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How Process Manufacturing CIOs Can Start Smart Manufacturing Initiatives

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Initiatives: Manufacturing IT Optimization and Modernization

To counter economic pressure and supply chain challenges, smart manufacturing aims for high quality, efficiency, safety, carbon neutrality and waste reduction. Process manufacturing CIOs should analyze three smart initiatives and develop a plan based on their company's IT maturity level.

Overview

Key Findings

- The smart manufacturing initiatives in the process manufacturing industry are advanced factory operations, supply chain (SC) alignment and engineering technology (ET) involvement.

- The maturity level of factory operations will be increased step by step, including paperless factory operations, standardization of work processes and IT/operational technology (OT), and autonomous production activities through AI/Internet of Things (IoT).

- The key capabilities for process manufacturers include not only quality, cost and delivery (QCD), and regulatory compliance, but also traceability information such as CO_2 emissions and ethical sourcing in the factory and supply chain.

Recommendations

CIOs responsible for IT optimization and modernization in process manufacturing should:

- Identify the smart manufacturing initiatives that are best suited for the company by discussing them with the leaders of the supply chain and product/process development.

- Develop a roadmap of use cases and underlying technical capabilities for gradual evolution by evaluating the current digital maturity levels of the manufacturing, supply chain, product/process and environmental, health and safety (EHS) departments.

Introduction

Process industries comprise specialty chemicals such as plastics and polymers that are produced in an order-based model, commodities such as refineries in a continuous-flow model, and food and beverage in a batch-based model. Production models and business trends may differ by product characteristics. Common initiatives in the process manufacturing industry aim to secure stakeholders' health and safety and improve the efficiency of plants, plant workers and equipment.

Smart manufacturing in process manufacturing increasingly leverages the principles of Industrie 4.0, such as reference architectures, standards and implementation guidelines, while embracing sustainability. It is the foundation for operational excellence — the most important objective of digital investments over the past two years. Operational excellence initiatives will have a broad impact across a number of vertical industry sectors that utilize chemicals and other processed materials, including information, electronics, displays, battery materials and apparel (see 2023 CIO and Technology Executive Survey: A Process Manufacturing Perspective).

Smart manufacturing is a concept that integrates technologies, data, processes and human interactions to transform and improve production's response to changing conditions in and across factory networks and value chains.

In other words, smart manufacturing is not just about upgrading factory operations. It should realize business outcomes such as revenue growth and cost reduction. So, the smart manufacturing initiatives in the process manufacturing industry are advanced factory operations, supply chain alignment and engineering technology involvement (see Figure 1).

Three Smart Manufacturing Initiatives in the Process Manufacturing Industry
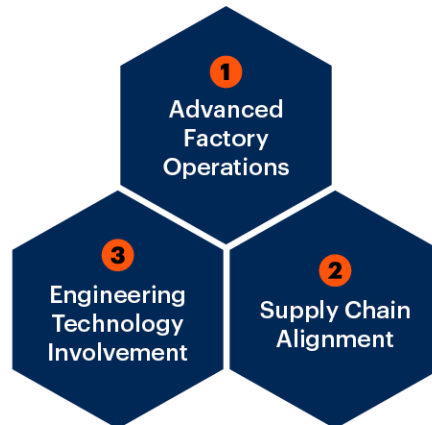
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Analysis

Identify Smart Manufacturing Initiatives

In process manufacturing, smart manufacturing is not simply an initiative to upgrade factory operations with emerging technologies. It will play a leading role in the pursuit of operational excellence, carbon neutrality, plastic neutrality and sustainability.

For example, Scope 3 reductions in the Greenhouse Gas (GHG) Protocol are critical in order to achieve net-zero GHG emissions. [1] Material and energy flows must be optimized not only in factories, but throughout the supply chain and asset life cycle. To achieve operational excellence, it is important to set business goals such as ROI, return on assets (ROA) and earnings before interest, taxes, depreciation and amortization (EBITDA), and create a more comprehensive blueprint that resonates with employees and external stakeholders.

In the real world, efforts are underway across the enterprise to optimize various supply chain and engineering technologies. First, CIOs driving smart manufacturing should understand what is being done in each of these initiatives. Then, they should discuss the business outcomes and sustainability objectives with the leaders of each initiative in the supply chain and product/process development divisions. The result will reaffirm the importance of aligning data and processes to identify and prioritize the smart manufacturing initiatives that are best suited for your company.

CIOs should consider three representative smart manufacturing initiatives in process manufacturing industries:

Advanced Factory Operations

Advanced factory operations aim to address the shortage of highly skilled workers, aging facilities and restructuring of the factory network. The maturity level will be improved step by step, including visualization of plant operations, standardization of work processes and IT/OT, and autonomous production activities using AI/Industrial Internet of Things (IIoT).

CIOs in the process manufacturing industry should consider advanced factory initiatives, which include:

- Secure connectivity among production assets leveraging one or multiple IoT platform tiers to aggregate, contextualize and visualize data from a variety of different IT, OT and ET data endpoints

- Paperless and standardized factory operations with a strong data backbone such as bills of materials (BOMs)

- Modernization of core applications such as manufacturing execution systems (MES)/manufacturing operations management (MOM), laboratory information management system (LIMS) or EHS

- Simplification of production planning operations based on vertical and horizontal integration

- Predictive maintenance with cloud-based equipment information by suppliers

- Automatic optimization through real-time production optimizers

- Real-time positioning systems for personnel and vehicles

- Safe equipment maintenance operations through augmented reality (AR)/virtual reality (VR)

- Autonomous vehicles for efficient site mobility

- Autonomous plant operation considering quality, yield, energy savings and sudden disturbances

- Smart grid management of energy, utilities and waste

- Robust safety and security in process facilities

- Hyperautomation to reduce night and weekend work for field workers (low-risk plants only)

Supply Chain Alignment

In the process manufacturing industry, plant availability directly contributes to sales. Achieving sales and operation planning (S&OP) excellence leads to more accurate plant production planning, so the sales department must deliver an accurate sales forecast. On the other hand, visualization of production plans, actual results and inventory will help the sales department improve its order-taking rate. In addition, sharing such information with specialty chemicals enterprises, who have large customers in the information, electronics, display, battery materials or apparel industries, will give them a significant advantage.

Traditional differentiators for process manufacturers are product specifications, price and short-lead times. In recent years, sustainable sourcing has become more important to customers in the process manufacturing industry. Therefore, it is beneficial for sales and marketing to disclose not only product QCD information, but also traceability, including CO_2 emissions and ethical sourcing.

Real-time procurement of raw materials is also important, and for specialty chemicals and refineries, for which just-in-time (JIT) inventory is difficult to apply, it is possible to optimize raw material procurement by sharing production plans with upstream factories. Since this involves a contractual obligation to deliver to the supplier, you should carefully consider whether this use case applies to your company.

CIOs in the process manufacturing industry should consider supply chain alignment initiatives including:

- Connecting upstream plants (large suppliers only)

- Efficient and effective S&OP operations

- Connecting downstream factories with customers (large customers only)

- Visualization of production planning and performance, inventory and third-party logistics

- Scope 3 visibility and reduction of GHG protocols

- Enhanced physical/cybersecurity throughout the supply chain

Engineering Technology Involvement

Optimizing the engineering chain in process manufacturing leads to shorter lead times and improved product quality through automatic recommended configuration of manufacturing conditions. Formula/recipe development, molecular chemistry, quality function deployment (QFD), manufacturing process design and factory design in a digital thread improve the efficiency of the entire value chain. In addition, sharing experimental data during product development and process development, as an engineering data lake to the factory, is beneficial in identifying the parameter ranges needed for instrument calibration. Similarly, it will help identify the parameter ranges for monitoring product quality and safety.

However, the ET portfolio is one of the oldest legacy technologies in process manufacturing. Investment in the latest ET is growing and becoming a larger part of the technology portfolio, but few CIOs are involved in their selection and support. Therefore, they should work with subject matter experts (SMEs) and become educated on ET. As a result, they will understand the ET portfolio and how these technologies are used and supported. They should then work with product/process development departments and external partners to create a coordinated IT/OT/ET roadmap. This will improve the resiliency of IT, OT and ET facing the rapidly growing IoT deployments.

CIO in the process manufacturing industry should consider ET involvement initiatives including:

- Digital threads with formula/recipe, molecular chemistry and QFD

- Automatic recommended configuration of manufacturing conditions

- Predictive quality control with an engineering data lake

- Digital feedback of voice of the customer (VoC) to product development

- ET/OT/IT interconnection

Develop a Roadmap for Gradual Evolution

At first, the business outcomes from the smart manufacturing initiative will depend on the digital maturity level (for example, skills, organizations, processes, IT/OT/ET landscapes) , contribution of use cases to business outcomes, and underlying technologies and their logical interdependence. IT organizations, at the most rudimentary maturity level, cannot go beyond addressing basic technical requirements or embark on advanced initiatives. Therefore, develop a plan to evolve IT maturity in stages, aligning capabilities with the business goals that you want to achieve with your smart manufacturing initiatives.

Specifically, this means considering and evaluating high-impact options with respect to expected business outcomes. Each company has a different IT maturity level and business environment, so the level of visibility, standardization, autonomy and sophistication to aim for will vary. Project leaders need to share their experiences directly with peers and stakeholders to generate demand for successful initiatives (see Roadmap to Assess and Advance IT Maturity in Manufacturing).

Table 1 illustrates a method to align on expected outcomes from smart manufacturing initiatives. Advanced factory operations initiatives contribute to cost reduction, sustainability or efficiency in factories, workers and equipment. Initiatives in supply chain or engineering technology Involvement enhance customer experience and responsiveness to market, which will be the fundamental to revenue growth.

Of course, the results can vary by company or product. However, to extend your stakeholders internally or externally in smart manufacturing initiatives will lead to more business outcomes.

Table 1: Sample of Business Outcomes From Smart Manufacturing Initiatives

(Enlarged table in Appendix)

		Advanced Factory Operations				
		Visualization	Standardization	Autonomous	SC Alignment	ET Involvement
Revenue /Customer Experience	▪ Revenue ▪ Quality assurance ▪ Net Promoter Score	◔	◔	◔	●	●
Responsiveness	▪ Lead time ▪ Demand accuracy ▪ Speed to market ▪ Design time ▪ Lot size	◔	◔	●	●	●
Efficiency	▪ Factory ▪ Worker ▪ Equipment	⬤	⬤	⬤	◔	◔
Cost	▪ Operating cost ▪ Product cost ▪ Energy cost ▪ Inventory	●	●	⬤	●	●
Environment	▪ Environmental impact ▪ Employee engagement	●	◔	◔	●	●

Key:
● Extremely Relevant
● Highly Relevant
◔ Relevant

Source: Gartner (May 2023)

Evidence

[1] Greenhouse Gas Protocol, World Resources Institute and WBCSD.

Recommended by the Author

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2023 CIO and Technology Executive Survey: A Process Manufacturing Perspective

Roadmap to Assess and Advance IT Maturity in Manufacturing

Scale Smart Manufacturing With a Clear Innovation Strategy

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Innovation Insight: Why Engineering Technology, IT and OT Are More Than the Sum of Their Parts

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