Understanding the Data-Oriented Tools Available to Facility Managers

Analytics, Alarms, Analysis Tools, FDD – They All Have a Place and Serve Different Needs

SkyFoundry

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INTRODUCTION

Applying analytics to the data produced by equipment systems has been proven to be a highly effective way to reduce operating costs, save energy, improve facility operations comfort and occupant satisfaction.

Analytics works by identifying patterns in the data from the equipment systems and devices that make the built environment possible. Patterns may represent faults, deviations, trends, or anomalies – almost all are opportunities for savings and improved performance.

Like most new technologies, however, a barrage of information and claims puts end users in a position where they are often faced with the challenge of comparing "apples and oranges" as they try to evaluate the benefits of different offerings.

Comparing different technologies using a defined set of criteria can help facility managers better understand the roles, capabilities and benefits of these tools so that they can assess the best fit for their needs. In this white paper we look at the range of tools available in an effort to help owners understand the differences between Alarms, FD&D, Analysis tools and Analytics. In this paper we will compare them on the basis of: Time of Implementation, Data Scope, Time Range of Data, Expressiveness, and Processing Location.

Alarms

Alarms are one of the fundamental functions available in automation systems since their introduction. They remain an important tool. Often, when first introduced to analytics people look to make comparisons with alarms. After all, doesn't an alarm programmed in an automation system tell me something is wrong? At a very basic level there is a similarity, but if we look a little deeper, we see that there are fundamental differences between alarms and more advanced analytic tools.

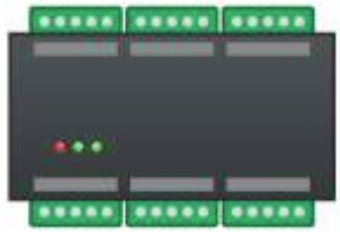
Time of Implementation. Perhaps the most important factor to consider when comparing alarms to analytics is that alarms require that you understood what you wanted to look for ahead of time – in other words, you need to be able to define the condition that you want to generate an alarm when you program the system. While this is fine for limit type issues like temperatures (or other parameters) going outside of desired range, there are many inter-relationships between equipment systems that may not be known at the time a control system is installed. And ideally, we would prefer to identify an impending problem before it results in an alarm. Having to know what we want to look for ahead of time is a limiting factor encountered with alarms.

The "Scope" of the Data. Alarms typically evaluate a sensor value vs. a limit. They may also include a time delay – e.g., the condition must be true for 5 minutes before an alarm is generated. One of the most common approaches is to set alarm limits for each individual point during initial configuration – the alarm limits are effectively a property of each point. This demonstrates what we mean by a limited data scope. External data cannot be easily used in controller-based alarms. Even in systems that allow for some level of logic-based alarms, the scope of data is typically limited to the data available in the local controller or perhaps other controllers on the network.

Time Range Evaluated. Alarms are typically evaluated "now". By this we mean the real time status of the sensor vs. the alarm limit. This is a key point - very different techniques are needed to look back over months or years to identify conditions, patterns and correlations that occurred in the past.

Expressiveness of Alarm Definition. The next factor to consider is the flexibility of expressing what we want to find. Alarms don't typically allow for sophisticated logic that interrelates multiple data items from different data sources. For example, an alarm definition might be: "Is the value of the Room Temp sensor above 76 degrees F right now?" An analytic algorithm on the other hand might be: "show me all times when any room temperature was above 76 degrees for more than 5 minutes during occupied hours in the last year and totalize the number of hours by site."

Processing Location. Adding new alarms typically means modifying control logic or alarm parameters in controllers. This means you need to have access rights to modify or create alarms. This can be very limiting if you just want to “find things” in your data or are trying to analyze data from a system installed and managed by others.



The need to “reach into the controller” makes alarms “expensive” when trying to apply them as an analysis tool. For example, could we justify reprogramming controllers in 500 remote sites because you have a theory about a data relationship or pattern you want to look for? Most likely this would be cost prohibitive.

In other cases, the people involved in data analysis functions simply do not have the access rights or skill sets to be reprogramming controller logic. The important point is that there is significant “friction” involved in attempting to use alarm techniques for anything beyond limit-based relationships on sensors or values.

Fault Detection & Diagnostics (FDD)

FDD that identify equipment performance issues are a type of analytics. FDD offerings are typically equipment-centric and characterized by pre-defined rules that are based on an engineering model of a piece of equipment.

Because of the model-based approach, most FDD products employ pre-written rules based on known models of equipment. Programmable analytic tools like SkySpark, provide more flexibility, enabling experienced engineers to implement rules based on their knowledge about their own specific equipment systems. They are not limited to only rules and algorithms defined by the software provider or equipment manufacturer.

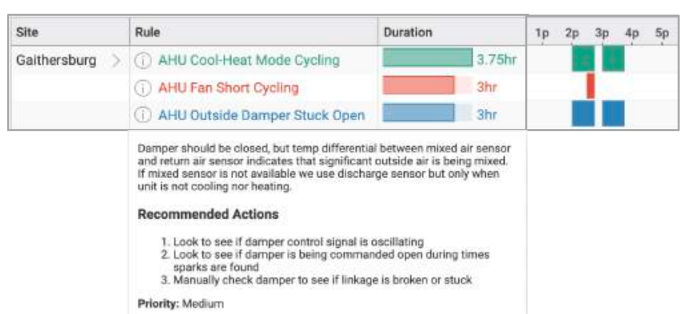
Time of implementation. Generally, FDD requires that an engineering model of the equipment be developed beforehand. In this respect they require significant pre-knowledge of the system. The rules are "part of the product" versus being programmable on a project specific basis. As such, FDD rules are often not a good fit for use on custom, "built-up" systems, and typically don't address whole-building level operational issues. The fact that no two buildings are alike can further limit where FDD techniques can be applied. And because of the dependence on predefined equipment models FDD is typically not a good fit for ad hoc analysis – i.e., "I have this idea about a behavior I want to look for".

Processing Location. FDD solutions are typically applied as a separate software application that pulls data from a control system. The software may be installed locally or hosted in the cloud. In some cases, FFD algorithms can be programmed into controllers, but this requires "touching" the control system.

Data Scope. FDD rules are typically focused on the predefined points associated with a specific piece of equipment. They do not typically encompass external data or provide the ability to roll up and correlate data across hundreds of pieces of equipment.

Time Range. FDD rules typically look at real time conditions or data from a sliding window of time – such as the last hour or day. Ad hoc analysis of random time periods (i.e., last August vs this June) may not be available

Presenting Results. With SkySpark, timelines show the occurrence and duration of faults (sparks) along with their correlation to other conditions or issues, giving operators insight into the cause of the issue. And "Help" associated with each rule provides operators with instructions for resolution or further investigation, as shown at the right →



Analysis Tools

Next let's consider Analysis Tools, a term most often used to describe software used to analyze time-based data such as energy meter data. Analysis tools provide an experienced user with the ability to look at data graphically and slice and dice it with a range of tools to identify peaks, and anomalies, and perform normalization against weather, building size, baseline data and other factors. There is no question that they are an important tool.

The most significant characteristic of analysis tools, however, is that they require a knowledgeable user to be sitting in front of a screen to interpret the charts and graphs to identify the important issues – in other words, the human is an essential part of the analysis. Analytics on the other hand automatically crunches through data to find the issues and report them to the operator.

Data Scope. Most commercially available analysis tools focus on a specific type of application, for example, energy meter data analysis. They may integrate weather, occupancy schedules and building size, but do not typically embrace the full range of equipment data such as temperatures, pressures, on/off status or other facility related data such as equipment vendor, or age of equipment.

Time Range. Analysis tools provide the ability to analyze across a wide time range and support historical data analysis. As for "real time" data, some products can handle data "up to the last reading" – often a 15-minute sample, in addition to supporting batch loads of historical data.

Processing Location. Analysis tools can be applied on top of existing systems as long as the data is available. They do not need to be part of the initial installation and typically do not require any changes to the control system. Analysis software can be hosted in the cloud or installed on-premise.

SkySpark provides a range of analysis tools in addition to the automated analytics it is known for. As an example, the Energy App provides users with a wide range of tools to visualize and analyze energy data including tools for normalization, baseline analysis, benchmarking, and multi-site comparison. Example →

Uncovering the Unknown – Exploring Your Operational Data

Perhaps the most important characteristic of analytics is that they expose things you were not expecting and could not have foreseen. Users find that SkySpark's visualization tools expose relationships and correlations even before rules are implemented. For an example, showing the correlation of equipment operation vs. energy consumption see page 10.

In many ways, analytics can be thought of as a superset of the other categories – analytics can be applied to "real-time" data and offer the ability to define more sophisticated alarm conditions, and FDD rules can be implemented with analytics as well. When compared with analysis tools, the key difference is that an analytics engine continuously processes data to look for issues. The human doesn't need to be there beyond contributing to the selection or definition of the initial rule. Automatic, continuous analysis is the hallmark characteristic of modern analytics solutions.

Time of Implementation. Analytics can be implemented anytime – during initial installation or after. And with SkySpark you can add new analytic rules and algorithms at any time without reaching back into the control system to make changes to alarm levels or logic. And a new rule added today will go back in time over to look for that issue in all available data.

Flexibility to Define Rules. While a typical alarm might evaluate a single item against a limit at a single point in time – analytic rules crunch through large volumes of data to find patterns that are difficult or impossible to see when looking only at real-time data. For example, while an alarm might tell us our building is above a specific KW limit right now, analytics tells us things like – "How many hours in the last 6 months did we exceed the electric demand target? And how long were each of those periods, what time of the day did they occur, and how were those events related to the operation of specific equipment, the weather or building usage patterns?" For an example see page 10.

User programmability is also important because analytics is a discovery process. Initial findings highlight issues that lead to insights for new rules. Programmability is also essential to address new priorities that emerge due to changing energy costs, operating requirements or usage patterns.

SkySpark's rule language enables sophisticated data transformations that go beyond limit checks. Tools include: Rollups across time periods, calculation of max, min, average, interpolation across missing data entries, detection of peaks and troughs, linear regression, and correlations.

A Wide Data Scope. True analytics allow the use of multiple data sources, with different formats and different time sampling frequencies. This allows for analytic rules that look for correlations between age of equipment, manufacturer, service history, weather conditions, and more. This is a key point – SkySpark is not limited to working only with control system data. In many cases the analytic process starts with data available without establishing live connections, such as historical energy consumption. This minimizes the cost and complexity of achieving initial findings and financial results.

Processing Location. Analytic tools can be applied on top of existing systems as long as the data is available. They typically do not require changes to the equipment or automation system. SkySpark analytic software can be hosted in the cloud or installed on-premise.

For more on the concept of data exploration refer to our white paper "**It Starts with Exploration: Rethinking Our Approach to Data Analytics**" https://skyfoundry.com/file/304/It-Starts-with-Exploration-Rethinking-Our-Approach-to-Data-Analytics.pdf

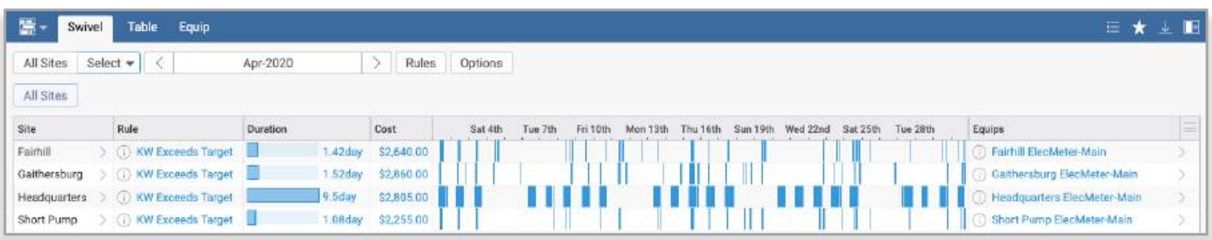
Next up – some examples help to highlight the differences.

Examples Help Highlight the Differences in the Various Tools

Let’s start with a look at alarms and analytics.

A Typical Alarm: Detect KW above a specified limit in real time.

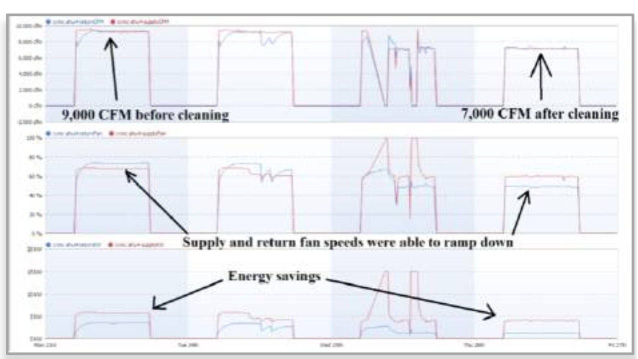
Analytic rule: Identify periods of time KW demand is above a specified KW limit across any user-selected time frame. Calculate cost impact, generate reports showing duration, frequency and cost of the issue. Provide continuous real time processing of the rule as new KW data is received, which might be minutely, hourly, daily or longer. SkySpark analytics can run against batches of data – it doesn’t require a live data feed. This makes it a great tool for commissioning and off-line M&V studies.



The view above shows periods of time when demand exceeded a target level, along with duration, and cost, per site for the month of Apr 2020.

An Alarm: Detect sensor values outside of alarm limits.

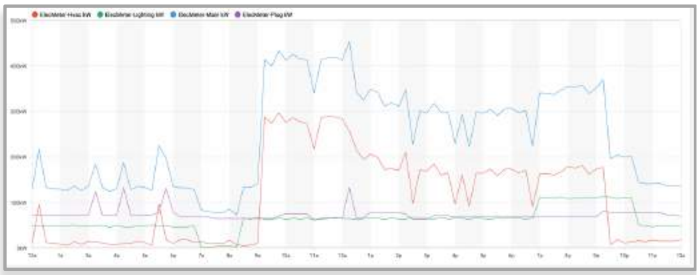
An Analytic Rule: Detecting dirty air flow sensors. In the example to the right, a dirty sensor caused the system to read a falsely high airflow on the supply. The return fan in turn ran at a high speed to try and maintain the same return airflow. This resulted in excess fan energy and an unbalanced space with airflow and pressure issues.



Once identified, cleaning the pitot tube sensor allowed the airflow station to read accurate airflow and the fan VFDs were able to ramp down. Result: energy savings of $1,300/year for about 15 minutes of cleaning for an issue that would likely have never been detected manually.

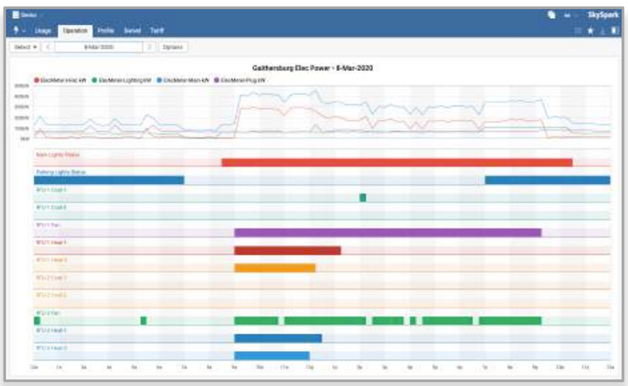
Now let's move on to some examples that show the difference between analysis tools and the results produced by automated analytics. Analysis tools enable experienced users to look at data and apply tools to identify patterns of interest. Analytics take us a step further to automatically identify correlations and patterns that are important to us.

An analysis: Generate a graph of energy consumption across a specific time. A user would then manually look to discern patterns, such as peaks or troughs and their duration.



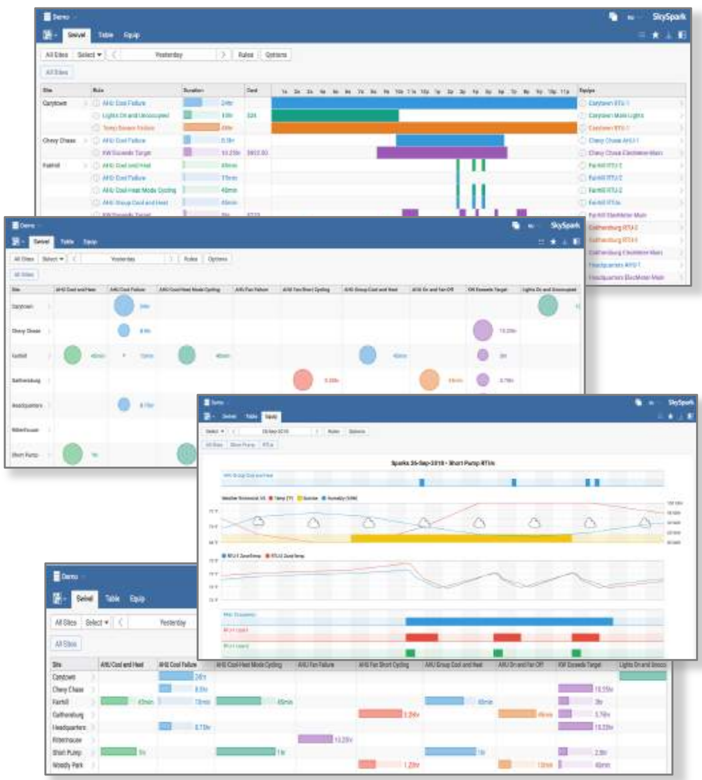
Analytics Example: Automatically correlate equipment operating status with energy consumption across a specific period of time to see how equipment operation influences energy consumption.

SkySpark's Operations View shows how equipment operation impacts energy consumption. Now when you have a peak you know what caused it – the correlation is clearly shown.



From automated issue identification, to visualization tools that show operators exactly how systems behave, SkySpark® brings together the range of tools needed to improve your facility performance.

SkySpark® – Analytics for a World of Smart Devices



The past decade has seen dramatic advances in automation systems and smart devices. From IP connected systems to support for web services and xml data schemas, it is now possible to get the data produced by the wide range of systems and devices found in today's buildings and equipment systems.

Access to this data opens up new opportunities for the creation of value-added services to reduce energy consumption and cost, and to identify opportunities to enhance overall facility operations.

Access to the data is just the first step in that journey, however. The new challenge is how to manage and derive value from the exploding amount of data available from these smart and connected devices. SkySpark directly addresses this challenge.

The new frontier is to efficiently manage and analyze data to find what matters.

ABOUT SKYFOUNDRY

SkyFoundry's mission is to provide software solutions for the age of "the Internet of things". Areas of focus include:

- Facility Automation and Management
- Remote device and equipment monitoring
- Energy management, utility data analytics
- Asset management

SkyFoundry products help customers derive value from the data in smart systems. Contact us to learn more.

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