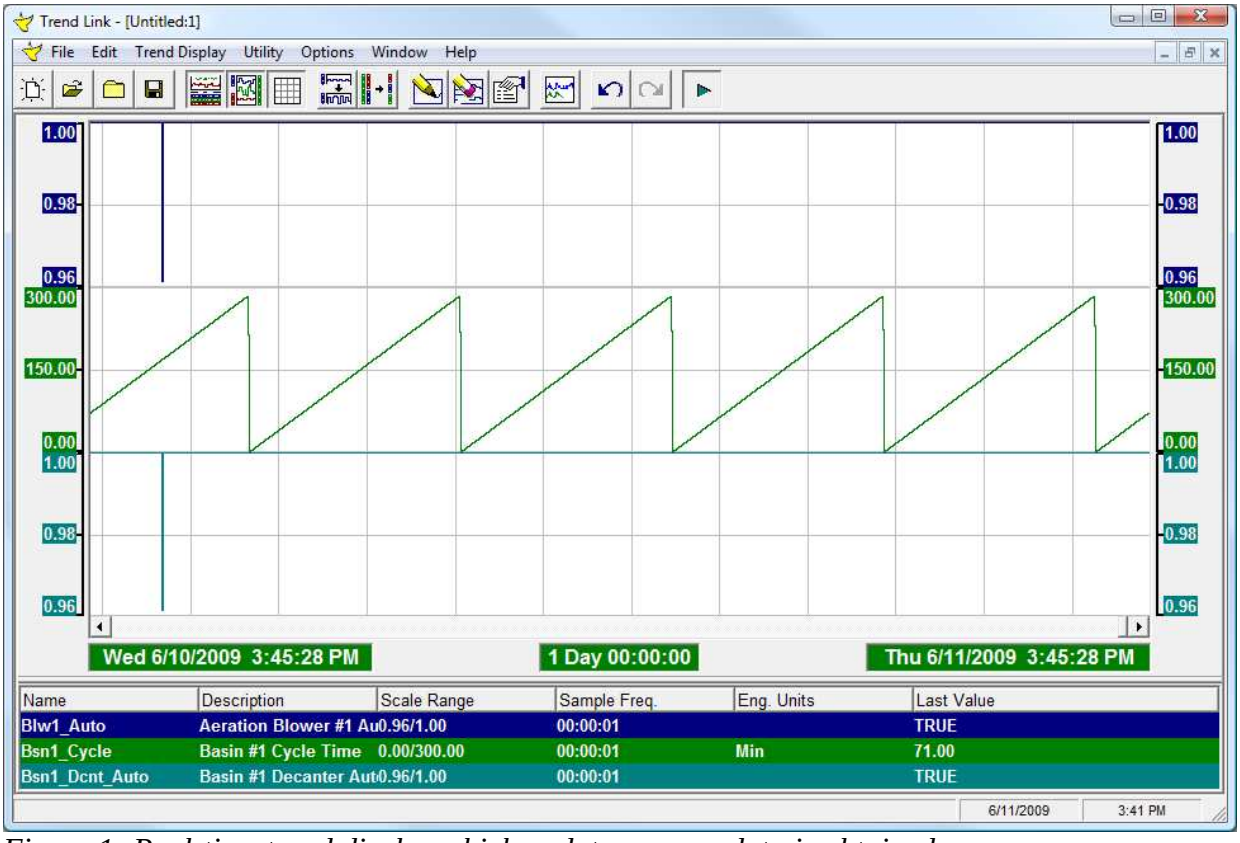

Figure 1: Real-time trend display which updates as new data is obtained.

Centerlining is another trending technique that simplifies the effort required for an operator to spot a problem. When the process parameters are centerlined, the ideal state is what appears towards the center of the chart. If, for some reason a process parameter deviates from its line on the chart, it will show as spikes and the operator can zoom in on this for additional details.

Many organizations will centerline the process data and monitoring of a large number of process parameters into a single chart. This allows them to reduce the complexity of their HMI/SCADA screens and gives operators a single place on which to focus, allowing them to manage analysis by exception.

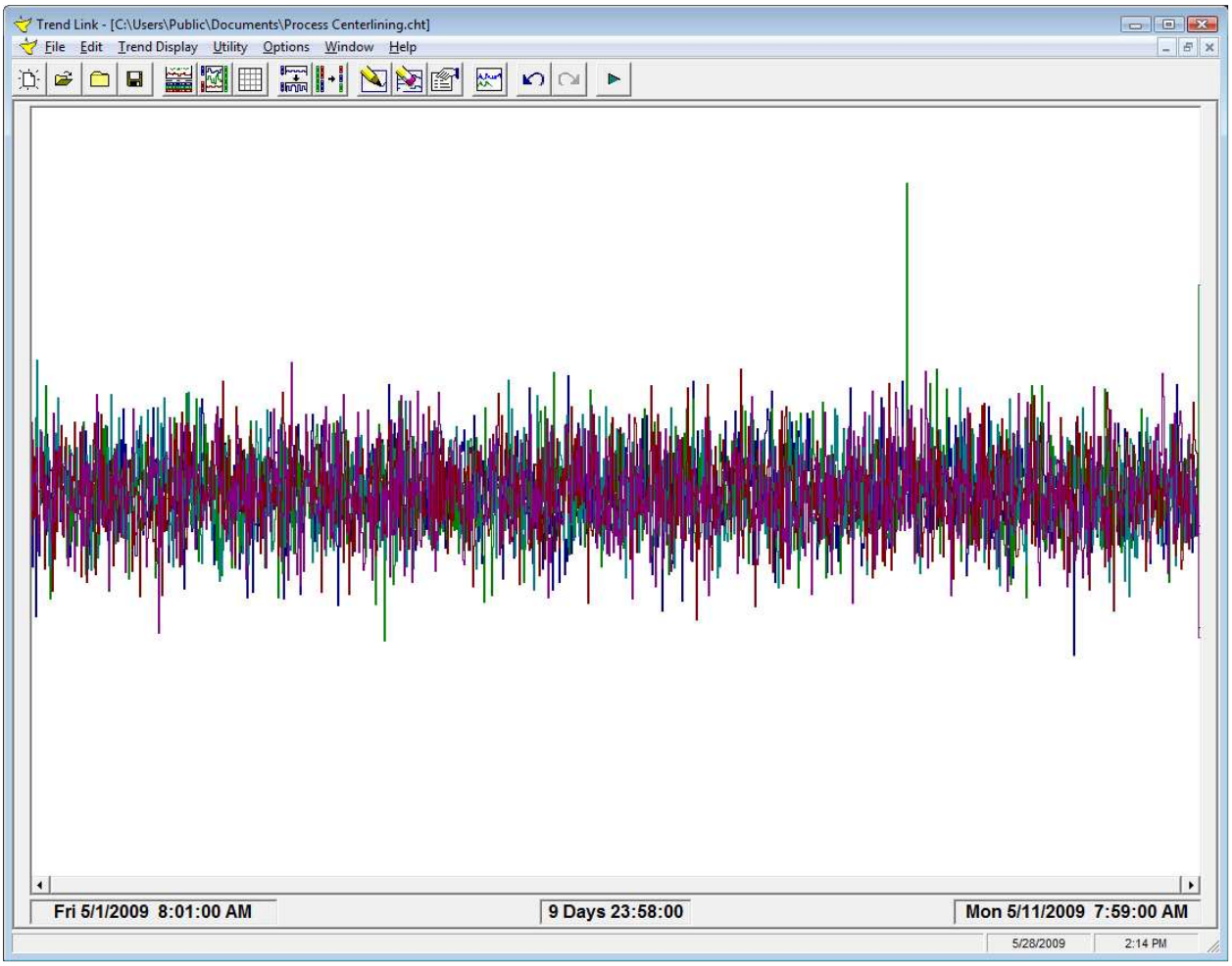

Figure 2: Centerlining data—that is, arranging the plot so that multiple variables are centered on the screen—allows operators to spot "spikes" in the data and then drill down to examine the offending data in more detail.

Trend charts are great tools for presenting a summary of how the process is performing and highlighting instantaneous problems. However, in many situations you need to get at the details behind the trend to better understand how the process is performing. For this, having access to statistical data can be very useful. For example, to understand the overall distribution of data values you'll want to view the data in a Histogram. Along with the Histogram, it's useful to display some general process statistics such as mean, standard deviation and the percentage of samples the chart represents.

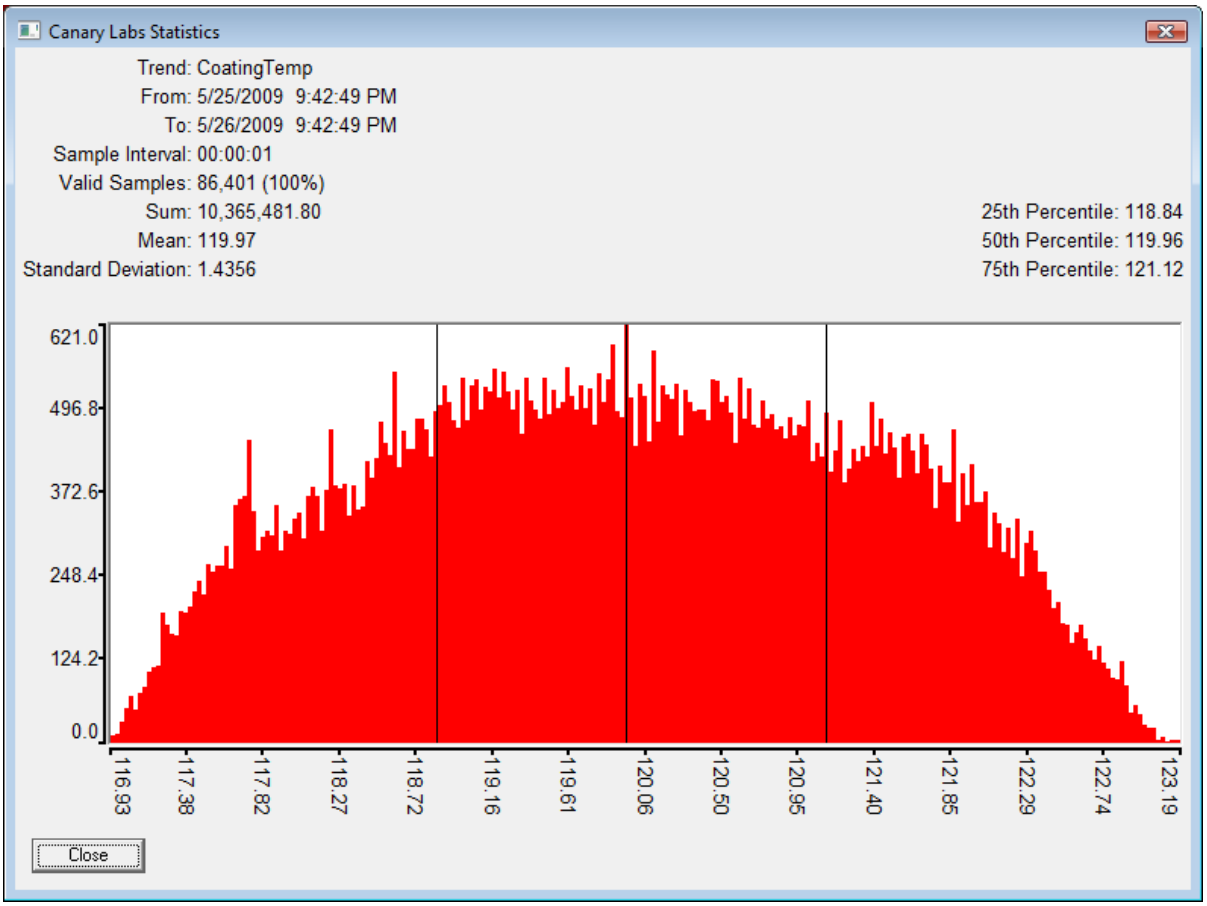

Figure 3: This histogram shows changes in coating temperatures over time. Note the statistical calculations for mean and standard deviation.

To check for relationships between process variables, use an XY chart that plots the data for a process variable against the data of another. Using this type of analysis helps to identify how changes in one process variable impact another. For example, as the heat in an extruder process increases, we might find that die life decreases.

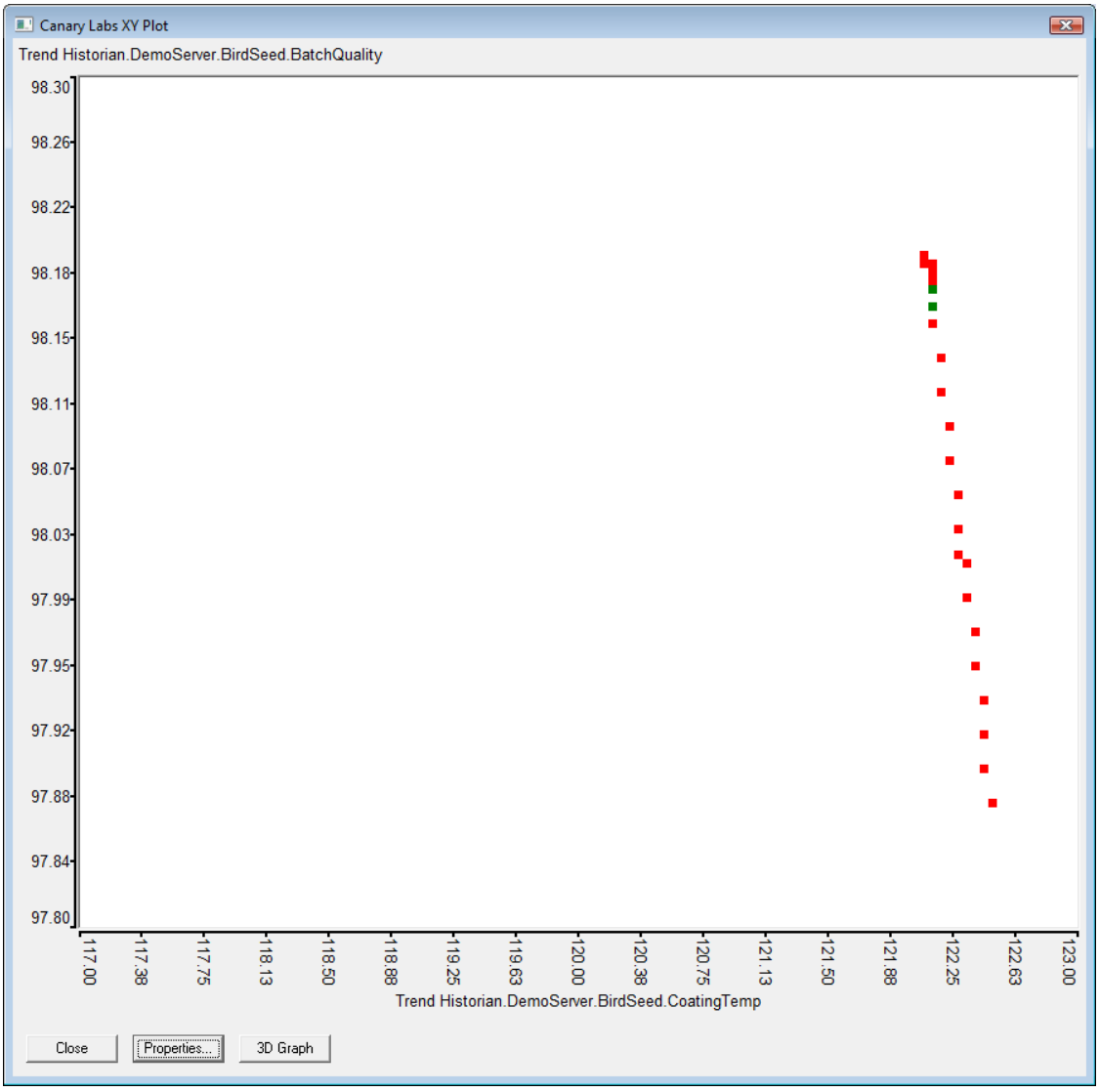

Figure 4: An XY plot shows the relationships between two process variables.

In some cases, customers will need to explore the data and their relationships more extensively using full featured statistical tools like Minitab. These products don't usually offer direct connection to process historians, so you'll want to ensure that your process historian offers a convenient method to export data. Using these high-level packages you're able to perform extensive correlation analysis, Analysis of Variance (ANOVA) studies, and Design of Experiments (DOE) calculations.

Historical Process Analytics

Historical Process Analytics can be applied to analyze process data off the plant floor. Off-line users can analyze data using standalone trend tools. With these tools an engineer or quality auditor can get process analytics and intelligence right on their desktop. Recently a new type of Historical Process Analytic tool has been developed which utilizes an interface similar to HMI/SCADA applications, but utilizes historical data to essentially "playback" a formerly live situation. This type of tool is described in the next section of this paper.

Personnel often have responsibility to analyze many processes within the plant. It's important that they can quickly switch between the various processes they're managing. As with real-time analytics, the use of centerlining with historical data is also used. This big picture view is used as a tool to help determine where personnel should focus their process improvement efforts. When issues are detected, they drill-down to analyze the raw data and get a better understanding of what factors are influencing the process in a negative manner.

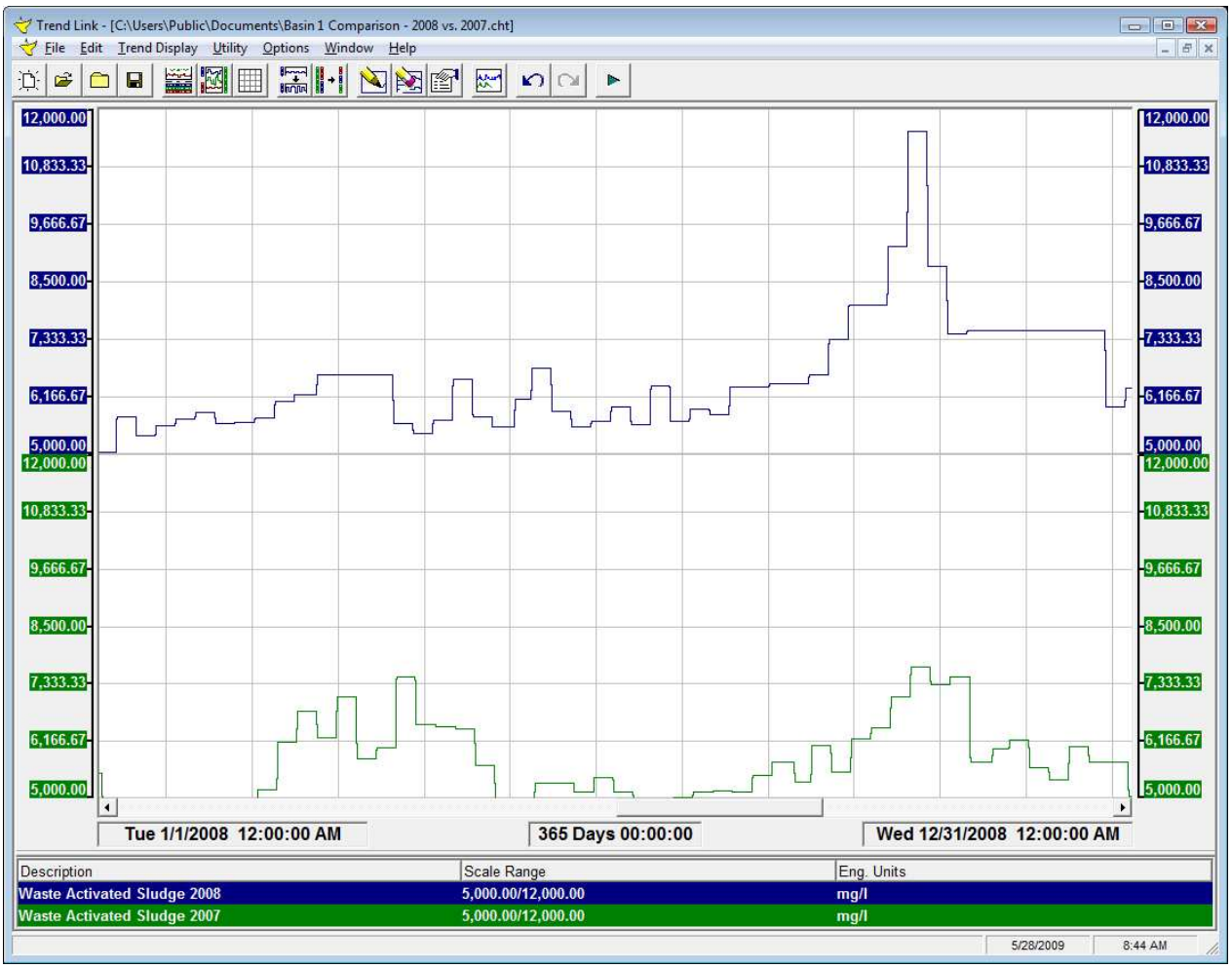

Figure 5: Being able to compare data from a previous run allows an engineer to spot what was different. Here, data from a run in 2008 is plotted against a similar run in 2007.

When using trends to explore data, they often find it's useful to compare the current process with how it ran in the past. Trend tools typically offer the ability to time-shift historical data, allowing the engineer to see older data and current data on the same trend. Once issues have been identified, they find it useful to add an annotation in the event the data is revisited sometime in the future.

The annotation capability provides a long term record of what happened and how it was resolved. It reduces the need to depend on a process engineer remembering what was done to fix the problem. It also provides documentation that can be included in reports.

New Process Analytic Tools

A new type of software has recently emerged that combines the functionality of HMI/SCADA style displays, standalone trend charts, Excel reports and web content all in one easy to use and robust solution. Such software, like Canary's InfoLink, enables the delivery and analysis of real-time data in the context of the manufacturing operation while allowing a look back in time at compliance reports or exceptions.

The software comes with built-in designers that create displays using multiple layers that provide finger-tip access to the data in an organized and efficient manner. The focus is on analyzing the process data, not searching for the information in separate applications.

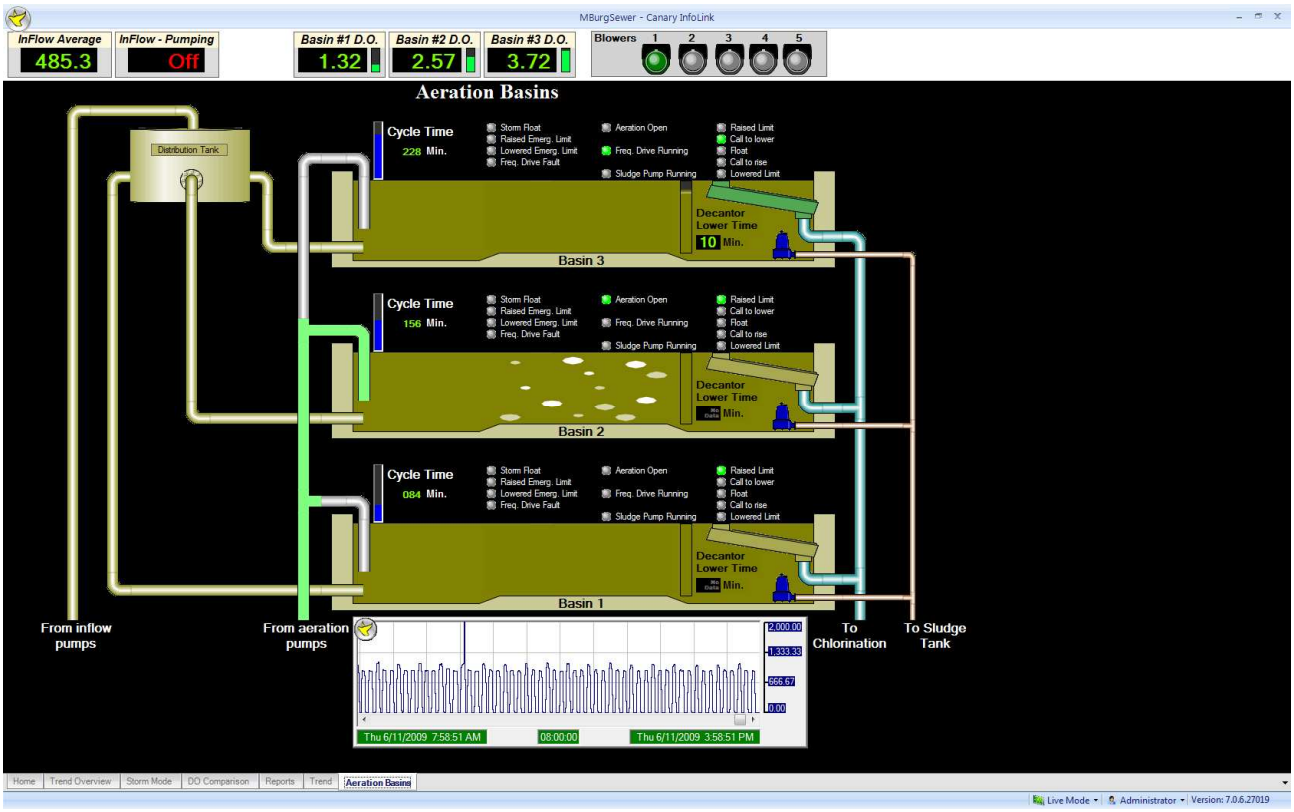

Figure 6: Canary InfoLink, a realtime and historical process analytic tool. A playback mode allows historical data to update the displays as if it was happening right now.

While the displays can show real-time data as the process is running, a playback mode uses process historian data to drive the displays, creating a historical look into the past. All graphics and trends show the data exactly as it happened in the past. The user can control the playback speed, allowing closer examination of a process at critical times when a failure occurred. Having a playback mode is like having a DVR player for your process analytics.

In addition to process analysis, another use of this feature is to provide training sessions that use the replay, stop and slow motion features to teach new users what happens at critical transitions in the process.

Managing and Distributing Process Analytics

Creating and displaying trends can be done in a variety of ways to meet an organization's needs. Trends are available in separate standalone trending software viewers available off the shelf. Trends can also be displayed on web pages and can be embedded within HMI/SCADA applications.

Putting Process Analytics in HMI/SCADA applications

HMI/SCADA products offer a rich capability to control and visualize many different types of processes whether it's running a single bottling line or a complex multi-site refinery application. The trends displayed within these applications tend to narrowly focus on the specific process being controlled by the HMI/SCADA, which gives the operator a detailed understanding of how the process is currently performing.

While many HMI/SCADA applications come with trending built-in, often these trending applications are outdated and lack critical features and the speed required by Real-Time Process Analytics.

Trend software must be easy to use and configure, so users can focus on improving the process, without a large number of steps just to create a trend. It must offer a rich feature set geared toward process analytics with capabilities like support for OPC-HDA and OPC-DA data sources, real-time updates and plotting, stackable pens (auto banding), user configurable time domains, and legends that include engineering and real-time data.

Trending software must be fast. An operator or engineer can quickly go from one time to another even if it was a year ago. Today's trending programs with the right Process Historian are capable of displaying months of process data graphically in seconds. This is what is required in order to implement Real-Time Process Analytics effectively.

About the Author

Jack Wilkins has over 20 years of experience in Manufacturing Intelligence system design. His implementations include pharmaceutical, biotech, automotive, and other industrial facilities including Pfizer, Wyeth, Novartis, Ford, General Motors, Toyota and Land Rover where his systems provided a broad spectrum of solutions to enhance manufacturing productivity.

Mr. Wilkins has assisted companies in defining their manufacturing IT framework to meet industry challenges and drive operational excellence. The pillars on which this IT strategy is based are: capturing and managing information from multiple sources, contextualizing the information and providing that information and analyses to multiple layers of the organization enabling the sharing of information and active collaboration across multiple business units.

Mr. Wilkins is currently the Director of Sales at Canary Labs, a company that provides historian trending tools and solutions on a global scale. Canary's products are extremely fast, supporting hi-speed millisecond data, yet are built to be scaleable to handle systems with 100,000+ tags.

If an HMI/SCADA application does not include a trending package with these capabilities, an organization should seriously consider getting trending software that will embed and link with their systems. Failure to do so can result in a system where it is impossible or impractical to do serious process analytics.

Putting Process Analytics on the Web

In many applications the preferred method for process analytics and intelligence is to deliver the information via the Internet. Delivering process analytics through a web browser allows you to reach a broad audience with a wide variety of dashboards, trends and summary data. Process Analytics becomes available to many areas in the organization … from the plant floor to the board room and beyond. Some organizations are now even providing this information to their supply channel and customers.

Using familiar tools like SharePoint Designer (formerly FrontPage) and Trend Web it is relativity easy for non-web developers to create intranet pages that remotely deliver process analytics and intelligence data. For extranet process analytics and intelligence pages it's best to work with your in-house web development team to create and manage these as there is usually more extensive requirements (like security) that must be considered.

Process Analysis Documentation - Reports

Once issues have been identified and resolved, engineers need to communicate the findings to others in the organization. This is typically done using email or a PowerPoint presentation. Many trend tools support a copy-and-paste capability that allows the engineer to take a snapshot of the trends and reuse them in other applications.

One of the most popular tools used for creating process analysis and intelligence reports is a spreadsheet, like Microsoft Excel. It's extremely flexible and many users are familiar with it. Reports of this nature usually represent static data and can be very useful for distribution to others in the organization or for compliance reporting. While Excel-based forms are readily available for many traditional reporting applications, there are only a limited number of forms that target process analytics and intelligence.

With Excel there may be a significant amount of time and energy required to design and produce a report. Although Excel has the capability to connect to Access or SQL Server databases, it does not have built-in capabilities that enable it connect to process historians directly. However, there are some Excel Add-Ins that can extend Excel’s ability to access process data and to streamline report creation and maintenance.

Add-Ins can greatly simplify the process of pulling data in, formatting it and enhancing the delivery of the report. Many of the Add-ins that support process analytics and intelligence come with a series of templates that can be adapted or used as-is. Using templates and retrieving data stored in the process historian can reduce the time spent each month pulling together data for internal production meetings or regulatory compliance reports. Repetitive reports like these take advantage of the static nature of the report content and are ideally suited to using Excel.

Reaping the Benefits of Process Analytics

Process Analytics and Intelligence has the potential to expose a significantly greater amount of knowledge and information than traditional process reporting is capable of delivering. This requires that we must manage how the data are collected, distributed and presented. Reports that provide data to knowledgeable users allows them to interpret and draw conclusions from the data based on their expert knowledge and understanding of the process. However, these reports may not be the best vehicle to deliver information to the majority of company personnel.

New Process Analytic tools allow large amounts of data to be presented graphically and in real-time to a wider audience in the organization. Process issues are brought into immediate focus. While Process Analytics may not answer all of the questions, they help to expand the understanding of the issues behind the data.

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