The Importance of Capturing and Sharing Operational Knowledge

Executive Summary

Operators today are overloaded with complexity. Multiple applications monitoring countless systems and an ever-increasing number of alarms are extremely stressful. Adding to the stress are the continuous departures of experts from the industry. Companies are integrating their systems, but ultimately humans are tasked with making critical decisions during abnormal conditions. The decisions made during abnormal conditions are directly related to the integrity of the process environment and the bottom line at an estimated cost of over $20B[1] annually, in the US economy alone.

It has never been more important than now to capture the knowledge from plant operations experts and make it readily shareable before the embedded knowledge of their experience is lost forever. Not only is it important to preserve the knowledge, but the real value is derived from applying it in **decision support** applications to enhance the role of the organization's personnel in the event of abnormal conditions. Therefore, the ultimate goal is to obtain the knowledge necessary to assist in decision-making actions that directly affect the bottom line.

Expertise required during times of need from the most qualified staff is not always available and is diminishing as a result of retirements and the lure of lucrative consultancy engagements. Over the next 5 years, approximately 45% of engineers in the electric utilities industry will be leaving the workforce, creating a void of 7,000 power engineers.[2] Michael Ohadi, interim president of the Petroleum Institute in Abu Dhabi, predicted in 2008 that the majority of employees are considering retirement, where up to 50% could potentially retire within 10 years. The average age of professionals in the oil industry is close to 50, there is already a 38% shortage of skilled petroleum engineers and geologists in the Middle East region, and countries each year are already investing billions of dollars on training and preparing its oil and gas workforce for the future.[3]

Consequently, a new generation of technology is required to develop knowledge into operational intelligence that can be applied and shared throughout the plant and enterprise environment. Through a deep understanding of the knowledge hierarchy and plant operations, Emerson developed the Plantweb Optics Analytics solution. It provides a decision support application for monitoring and managing process operations and supply chain performance. The intelligent application framework identifies opportunities for profitability enhancement which includes management of continuous process improvements, enforcement of best practices, and recommendations of the best responses for abnormal conditions. With Plantweb Optics Analytics in place to support more **effective operations management**, data and information are transformed into the knowledge necessary for improved process and enterprise performance. In other words, ***Plantweb Optics Analytics becomes the plant's operational expert***.

[1] *ARC Advisory Group: Rockwell Automation Builds a Business Value Proposition for the Oil & Gas Industry; January 2008*

[2] *Preparing the U.S. Foundation for Future Electric Energy Systems: A Strong Power and Energy Engineering Workforce; U.S. Power and Energy Engineering Workforce Collaborative; IEEE Power & Energy Society*

[3] *Jodie Humphries: Oil and gas workforce - a shortage in skilled labour?; Oil & Gas Next Generation Magazine; February 2010*

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Dissolving Skilled Workforce Impacting Operations and Costs

Humans are responsible for making the decisions

As the global economy begins to recover and competition increases, companies are more stressed than ever due to increasing complexity and plant incidents. Adding to the stress are the continuous departures of experts from the industry. A strong majority of the existing workforce will be eligible for retirement in the next 10 years, predict experts, leaving a large vacuum of needed professionals in the energy industries where there are already shortages.[4] As such, it has never been more important than now to **capture the knowledge** from these professionals and make it readily shareable before the expertise of their experience is lost forever.

Not only is it important to preserve the knowledge, but the real value is derived from applying it in **decision support** applications to enhance the role of the organization's personnel in the event of abnormal conditions. The U.S. National Institute of Standards and Technology (NIST) estimates that the inability of control systems and operating personnel in the process industries to control critical conditions costs the U.S. economy at least $20 billion a year.[5] By making **operational intelligence** available, companies striving to better manage these conditions can minimize plant incidents primarily caused by human intervention due to insufficient knowledge, procedure, and operator errors.

Expertise required during times of need from the most qualified staff is not always available and is diminishing as a result of retirements and the lure of lucrative consultancy engagements. Over the next 5 years, approximately 45% of engineers in the electric utilities industry will be leaving the workforce, creating a void of 7,000 power engineers.[6] Michael Ohadi, interim president of the Petroleum Institute in Abu Dhabi, predicted in 2008 that the majority of employees are considering retirement, where up to 50% could potentially retire within 10 years. The average age of professionals in the oil industry is close to 50, there is already a 38% shortage of skilled petroleum engineers and geologists in the Middle East region, and countries each year are already investing billions of dollars on training and preparing its oil and gas workforce for the future.[7]

In addition to the process and operational knowledge capture, another very important component is the information used by the engineers to construct the original plant and subsequent additions. Much of this information is available from the applications used in design and construction, but little attention has been provided to make it available after construction. Most would agree that this type of information and knowledge is of the utmost value.

So how can the priceless knowledge of these experts be captured and made readily available during an abnormal situation or to the benefit of incoming generations of operators? What types of knowledge are required and how can it become operational intelligence? Let's take a look at knowledge, the importance of meta knowledge, and their integral links to effective plant operations.

Knowledge and Its Relevance to Effective Plant Operations

Effective operations management requires knowledge from the best people and the most critical systems

Operators, shift supervisors, production superintendents, operations managers, and engineers all make decisions that impact operations. However, many of them do not have access to the needed information in an optimal format. This can be especially obvious when quick response is required. Delays generated by multiple access points to obtain data and information can interfere with decision-making and problem resolution. The result is that operations personnel are not always fully empowered to make timely decisions to either prevent an abnormal condition or take advantage of an opportunity.

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[1] Jodie Humphries: Oil and gas workforce - a shortage in skilled labour?; Oil & Gas Next Generation Magazine; February 2010

[2] ARC Advisory Group: Rockwell Automation Builds a Business Value Proposition for the Oil & Gas Industry; January 2008

[3] Preparing the U.S. Foundation for Future Electric Energy Systems: A Strong Power and Energy Engineering Workforce; U.S. Power and Energy Engineering Workforce Collaborative; IEEE Power & Energy Society

[3] Jodie Humphries: Oil and gas workforce - a shortage in skilled labour?; Oil & Gas Next Generation Magazine; February 2010

People and computer applications both depend on data and information, but effective decision-making requires more than merely data and information aligned in workflow processes. Rather, *knowledge* is the key ingredient. A classic figure describing the essential associations between data, information, and knowledge is shown below.

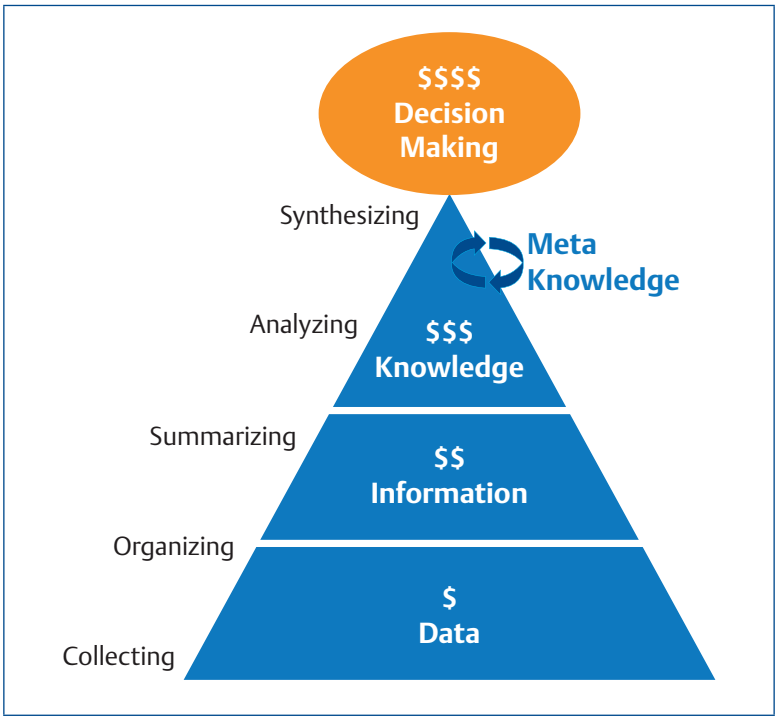

Figure 1: The links and process of converting data into vital knowledge

The ultimate goal is to obtain knowledge to assist in decision-making actions. This goal can be reached by building meta-knowledge, which is defined as “knowledge about knowledge,” or as the understanding about the mechanisms necessary to acquire knowledge. Two examples of the need for meta-knowledge management are featured below:

Example 1 – Statistical Regression Models: Statistical regression model development requires knowledge of how to build the model and to directly introduce data into it

Example 2 – The Scientific Method: Knowledge is needed to propose a theory such as a model, testing the model against historical data and information, and inventing new experiments to test the theory

Knowing how to collect and manage the necessary information is where meta-knowledge becomes useful, because ultimately, data and information is valueless unless it is acted upon. Actions are derived from the decisions needed to improve or correct operations. Finally, it is the meta knowledge of operational intelligence that enables effective or good recommendations for decisions. The timeliness and quality of these decisions will directly impact the bottom line.

About Plantweb Optics Analytics

Plantweb Optics Analytics is a new generation of integration technology. It is different from earlier generations of integration technology which were focused solely on the exchange of data. Plantweb Optics Analytics provides a higher level of integration that gathers the required knowledge and information for applications and then acts on it.

Plantweb Optics Analytics is based upon on a 3-tier client/server architecture, composed of the **data sources layer**, the **server layer,** and the **client layer**. The data sources can be part of the process control system such as DCS and SCADA systems, or part of the enterprise network such as MES and SAP (ERP) applications. The server layer contains the Plantweb Optics Analytics server and Plantweb Optics Analytics engine. These include core components and user-defined components. The client layer includes a generic client Plantweb Optics Analytics Project Studio and custom Plantweb Optics Analytics clients that can be built using APIs (Applications Programming Interfaces) and SDK (Software Development Kits). Plantweb Optics Analytics enables an integrated plant network as shown in *Figure 2*.

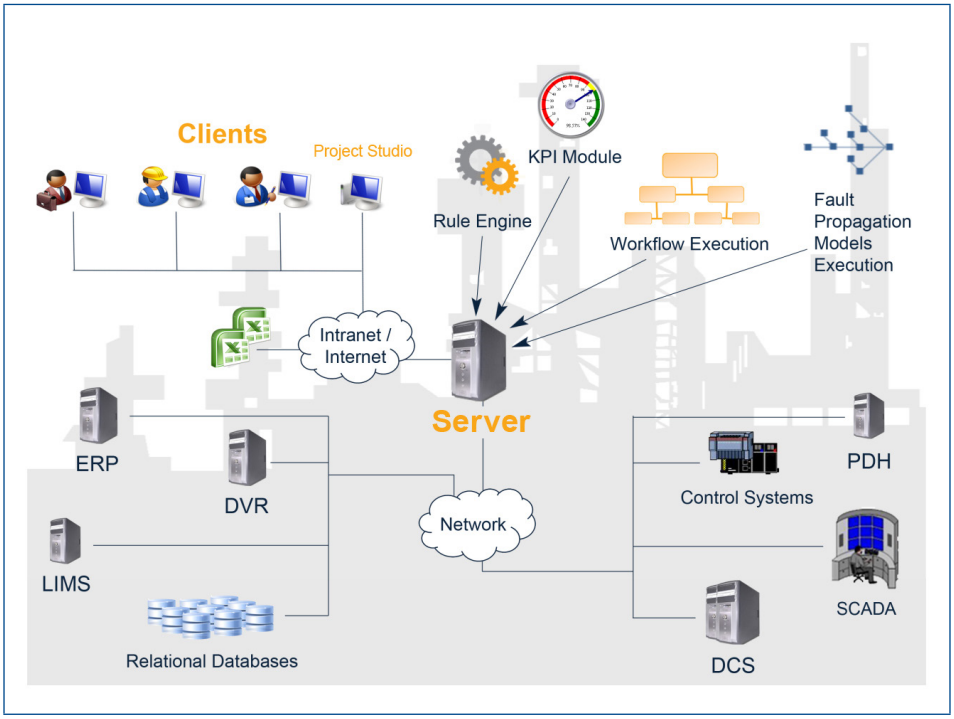

Figure 2: Emerson's Plantweb Optics Analytics architecture

Although Plantweb Optics Analytics offers a comprehensive set of application blocks that users can drag, drop, and connect to build applications, it also allows the option to create user-defined blocks written in C# with full access to the data presented to Plantweb Optics Analytics, extending the existing library set of blocks. These blocks provide the ability to:

- Process complex events
- Observe the progress of operations activities
- Detect situations relating to inefficiencies or safety issues
- Compute and monitor key performance indicators (KPIs)
- Trigger automated actions, procedures, and reports using workflows

A user-friendly HMI may be used to quickly and accurately resolve operations issues. Real-time updates may be sent to different users via messages or emails to notify them about the process evolution.

For example, the fouling factor in the heat exchanger is monitored online to prevent the sharp drop in the heat exchanger effectiveness. Any deviation in this KPI will be automatically detected and Plantweb Optics Analytics will notify operators that the heat exchanger is due for water wash. At the same time, Plantweb Optics Analytics will send e-mails or messages to the maintenance department. A workflow will be launched to coordinate the work that must be planned between maintenance and the operators, track the cleaning up tasks and, ensure the schedule of the proactive maintenance.

Besides, an intuitive dashboard may be used to display metrics as charts and graphs in order to inform operations manager when process issues with potential impact on production, safety or environment are detected.

Other systems may represent data and information as variables, events, objects, time series, data sets, and similar standard structures, but Plantweb Optics Analytics leads the explicit representation of so many different kinds of knowledge. By enabling the building of explicit knowledge in a graphical form, Plantweb Optics Analytics makes it easy for people to transfer their knowledge into Plantweb Optics Analytics.

Plantweb Optics Analytics can become the operations' expert by using and explicitly representing knowledge from an integrated plant environment

Plantweb Optics Analytics supports the building of decision support systems through the application and sharing of knowledge. Plantweb Optics Analytics uses knowledge to transform data into information for generating recommended actions. Users can build knowledge into the system so that Plantweb Optics Analytics can become the operations expert as it quickly identifies opportunities for operations improvements. It identifies root causes of problems when they arise and swiftly guides plant operators in making the most effective decisions. Knowledge can be modeled and executed using Plantweb Optics Analytics' graphical rules and business workflow engines.

Plantweb Optics Analytics provides tools to facilitate the organization of knowledge and the transformation of data into graphical views, thus simplifying and improving visibility at every level of the business and plant computing hierarchy. It also provides a graphical object framework that makes applications such as enterprise asset management and operational performance reporting easy to integrate.

Plantweb Optics Analytics offers much more than just a set of tools, technologies, and practices. It enables a way to manage meta knowledge leading to operational intelligence for better decision-making and increased business performance that improves the bottom line.

Keywords

A

abnormal conditions – situations occurring within a process that deviates from planned courses of production that could have significant impact on the enterprise's safety, cost, and efficiency

alarm filtering – applied to reduce the number of alarms and to prioritize them, where the goal is to produce fewer alarms and to help identify the most critical ones

applications services – represents the services offered to communicate with the business layer

automated root case analysis – the ability of an application to directly investigate the original sources of plant and process interruptions before they can have potentially critical consequences on the enterprise without requiring operator interference

C

client layer – represents the presentation layer. This layer stands for the top-most level of the application and is used to translate tasks and results to something the user can understand

corrective action – the resolution to be taken in order to correct an abnormal condition such that the process once again aligns with planned actions

D

data service – represents the services offered for data collection from data sources

data sources – represents several systems from which real-time, historical, or transactional data can be gathered

data sources layer – represents the data access layer, it includes several systems from which real-time, historical, or transactional data can be gathered. The data is passed to the logic tier for processing, and eventually to the user

decision support – information and knowledge provided by intelligent solutions to aid the resolution-making process

decision support systems – intelligent solutions that gather information and knowledge from throughout the enterprise in order to aid the resolution-making process in the case of an abnormal condition

E

effective operations management – Operations management typically represents the supervision of the bulk of a business' assets. Effective operations management helps companies reach their business and performance targets as well as develop capabilities that will keep them ahead of their competitors into the future, often by (but not limited to) reducing costs, increasing the safety of operations, reducing the risk of operational failure, and providing the basis for future innovation

F

false alarms – inaccurate or mistaken notifications of threats or problems

fault propagation model – a technique used to analyze an undesired event and all associated causes in order to identify the root causes of the event

K

knowledge capture – the act by which intelligent solutions preserve and archive valuable user experiences for future use

knowledge out-of-the-box – a ready-made technology that meets a need that would otherwise require a special development effort

O

operational intelligence – the goal of reaching optimized business efficiency by using real time monitoring of processes to detect and respond to situations involving interruptions, opportunities, and bottlenecks

P

Plantweb Optics Analytics – Emerson's intelligent application that seeks to proactively detect and diagnose operation issues before they impact production and safety, reduce the problem-to-resolution cycle time, and aggregate and transform data into valuable knowledge and information

problem-to-resolution cycle time – the entire period during which a process problem starts, manifests, and is conclusively repaired

R

root cause – the original sources of plant and process interruptions

root cause analysis – investigation of the original sources of plant and process interruptions before they can potentially have critical consequences on the enterprise

S

server layer – represents the business logic layer. It coordinates the application, processes commands, makes logical decisions and evaluations, and performs calculations. It also moves and processes data between the two surrounding layers (data sources and client layers)

References

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