

White Paper
October 2020

Improving Process Performance through an Intelligent Integrated Framework



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Executive Summary

Companies, over the past decades, have invested heavily in data historians. As a result, an enormous quantity of data has been and is currently being accumulated, analyzed, and stored. So much in fact, that it is impossible for a human to manually manage for the achievement of outcomes desired in the time frames allotted. Instead, valuable time is consumed searching for an answer through a myriad of information, and time can be directly correlated to money in a complex process environment.

Manufacturing execution systems layer, including multiple tools and applications, has been developed over the years to process some of the data and information. In 2003 MES Market for process industry globally reached 1.1\$ billion and experienced growth of 11% annually. However, many of these tools are still not able to provide the process performance improvements and profitability required. In addition to automation, process knowledge must be applied to the information to provide a context for the content. The contextual content or knowledge derived from automation and applied through an intelligent framework makes the application of standards and best practices easier to utilize throughout the organization.

Emerson, through its deep domain knowledge and industry expertise, has developed a new intelligent framework that puts data, information, and more importantly knowledge at the fingertips of the users. Finally, companies can be assured the information and knowledge made available from the process floor level to the executive suite through an intelligent integrated framework is not only relevant, but also provides value for their investment.

Plantweb Optics Analytics from Emerson focuses on where to get data, information, and knowledge, for applications, rather than focusing on accumulating data. Plantweb Optics Analytics is complementary to the plant data historians and other databases already in place, providing additional capabilities for integration, improvement of the process visibility, and reasoning for decision-making.

Plantweb Optics Analytics provides tools to enable improving the performance visibility of the enterprise, which supports the linkage of business decisions with operational goals. It allows users and partners to institutionalize best practices while organizing knowledge and transforming data into graphical views. Therefore, the Plantweb Optics Analytics solution improves visibility at every level of the business and plant computing hierarchy empowering users across the enterprise to reach their business objectives.

Process Automation Requires an Intelligent Integrated Framework to be Effective

Access to data and information alone will not provide the real value desired for the process industry

Access to data and information alone will not provide the real value desired for the process industry. In addition to real time access and ease of use, process knowledge must be applied to provide a context for the content. Recognizing the need, many have addressed the problem with various approaches and until now, with limited success. To provide real value, the data and information transformed through diagnostic and decision support system must be integrated via an intelligent framework for utilization throughout the organization.

Companies also want to be assured that new tools and applications are enabling faster and safer decisions. They must also feel confident that the information and knowledge made available from the process floor level to the executive suite through an intelligent integrated framework is not only relevant, but also provides value for their investment. To this end, it is important to note that studies have shown that data warehouse and business intelligence systems implementation can generate a median five-year return on investment of 112% with a pay back of 1.6% on average costs of 4.5 million. Out of the organizations included in this study, 54% have a ROI of 101% or more.²

Let's take a look at how the process industry has evolved over the past few decades and discover why the new Plantweb Optics Analytics intelligent framework is in high demand.

A Historical Perspective on Integrating Systems for the Process Industries

Exponential growth of applications required the development of industry standards and interoperability

As organizations installed computer-based systems in their operations, “islands of automation” created. Individual systems were developed for applications such as historical data collection and reporting, data reconciliation, decision support system, maintenance management, and many more. It was quickly determined that these applications needed to work together. Initially, individual bridges to link pairs of systems together for data exchange were built. But this proved impractical as the number of applications grew (too many possible individual interfaces were needed to potentially link every pair of applications). In addition, interface development required significant work, involving proprietary toolkits for the software on each side of an interface.

Another approach attempted was to centralize servers (such as data warehouses, when only data retrieval was needed). This allowed each application to communicate individually with the centralized system. The total number of interfaces required was reduced because each application could communicate with the central system instead of linking directly to each other.

The approach became known as “JABODAT” or “Just A Bunch Of Data”, because it duplicated the data already available in the disparate systems. Using a central database was found to be less efficient than highly customized application databases. In addition, existing database applications were already included in the laboratory information systems, plant data historians, high-speed vibration monitoring systems, and those related to the ERP systems.

Another new approach developed was CORBA (Common Object Request Broker Architecture) and it seemed to be the solution to all these problems. It was already in use in industries such as telecommunications and established integration standards for each application utilizing an object-based protocol. Each application required a single interface to a standard protocol, rather than one for every system. But, usage did not expand beyond a few market niches for a variety of reasons and the process industries moved to the Microsoft-centric approach.

In the meantime, standards arose to address specific needs by application and industry:

- OPC became a successful standard to integrate the DCS or SCADA system data and events with other computers and was widely adopted in the process industries.
- ISA95, an international standard based on models and terminology, was used to integrate enterprise and control systems.
- BPEL became widely accepted to represent and integrate workflows.
- MIMOSA has emerged as a favorite standard to represent physical or functional assets typically needed for operations, maintenance, and engineering applications in process plants and other applications.

The standards such as MIMOSA, BPEL, ISA95, and OPC exchange more than data and information. They represent a new generation of integration standards to address the exchange of knowledge. For example, knowledge is encoded in the form of classes of objects in a MIMOSA/ISA95 hierarchy, the data flow organization, and scheduling between assets and BPEL for workflow representation. In addition to providing data transfer, OPC offers a browsing capability that exposes structural information in the form of tag names, with some hierarchy and grouping as well.

Standards and interoperability were developed, but how could this new data availability and knowledge be integrated with best practices and transformed into good decision making for the process industry?

Expert Decision Support Systems Required to Provide Executable Knowledge

A modern framework that enables the utilization of best practices in real-time is required for the deployment of executable knowledge

As the process industry began to address the need for application integration, efforts were made to improve operations by making best practices more accessible. Some suggested the housing of available documents online. Documents could include operating manuals, troubleshooting procedures, incident reports such as near miss reports or safety studies, engineering documents, along with new material. Documentation could be readily available and searchable. Tools to assist availability and search included knowledge management systems, wikis, blogs, custom built internal web sites, and other means of collecting site information in the form of documents. This approach has been called “JABODOC” or “Just A Bunch Of Documents”.

This approach can be a useful repository of static information, especially for training and research. It is an improvement over a large printed operator’s manual and file cabinets full of incident reports, engineering documents, and so on. It is especially beneficial for users remote from the operations control centers.

Ultimately, these solutions alone are just a bunch of documents. Executable knowledge in the form of executable workflows, as well as graphical models for diagnosis and data manipulation that specify execution using real time data, are not provided. The need to automatically receive live data, perform diagnostic or Key Performance Indicator (KPI) calculations, diagnose problems, communicate actions required, and enforce workflows necessary to consistently delivers the right responses and documents at just the right time is absent.

The development of real-time decision support systems achieved some success in process applications. The focus has typically been on diagnosis and alarm filtering. The real problem that was not addressed properly is the integration between plant control systems and enterprise computing systems. In addition, the complexity involved in updating these systems to reflect plant changes or the inevitable recognition of incomplete or incorrect models had not been satisfied.

Therefore, a modern intelligent framework for integration is required to directly support the current standards needed for industry applications. Additionally, to ensure that applications can be successfully developed, basic functionality of a rule engine, KPI calculation, diagnosis, workflow management, and user interface must be present. Note that most process plant environments have some software components, but to truly move to a robust decision support system that is complementary to existing applications and empowers the users, the Plantweb Optics Analytics intelligent framework must be utilized.

Finally, a new intelligent and integrated framework has been developed to provide the process industry with the efficiencies and links to best practices that has been needed to empower uses and increase profitability. Let’s take a look at how the Plantweb Optics Analytics solution addresses the current and future needs of the enterprise.

Plantweb Optics Analytics Integrates Data and Events to Represent the Plant or Enterprise

Plantweb Optics Analytics is the new generation framework for intelligent integration

Plantweb Optics Analytics is an intelligent decision support application. It allows users to monitor, manage, analyze, and improve performance visibility of the plant and enterprise operations. It also allows for the implementation of diagnostic and decision support systems within the plant and enterprise. Plantweb Optics Analytics empowers users to make effective business and operations decisions by gathering the right data and information, and intelligently integrating knowledge scattered in the many islands of automation.

Plantweb Optics Analytics is based 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 Manufacturing Execution Systems (MES) and Enterprise Resource Planning (ERP) applications.

The server layer contains Plantweb Optics Analytics servers and engines, including core as well as user-defined components. The client layer (Plantweb Optics Analytics Project Studio) includes a generic client. If desired, custom Plantweb Optics Analytics clients can be built using different APIs (Applications Programming Interfaces) and SDK (Software Development Kits). A graphical representation of Plantweb Optics Analytics in the plant networks is shown in Figure 1.

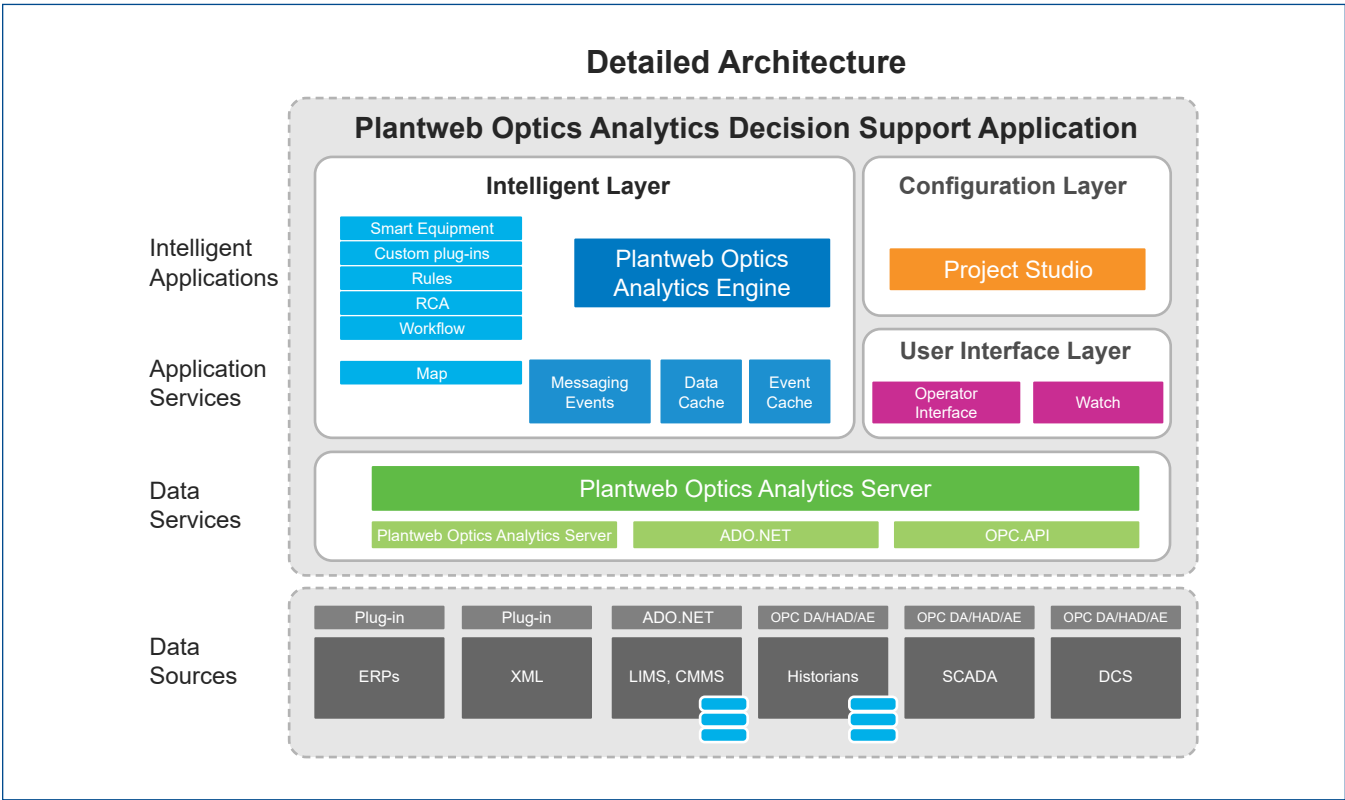


Figure 1: The Plantweb Optics Analytics framework application architecture.

Within the lowest level or server layer, the Plantweb Optics Analytics Server provides a data service to exchange data and events with many applications. Multiple systems can share the applications services provided, including message management, event management, security, end user displays, and caching of recent data and events for efficiency.

The Plantweb Optics Analytics solution also incorporates references to documents available on internal web sites to perform event detection and diagnosis. Plantweb Optics Analytics Workflows point to the appropriate documents when needed to help understand a problem, or taking mitigation or corrective actions. The users do not need to search – the documents are made available when the user needs them.

Another applications service highly utilized is the “plant map”, called Map. This module represents plant equipment, as well as more abstract entities like “process unit” and “plant”. It also contains objects needed in enterprise applications such as orders, customers, and so on. The relationships between objects are represented including containment (e.g., tower 101 is part of Unit 1), connections by pipes, or instrument signals and communications or logistics networks. Therefore, it is a key part of the unified user interface that serves as a window to the enterprise.

Above the applications services layer, knowledge supplied components provide functionality for applications such as workflow management, diagnosis, calculating KPIs, event detection, and data validation. The Plantweb Optics Analytics engine executes these applications based on models that can be user configured or supplied by Emerson. Plug- ins can be constructed to access any of the applications components, as well as the applications services.

Plantweb Optics Analytics enables more intelligent data distribution

Plantweb Optics Analytics enables more intelligent data distribution by modeling how data is distributed, synchronized, and used. Data is not always needed in a particular place at a particular time (e.g., a system may be shut down or overloaded; or data is associated with a particular product that is not being made at the time). By modeling the data flows, Plantweb Optics Analytics can also act as a “traffic cop” when needed. For instance, Plantweb Optics Analytics can detect operational problems and immediately notify the ERP system to re-initiate planning. Plantweb Optics Analytics, in conjunction with the tunneling capabilities in associated OPC products, can explicitly manage issues related to the passing of data back and forth across firewalls separating the different levels of the plant computing hierarchy (e.g., ERP systems have been known to have trouble coordinating with actual plant capabilities).

Plantweb Optics Analytics uses an object-oriented approach to organize its models of plant knowledge. Diagnostics and decision making systems depend on this type of knowledge. After all, once past the most basic sensor checks, applications such as troubleshooting depend on the knowledge of plant equipment and its inter-relationships (how equipment operates or fails, how it is connected to other equipment to achieve process goals or propagate problems, and how to troubleshoot it).

Plantweb Optics Analytics incorporates, synchronizes, and validates knowledge obtained from other systems or documents providing a unified window into the process for each user

Plantweb Optics Analytics provides a single, unified window into the process for each different type of user to view all aspects of the plant. Users have the ability to run separate clients with custom views. The views combine data and additional calculations like KPIs. Views can include diagnostic information for process problems, which include diagnosis of the reasons for deviations from KPI targets. All are provided by Plantweb Optics Analytics’ ability to work with HMI (Human- Machine Interface) products such as Wonderware’s InTouch for the end user interface. In addition, Plantweb Optics Analytics includes an SDK (toolkit) for developing a customized GUI (Graphical user Interface) using Visual Studio.NET and it can be used to integrate third party GUI tools. Plantweb Optics Analytics also offers a default end-user HMI as well.

Map's plant map provides object-oriented representation of knowledge with associated with events enabling decision support for the plant or enterprise structure

Map represents, as objects, the plant or other parts of enterprises involved in applications as shown in Figure 2. The “domain objects” can include equipment, sensors, controls, ships, warehouses, and invoices, as well as more abstract entities such as plant units, customers, enterprise organizations, or tag groups. The objects are managed by the business and incorporated into the decision support applications and referenced as “managed objects”. Consequently, it is important that the domain objects include the properties needed for other applications (e.g., a heater and reactor are represented as an object with properties needed for diagnostic applications or logistics planning applications).

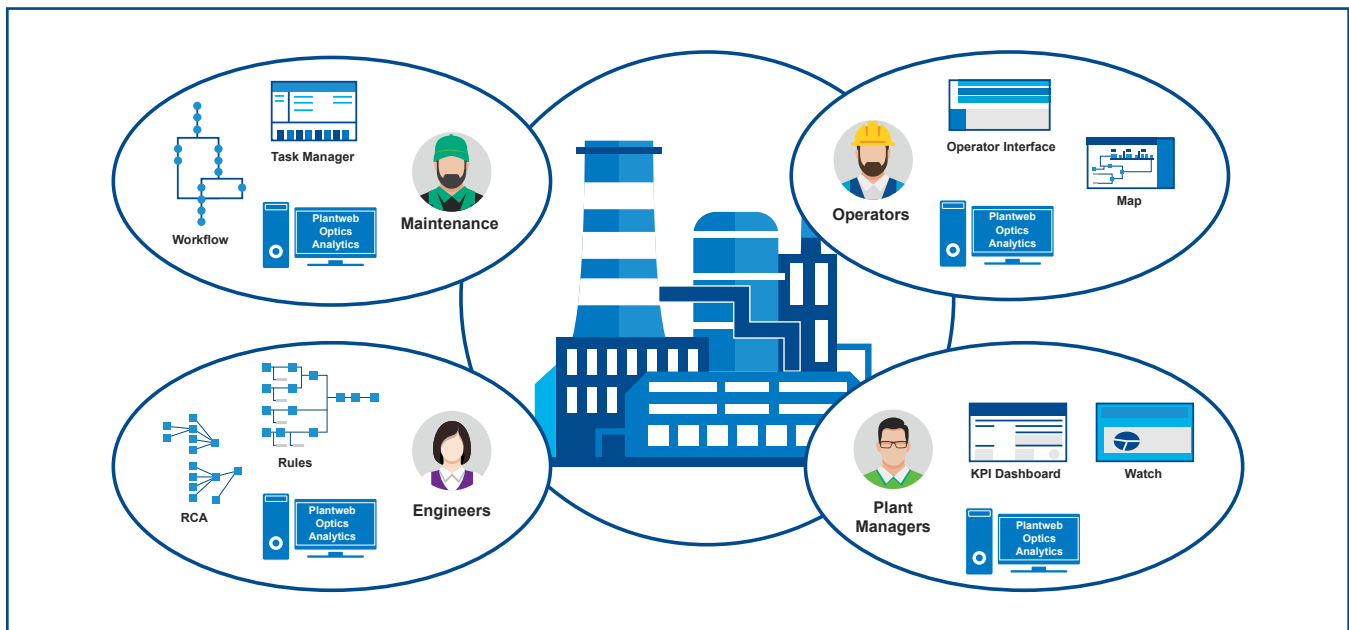


Figure 2: Improving performance visibility across business levels.

The Map plant map also includes the relationships between these domain objects. The relationships may include connections via pipe or instrument signals, domain objects, properties, and relationships are all available for use by any application inside or outside the Plantweb Optics Analytics framework. For example, before setting up oil movements, Plantweb Optics Analytics would enable the avoidance of contamination between two products by ensuring that no valve is shared between the two movements. The isolation valves would be closed between the two oil paths and thereby restrict contamination.

Many applications graphically display equipment and associated variable values. However, the systems generating these displays do not really “know” that a displayed value such as a level sensor or calculated value is associated with a particular piece of equipment. The knowledge is stored in the mind of the user and only suggested by the picture. Any relationship between temperature and pressure of the same equipment is stored in the mind of the user and not derived from the application providing the display. Therefore, diagnosing problems requires a deeper knowledge of the linkages which are provided and formalized by Plantweb Optics Analytics’ plant map.

Emerson’s Plantweb Optics Analytics solution is the leader in the provision of a graphical object framework that makes applications such as enterprise asset management and operational performance reporting easy to integrate. It provides tools to improve performance visibility of the enterprise, which supports the linkage of business decisions with operational goals. As well, Plantweb Optics Analytics allows users and partners to institutionalize best practices while organizing knowledge and transforming data into graphical views. Therefore, **the Plantweb Optics Analytics solution improves visibility at every level of the business and plant computing hierarchy empowering users across the enterprise to achieve higher process performance.**

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.

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.

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

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).

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