CHRONICLING PROCESS INDUSTRY INNOVATIONS SINCE 1966
CHEMICAL ENGINEERING WORLD

Digital Transformation of Chemical Manufacturing Plants

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Author has brought out an insight here on digitalization as a mandatory way forward for chemical processing industry to win over various challenges. Towards this endeavor, light has been thrown on to various facades viz data collection and analysis, digital operational infrastructure , predictive analysis, pervasive networking, pervasive sensing, and associated others.

The chemical manufacturing industry faces many challenges affecting plant performance and reliability, safety and compliance, and production.

Plants may struggle with unscheduled downtime due to unexpected equipment failures or excessive scheduled downtime for turnarounds, thus losing several days of production every year. In addition, it may be difficult for personnel to keep up with a preventive maintenance schedule, and many plants have escalating maintenance costs.

Some process equipment may see a premature end of life, due to a reactive maintenance culture. Loss of containment due to aging of piping and vessels is another challenge. Moreover, plants are expected to improve performance without increasing headcount.

Keeping pace with inspection and verification requirements in new health and safety directives also can be difficult, leading to potential fines for noncompliance. Again, manpower cannot be added to perform these tasks.

Finally, manual operation causes production bottlenecks. Operating costs may be escalating, and as staff retires the remaining personnel are left with more to do.

Improving data collection and analysis:
To achieve operational excellence, chemical manufacturers can now digitally transform how the plant is run and maintained. For example, plants are switching to new automatic, digital, software-based and data-driven working methods that enable personnel to carry out their daily duties more effectively.

Routine manual collection of maintenance, reliability, and integrity data from equipment like pumps and valves with portable testers, and time -consuming interpretation, are no longer required.

Instead, vibration, acoustic, corrosion, and other data is collected automatically to detect early signs of potential problems, transmitted digitally, and analyzed by software to predict and distinguish between various equipment failure modes. Notifications of developing issues can be sent to an operator's smartphone or tablet at any location.

Any remaining manual inspection rounds make use of a tablet, software, and secure connectivity to supply information to a central pool of domain experts who analyze the data and provide actionable information in support of plant personnel. This support includes two-way digital video and audio between a field technician via a wearable camera on-site, and a remotely located expert seeing the problem in real time via a software application (see Figure 1).

Figure 1: Remotely located expert seeing the problem in real time via field technician with wearable technology

Procedures, drawings, and manuals can be accessed on a tablet in the plant, eliminating the need to carry papers or return to the office to pick up additional documents.

Ad-hoc visits to the plant to check if a manual valve was closed, dipping to see if the tank is nearly full, or inspection for leaks and spills can be replaced by automatic detection, digital transmission, and indication in control room software as well as use in interlocks.

What's more, the geo-location of every person is sensed digitally in real -time and automatically tallied in software. An alarm is issued if personnel breaches permitted work areas or enter high-risk areas. Automatic detection, digital transmission, and alarms on safety shower activation or "man-down, not moving" situations all increase safety.

Digital operational infrastructure
There is no need to replace or significantly overhaul the existing control system, as the operational infrastructure is compatible with existing automation. In addition, the existing historian can be used as an analytical platform.

In a digitally transformed plant, work done by everyone from the plant manager down is data-driven. A key success factor is that the information must be easily accessible in a timely manner, and it must directly be delivered to the person responsible. For instance, predictive instrument alarms and data should be delivered to the laptop and smartphone of the instrument technician.

Dashboards and alarms are generated by mobility software using information from underlying analytics applications that perform functions such as equipment condition monitoring. Dashboards (see Figure 2) contain KPIs specific to the person's responsibilities, displayed on tablets or smartphones, making information immediately available at any location.

Figure 2: Plantweb™ Insight Dashboard

Predictive analytics
Many digital transformation solutions involve simple monitoring of key elements such as corrosion, temperature, and pressure, needing no analytics. However, predictive equipment analytics applications which leverage embedded subject matter expertise are used for performance and condition monitoring of complex process equipment. They use multiple measurements to anticipate problems, allowing failures to be averted.

Such equipment includes - for instance - pumps, compressors, and valves. Through these applications, raw data from sensors is distilled into actionable information. When a problem arises, the technician already knows the most effective course of action and what tools to bring before going to the field. The fault models uncover early signs of trouble and distinguish between many types of equipment-specific failures.

Analytics software can be installed on servers, on-premise, or on virtual machines in the cloud. A layered, open architecture has real-time analytics at the sensor level, and edge analytics are conducted in higherlevel devices and servers, feeding up to big data analytics.

Web-based analytics applications are not dependent on any particular control system or historian. The plant's existing historian remains in place, with no need to add another middleware platform, thus protecting the plant's investment and keeping the administration cost low.

The analytics use data aggregated from multiple sources: new wireless sensors, existing sensors, package unit PLCs, control systems, safety system , machinery protection systems, intelligent device management (IDM) software , and any historian or future platform.

Real-time equipment monitoring makes it easy to maintain; and is also reliable for professionals to use with features like overview dashboards, an alarm summary with simple health index, priority, plain text problem description, the ability to zoom into detail, and history-trend to see accelerated degradation as well as to estimate remaining life (see Figure 3).

Figure 3: Easy-to-use analytics apps

The analytics uses verifiable first-principle models and statistical algorithms to detect signs of developing equipment issues, predicting failure, and providing an early warning on these leading indicators so that breakdown can be prevented.

These applications are pre-engineered based on years of experience, so no long algorithm learning periods are required, just baseline to capture. No custom programming or code maintenance is required.

Pervasive networking

Data-driven practices require sensors to collect the critical data. It would be impractical to hardwire hundreds or thousands of sensors using 4-20 mA and on-off signals point-to-point. Plants built with Foundation Fieldbus networking can simply add instrumentation to existing field junction boxes with minimal wiring to the sensors.

Plants deploy a plant-wide wireless sensor network and, optionally, a wireless LAN infrastructure, depending on which tasks will be digitally transformed. The infrastructure consists of wireless gateways for the sensor networks, and wireless access points for the Wi-Fi network as the central nervous system of a digital plant.

The gateways can be embedded inside the access points when WirelessHART and Wi-Fi are deployed together. Since these networks are used for operational functions, both wireless networks integrate with the control system, historian, machinery protection system, safety system, and other operations systems.

Pervasive sensing

Equipments such as pumps, compressors, valves, and steam traps have process sensors but usually no sensor for condition monitoring. This equipment is instrumented with additional sensors to cover these missing measurements.

Figure 4 - Connected services installation

Automatic data collection is much faster, providing early detection of developing problems, thereby making the asset management more predictive and far more productive.

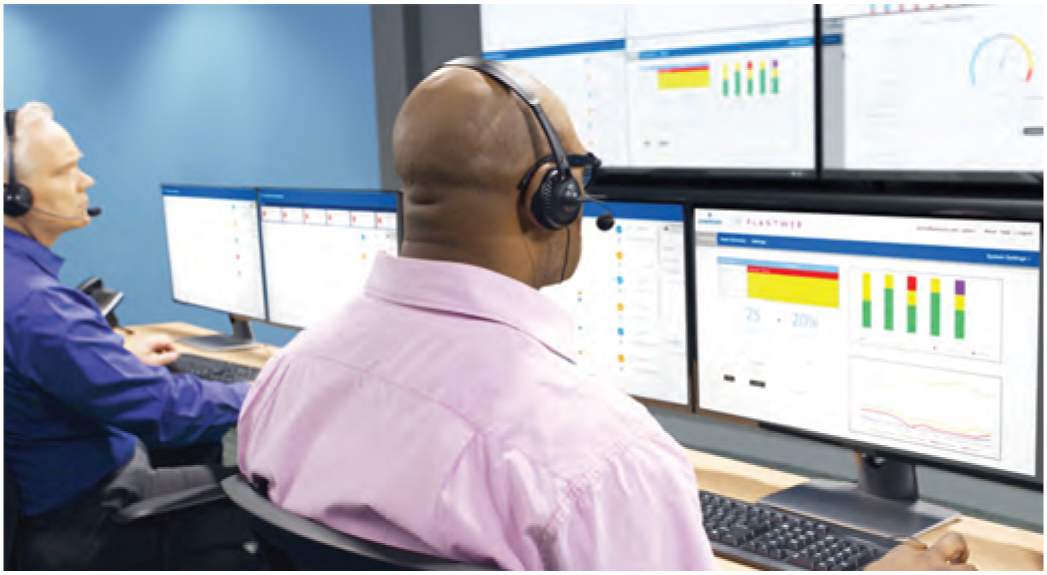
Figure 5 - Experts monitor critical equipment

Wireless sensors often take the place of mechanical instruments, portable testers, and clipboards. Control valves, steam traps, and pressure relief valves - not already digitally integrated - are fitted with wireless adapters. Many of these sensors are non-intrusive or reuse existing process connections, meaning they can be installed while the plant is running, without shutting down the process.

Condition monitoring and reporting
Often there are not enough experts at a site. To address this, some plants opt for a digital solution with experts in a central location, monitoring equipment across multiple sites globally. Companies have the option of either performing this analysis inhouse or using external experts.

Developing dedicated in-house experts can be costly and hard to retain. Automation technology suppliers are helping by offering remote, continuous assessment of critical equipment and processes and delivering the actionable insights that maintenance departments need to improve performance.

With Microsoft Azure cloud services, as well as with a scalable and secure application environment, automation technology suppliers can offer support via subscription-based health monitoring services. This eliminates the need for companies to focus on developing in-house domain experts and instead can leverage services that can immediately deliver improvement as well as cost reductions across many operational areas.

For example, diagnostic data is helping to identify potential control valve failures before they cause significant interruptions to operations. By analyzing a wide variety of diagnostic data collected from digital valve controllers, remotely-located experts are identifying failure conditions.

Conclusion:
Embracing digital transformation is not about a single software installation. Instead, it requires a focused commitment from company leadership to alter the technological foundation of the company and critical business processes for the good of the business.

Companies that embrace this outlook and the innovations that enable to realize improved performance along with reliability with better safety and less compliance issues within their manufacturing operations and position themselves to add more value to customer interactions. This will, in turn, lead to sustained success and long-term profitability.