PROCESS AUTOMATION

A Framework for **Digital Transformation**

The digital transformation is overhauling the chemical process industries. Follow these five steps to implement Industry 4.0 projects at your facility.

SIEMENS

Manufacturers around the world are being forced to do more with less, as they grapple with finite resources and numerous challenges. The chemical process industries (CPI) in particular are facing challenges as they look to increase productivity. Digitalization and automation are game changers that can help to overcome obstacles, but they come with their own set of challenges. With the right digital tools, however, companies in the CPI can increase operational efficiency, security, and productivity while reducing costs and improving customer experience. Digital transformation (DT) will mean something different to every company. There is no cookie-cutter approach to DT that allows companies to simply order "digitalization" and get it delivered in a neat package. Instead, implementing digitalization requires adapting to specific situations and needs. A defined strategy, executive support, and culture committed to change can accelerate DT and help companies-reap the benefits, for example, through:

- easier connections to remote equipment
- increases in plant uptime (Figure 1)
- attraction of next-generation talent
- mitigation of critical labor shortages

Frameworks are available to jumpstart DT efforts at any size company in any industry. This article takes a closer look at one of those frameworks (1).

Demystifying digital transformation

What is digital transformation? It is important to understand that DT is not an effort to rip out and replace existing infrastructure or eliminate jobs. DT technologies allow organizations to access and utilize existing data from the plant floor to better synchronize manufacturing systems. This, in turn, improves business procedures and enables employees to do their jobs more efficiently and flexibly.

Is digital transformation all about data? While data plays a significant role in DT, it is not the only focus. The primary intent of data capture is to use it to gain meaningful insights into a process, plant, or operation.

Process facilities continuously generate high volumes of data — friction coefficients when a valve moves, tiny changes in pressure or flow, temperature increases in electronics, and pump vibrations — all of which are valuable information. Digital technologies are able to extract this data using simple and cost-efficient gateways, store it, analyze it using cloud-based tools, and allow employees to visualize it to meet specific needs.

Basic digital tools can be used to develop visual representations of critical data, or more complex systems that use artificial intelligence (AI) and machine learning can be used to provide valuable insights in operations. Whether companies can derive immediate value from these tools or systems depends on their digital maturity, which typically falls into one of three stages:

Stage 1. Connect and monitor. Connecting to existing data and monitoring assets is the starting block for DT. Accessing a limited number of datapoints allows businesses to gain visibility into equipment performance, as well as initiate condition monitoring and management of critical assets to avoid costly unplanned downtime.

Stage 2. Analyze and predict. Building on the device connectivity established in the first stage, more advanced data algorithms can be applied to analyze data, provide insights into asset usage, and define trends to predict possible issues. This can be combined with prescriptive steps to improve operational health, maintenance, and energy usage, as well as optimize resource scheduling.

Stage 3. Digitalize and transform. In this final stage, the use of data enables more complex capabilities, which include developing digital twins of physical assets and evaluating simulations and "what-if" scenarios to improve operations.

Common areas of implementation for digital technologies

The potential applications for digital technologies in the CPI are broad. In this section, we review four common areas of implementation, including control valve monitoring, alarm and event management, predictive maintenance, and connected workers.

Control valve monitoring. Control valves are critical to efficient operation and safety. Valve failures can lead to process upsets, unsafe conditions, and unexpected downtime. Preventive maintenance plans established to avoid valve failures often result in high operating costs. Control valve monitoring tools are available, in both on-premise and cloud-based architectures, to collect data from smart valve positioners and enable cost-effective monitoring. These tools are able to:

Figure 1: Digital core technologies can be applied to existing systems to increase uptime, throughput, and operational efficiency.

• Identify and report control valve anomalies, such as air leakage, material buildup, valve plug wear, wire drawing (i.e., erosion or scoring of the valve seat and/or disc material),and stiction change. These issues can increase production costs, cause premature wear of valve and equipment components, process upsets, and more.

• Identify configuration issues and other key performance indicators (KPIs), including total valve travel, number of direction changes, operating hours, change of end positions, stiction, control deviation, and electronics temperature.

• Diagnose problems and trigger corrective actions.

• Recommend maintenance dates and generate optimized control valve maintenance plans in a scheduler function that factors in plant outage dates.

Alarm management and process event analytics. Alarm systems play a critical role in alerting plant operators of abnormalities and helping them resolve issues before activation of other protection systems. The effectiveness of alarms depends on the quality of the alarm system configuration. Poorly configured alarm systems overload the operator with information, preventing timely de-escalation and increasing the risk of inefficient production, low-quality products, and unexpected shutdowns. These risks are exacerbated by increasing process complexity and budget cuts.

To enable efficient alarm optimization, analysis techniques should be implemented that break down the overall improvement process into focused steps. Cloud-based applications are available to analyze alarm and other event data such as operator adjustments, providing an interactive method to monitor and assess distributed control system (DCS) alarm systems without special training. Tools are available that:

• Calculate process alert and event characteristics based on international norms and standards, including ISA 18.2, IEC 62682, and EEMUA 191.

• Detect chains and sequences of process alarms and events, as well as recommend optimization.

• Provide transparency of alarm system performance to reduce workloads and production risks, as well as improve performance.

• Provide an overall performance matrix.

• Produce a watchlist of up to ten specific events (e.g., a high- or low-level alarm on a tank) at the plant level that should be monitored.

Before looking at any specific project or technology, gain a basic understanding of where your company is when it comes to digitalization and what you want to achieve.

Artificial intelligence-based predictive maintenance. Key drivers of implementing predictive maintenance are maximizing uptime, operational efficiency, and decision accuracy. To effectively address these drivers, AI and machine learning can be combined with human experience to holistically analyze equipment, process areas, and/or entire plants. This provides an intuitive picture of the equipment, process, and plant health; enables remote monitoring; identifies correlations and anomalies; and predicts failures.

AI-based tools are available for the CPI and are becoming more popular. While AI isn't new, these tools are gaining traction because the necessary data, communication networks, data integration capabilities, and computing power are all more widely available than ever before.

• ***Data.*** AI requires large amounts of data from a variety of sources, and the industry has reached a point where enough sensors have been deployed to provide this quantity of data.

• ***Communication networks.*** It is critical to have communication networks to move data. A combination of wired networks and the ongoing evolution of wireless technologies, such as industrial wireless internet and 5G, are facilitating data movement.

• ***Data integration.*** Once data has been moved from the sensors on the plant floor to the data analytics engine on a computer or on the cloud, it must be seamlessly integrated, and industry standards are making this easier than ever.

• ***Computing power.*** Processing the large amounts of data needed by AI requires powerful computers that are now common.

AI tools offer the ability to build asset models, train the models based on machine learning and domain experience, and use them to generate maintenance and inspection requests. They can also predict and alert of equipment condition-related deviations, as well as consolidate expert knowledge to reduce the workload of over-extended experienced engineers.

Connected workers. Employees can be equipped with mobile platforms to:

• install and commission equipment and instrumentation

• complete recurring maintenance tasks

• digitalize forms, work orders, and checklists

• employ radio-frequency identification (RFID)

• leverage augmented reality and other new technologies

• expand control room capabilities into the field

• increase the productivity of remote support and services

• manage fleets of field devices.

The robust, powerful, and versatile industrial tablets of today are valuable tools that are ready to meet the most demanding automation requirements. These tablets include a vast array of capabilities, including:

• the necessary operating system to accommodate relevant software tools

• Class I Div. 1 and 2 certification for operation in hazardous environments

• multitouch displays (i.e., displays that recognize more than one point of contact) to facilitate operator and technician interaction in the field

• front and rear cameras to enable communication with remote support resources

• built-in RFID scanners to enable access to specific areas for certain personnel

• wireless communication options, providing connectivity to the plant network from almost anywhere on the plant floor

• hot swappable batteries for use during extended periods of time between charges

• IP65-certified design to prevent dust and water ingress

• rugged according to MIL-STD 810G testing.

Production Scheduling	Warehouse	Quality	Manufacturing	Shipping	Maintenance
• Scheduling is done in excel sheet • Manual entry of inventory, stock, etc. • Remote access to multiple plants not working well • Little visibility into customer inventory, orders, status, etc. • Not getting order data from customers • Plant resources and processes are not integrated and are siloed	• Lack of real-time inventory • Shipment notices are not uniform	• Quality database is standalone • Unplanned power outages • No tracking and tracing of historical data • Spot checks only of incoming raw material	• Data available in multiple silos but difficult to use • Temperature values not transfered to DCS • No overall visibility into process status • Continued support of process historian • No advance process control loops • Various types of equipment installed at plant	• Manual printing of labels • Cannot create transfer orders • Different transfer types are recorded numerous times • Issues with locating items ready to be shipped • Packages will get same labels; not in sequence	• Little visibility into what is causing unplanned downtimes • Lack of transparency of plant-wide instrumentation • No automatic work order created based on unplanned downtime • Lack of bandwidth to support upgrade issues • Difficult to schedule preventative maintenance • No configuration control • Vibration readings from motors are stored in Excel file

Figure 2: Challenges should be divided into departments or cross-functional columns if more than one department is experiencing the challenge.

How do you begin a digital transformation effort?

Get started with DT by defining the business drivers, assessing the current level of digital maturity, choosing initial projects, assembling a cost estimate, and developing an implementation plan.

Step 1. Define the relevant business drivers. First, determine why you are pursuing DT, which will involve identifying the scope of the effort. Before looking at any specific project or technology, gain a basic understanding of where your company is when it comes to digitalization and what you want to achieve. For example, does your company want to increase throughput by a certain percentage or respond to customers' increasing demand for customized solutions? To identify the drivers, answer:

• Why are we pursuing digitalization?

• What are our digitalization goals and how do we intend to get there?

The goal of Step 1 is to obtain an in-depth understanding of why digitalization is being considered across the business. Ensure all relevant stakeholders are involved in this discussion. The drivers identified will be used in later steps.

Step 2. Assess the digital maturity of your organization, manufacturing facilities, and equipment. While touched on in Step 1, Step 2 focuses on assessing the digitalization readiness of the company. Determine what digitalization and automation has already been done, and identify the data being captured and used to create insights.

The simple maturity assessment introduced earlier in this article is a useful tool in Step 2, but other, more elaborate assessments are available, such as the Smart Industry Readiness Index (SIRI) (2). Regardless of the assessment tool used, key questions to ask include:

• What equipment do we have available to transmit data to the cloud?

• How automated are our plants and processes?

• How well integrated are our information and operational technologies, and how does information flow across these systems?

• What networks and connectivity options are available to share insights based on the data?

For companies with multiple facilities, either assess all of them or choose three to four that represent the overall business.

Step. 3. Choose initial projects. Identify equipment that is already digitalization-ready to choose projects that could be completed with little effort. These projects typically fall within information technology (IT) and operational technology (OT) systems, plant processes, and network and connectivity. Deploy these projects at smaller scales first to verify the outcomes. The preferred location for such a pilot would be a plant or facility that is somewhat digitally mature, i.e., a strong data network is in place to transfer data to the cloud.

Somewhere between three and five projects is suitable for most companies, regardless of size. It is important to have enough resources to manage the projects while continuing to take care of day-to-day business. The process to identify these projects involves five stages:

1. Assemble key stakeholders from all impacted departments to identify the challenges that they experience in their daily operations.

2. List these challenges by department, indicating if they are shared by two or more departments. Do not be limited at this stage — 40 to 60 challenges may be appropriate (Figure 2).

3. Identify process improvement projects that will address the challenges. In some cases, one project can address several challenges. This will create a list of 12 to 15 projects to prioritize.

4. Determine the priority of these projects based on the business drivers identified in Step 1. Develop a plot of these projects with implementation effort on one axis and business impact on the other as a helpful visualization (Figure 3).

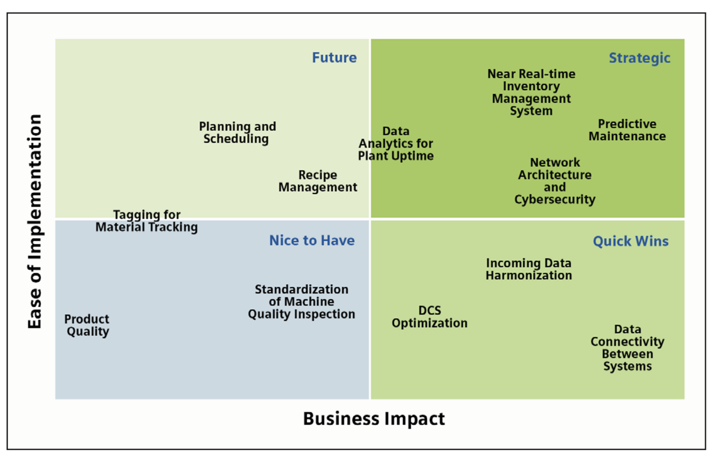

Figure 3: A matrix with ease of implementation on one axis and business impact on the other helps identify projects that deliver quick wins.

5. Pick three to four projects that have a high business impact and low implementation effort as your first projects.

Step 4. Estimate the cost of the chosen projects. The goal here is to conduct technical and financial feasibility studies of the quick-win projects. During this step, evaluate which technologies could be employed to implement these projects, what skills are needed to roll them out efficiently, and the required investment for each project.

After determining the necessary technologies for the specific projects, gather financial data to assess whether they are worth implementing. Estimate the total project cost, the expected investment payback period, the internal rate of return (correlation between the money spent and money saved), and the net present value (relation between cash flow in and cash flow out during the review period) (Figure 4).

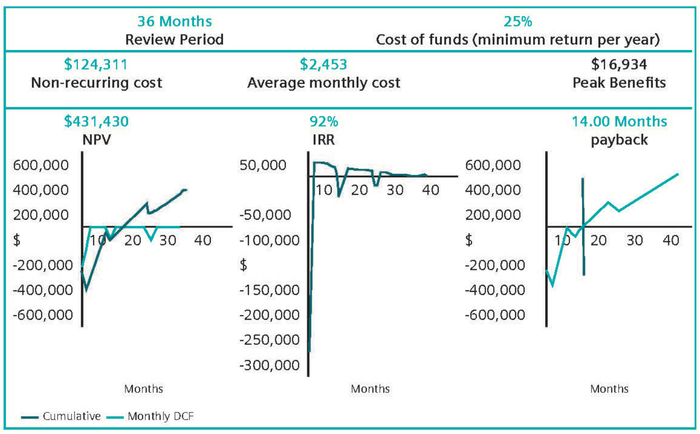

Figure 4: Financial metrics such as return on investment, internal rate of return, and payback period will help evaluate the feasibility of a specific project.

With this information in hand, you now know which projects will provide the strongest return on investment.

Step 5. Create an implementation plan. This step is similar to any other strategy implementation in that it will require program management resources, creation of a clear timeline, KPIs to track progress, etc. A few key elements, however, are particularly important to consider:

• ***Executive sponsorship is key.*** While the goal of DT is to not simply replace existing assets, investments are still required, so executives need to be engaged from day one.

• ***Get everyone involved.*** Do not let the C-suite be the sole drivers of DT. In our experience, a combination of a top-down and bottom-up approach works best. From the top, the C-suite can create a vision and look at the bigger picture. From the bottom, personnel can focus on daily technical challenges on the plant floor, as well as manage perspectives and priorities of various departments.

• ***It's not all about technology.*** New technologies affect why and how people do their jobs, so it is critical to establish a change management plan. Affected staff need to be involved in each step and feel their inputs are valued.

Looking forward

The DT of the process industries cannot be ignored. Frameworks and methodologies are available to get started, and numerous companies have been supporting customers in their DT for the last several years. Collaborating with trusted partners can help to speed DT efforts, and plenty of case studies show the dramatic results that can be achieved (3–5). Your company's competitors aren't likely to be resting on their laurels, so get out there and look for ways to start your DT journey.

Literature Cited

1. "Competitive Thanks to the Digital Transformation," Siemens, https://new.siemens.com/global/en/company/topic-areas/ digital-enterprise/process-industry/digitalization-consulting.html (accessed Oct. 21, 2021).

2. "The Smart Industry Readiness Index," Singapore Economic Development Board, www.siri.gov.sg (accessed Oct. 21, 2021).

3. "Well Advised in the Digital Production and Analysis," Chem- Con, www.chemcon.com/en/about-chemcon/news-events/newsdetails/ well-advised-in-the-digital-production-and-analysis (Mar. 2018).

4. "Refinery Improves Efficiency Using Smart Data," Siemens, https://new.siemens.com/global/en/company/stories/ industry/refinery-improves-efficiency-using-smart-data.html (accessed Oct. 26, 2021).

5. "Unlocking the Potential of Paint Production," Siemens, https://youtu.be/z7tCDc8JcFY (May 7, 2018).

JONAS NORINDER *is a digital transformation consultant at Siemens, where he identifies and promotes process optimization opportunities that help companies become more efficient, reliable, and agile using technology, data, analytics tools, and services. Since joining Siemens in 2006, he has held several roles within business development and sales, marketing, and communications. Norinder has presented on digital transformation topics at several industry conferences, including those held by AIChE. He has a Master's degree from the Univ. of Business in Aarhus, Denmark.*

DON MACK *is a chemical industry manager and automation alliance manager at Siemens. His focus is finding process automation and digitalization solutions for customers, as well as providing technical education and support to the company's plant and corporate personnel. During his more than 30 years with Siemens, he has held roles in pre-sales technical support, marketing, sales, and business development. Mack regularly presents at industry and web conferences. He graduated with a BS in electrical engineering from the Univ. of Pittsburgh.*

Legal Manufacturer
Siemens Industry, Inc.
100 Technology Drive
Alpharetta, GA 30005
United States of America
Telephone: +1 (800) 365-8766

Subject to change without prior notice
All rights reserved
© 2023 Siemens Industry, Inc.