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Digital technologies

To shape the future of manufacturing - B

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Global chemical enterprises face complex challenges on many fronts: manufacturing and research and development (R&D), supply chain management, industry consolidation and more importantly ever increasing customer, regulatory and sustainability pressures. Across the chemical value chain these trends are pushing for newer operating and revenue models to be able to manage the risks emanating from supply chains, markets and customer demands. In its quest for operational excellence the chemical industry has invested in a host of systems and tools to rationalise cost structures.

In the last ten years there has been a steady shift within the industry to move from a linear to closed model; a hardware driven chemical platform to a digitized chemical platform. A host of new generation technologies are poised to sweep the chemical landscape in the next decade and driving these shifts will be the e-digital technologies which have now brought major changes in business functions across the company and within the industry.

The burst of data and new computing capabilities complemented by advances in automation-robotics, artificial intelligence, additive technology, and human-machine interaction are now poised to usher in a new era of manufacturing spurred by digital technology platforms. Cloud computing–based tools allow suppliers to collaborate faster and more efficiently.

At present the steady absorption of digital-manufacturing technologies aided by digital connectivity has already begun to change the value chain, from research and development, supply chain, to customer services. This is expected to open up new value and in the process change the basic fundamentals of manufacturing.

Historically this industry has lagged behind in leveraging the extensive big data it generates. Today the new age digital companies are creating value just by providing the desired connectivity using Internet of Things (IOT) tools Globally new manufacturing initiatives have taken off in light of the new digital technologies and their impending dominance - National Network for Manufacturing Innovation, US; Germany’s Industry 4.0 effort; China’s Made in China 2025 and Industrial Internet Consortium are some of the leading ones.

Today the chemical industry uses resources and people in dramatically newer ways; data storage are becoming inexpensive and flexible; new range of analytics are enabling companies to draw far reaching insights into their operations. Robotics backed by advanced automation and additive manufacturing are now poised to bring in a new era of chemical manufacturing technologies supported on digital platforms which will allow chemical firms find new pathways to digitally connect all aspects of organizational functions from concept, design, sourcing, R&D, instrumentation, pilot plants, production to distribution and final customer.

The implications of digital intrusion into chemical landscape will have far reaching implications for the fine and speciality chemical players who seek to create sustainable value through improved operational effectiveness, product innovation and new customer delivery models.

Chemical companies have been sourcing data analytics capabilities to rationalize plant operations, facility management, site security systems, enhance utility management while also optimizing energy usage. Integrated supplier and customer network tools aided by digital systems have helped chemical firms gain newer perceptions on productivity and quality management processes. IOT tools are connecting products to customer and quality managers and in the process closing the loop.

Chemical engineers are investing as much time in data mining and analytics as they do in process design and engineering and gaining fresh knowledge on predictive maintenance, material tracking and safety controls. It is in the pharmaceutical industry (where there is a high emphasis on intensified process and continuous manufacturing models for API manufacture) where cloud computing will find a major role.. Integration of digital threads into process intensification will allow for continuous monitoring of the processes and led to precision manufacturing with high levels of quality and safety controls

Many speciality chemical players are focusing on enhancing their customer delivery systems and supply chain costs by tagging radio frequency identification (RFID) tags to containers of high performance products.

The Internet of Things (IoT) to reshape chemical business

IOT has unleashed major disruptive changes within the chemical industry from the way sourcing, manufacturing, logistics and customer services are

being managed. They play a very interactive role in deciding how the future of this industry will be shaped using digital devices backed by sensors and actuators which monitor, track and analyse data on a real time basis and in the process enabling the new shifts in assets management, maintenance systems, and supply chains.

A wide array of new technologies driven by augmented realities are now connecting assets, people, products, and services by streamlining information flow and enables real-time decisions. Major chemical players with major challenges in asset optimisation, supply chain risks, product quality and delivery integrity are slowly realising the immense potential in IOT and its crucial role in meeting the challenges posed by global mega trends. Some of the major domains within the chemical and related value chain are indicated below.

IOT in chemical industry

Asset Maintenance: Location intelligence; Pipeline and equipment monitoring; Predictive maintenance; Energy and emissions monitoring and control; release management

Responsive Manufacturing: Cross-plant analytics; Process optimization; Production monitoring; Predictive quality; Short interval control, Real-time costing, Sensor-driven dynamic replenishment and Automated 3D printers

Supply Chain Management; Logistics and quality monitoring; Counterfeit detection and control; Container management tracking; Container security; Loss prevention; Precision farming; Chemical Factory Anti-Terrorism Standards (CFATS)

(Source: www.sap.com)

According to the consulting firm The Gartner *(www.gartner.com)* IOTs made up of sensors linking physical objects together using internet technology will usher in radically newer business models within the chemical industry (1). Some of the major impacts are discussed below.

Equipment monitoring and predictive analytics: in an industry such as chemicals unplanned breakdowns and volatile operating and maintenance cost are often the norm. These will be resolved to a great extent through sensor and in-memory analytics mounted equipment and utilities to track

processes and throughputs on a real time basis, to enable predictive capabilities about possible failure of systems**.**

Predictive ability to detect deviations in batch production*:* Typically a batch driven manufacturing model is adopted by the chemical industry and more often this leads to limited insights into operating conditions for a larger set of batches. IOT enables leveraging the power of data and predictive analytics for a large number of batches to pin point the right conditions by improved balance of variables and lead to better product quality and lower the costs of quality improvement.

Energy efficiency systems*:* Being a highly energy intensive industry developing improved energy efficiency models is critical for the chemical industry faced with ever increasing compliance and regulatory pressures. Connected sensors, which continuously track energy usage and allow better energy cost management holds immense promise to make chemical manufacturing energy efficient and sustainable.

Cybersecurity: securing chemical process plant from diverse threats is a primary concern for governments and companies. It is now a key strategic security issue. The complexity of threats faced by the society has led to far reaching shifts in the way chemical companies assess security concerns. With increasing volumes of diverse chemicals and large amount of data generated it is an imperative that securing facilities and lives are driven by Cloud based systems using in-memory computing and big data analytics.

Shifts in chemical business models

In the next five years chemical industry will continue to invest in machines, tools, and parts that are equipped with digital technology: autonomous vehicles to improve mobility of internal processes and digitally connect global manufacturing locations on a real time basis.

The promise of using 3D printing to synthesize large number of molecules holds a distant promise but in plant operations does give options to develop custom parts of laboratory equipment for chemical synthesis efficiently. According to a 2015 report from the American Chemistry Council (*www.americanchemistry.com*) it is likely that real time data analytics will find increasing use to spot safety, risk and quality issues and help minimise losses. It reports that KPI dashboards on mobile devices will provide real-time data.

Accenture forecasts that chemical companies' investments in digital technologies will rise in the next three years, with cloud computing and big data analytics leading the game. In the future sensor-driven technology and intelligent devices/machine will enhance communications between a company's assets, products and systems in ways never thought of before. Turning into a digital enterprise might be a big challenge for the chemical firms but the long term positives in terms of higher levels of efficiency, safety and cost rationalisation outweigh these concerns.

Perhaps the fastest pay back on digital platform investments might come from utility and resource rationalisation, productivity optimisation, new product design and development and improved customer management. Cybersecurity and the protection of intellectual property have always been major concerns for world governments and the industry. Data management and security, new regulations on cyberspace will pose fresh challenges which will need to be resolved.

The new digital revolution will throw up new challenges testing the capabilities of the chemical industry and it will have to be ready with the right questions; what level of disruption of the business can happen; will it create sustainable value for the business; what level of investments and in what platform they will have to made: does the industry have the right human skill sets to manage both digital and traditional manufacturing technologies

Cloud computing has the potential to impact the chemical industry in multiple ways states an Accenture report (2). These relate to

- Real time remote, predictive and mobile asset monitoring and maintenance;
- Integrating, sharing and analysis of Big Data along the value chain to transform visibility, speed and agility (*Microsoft launched chemicals industry reference architecture*)
- Enhanced employee health and safety and remote medical monitoring and assistance (*The Italy-based Gruppo Mossi & Ghisolfi (M&G) is in cloud based software provision services*)
- Efficient, platforms and utilities based on "community clouds"
- knowledge sharing and R&D powered by cloud computing and mobile solutions (*Clariant's payment solutions using Ariba cloud solutions*)

- Empowering new design engineers (*Air Products starts an initiative in cloud for accessing scalable computing power to improve process design*)

With rising emphasis on cloud computing, chemical firms have also realized that value creation can happen only when cloud computing systems find convergence with mobile, analytics, remote online sensors, biometrics and unmanned drones—to name a few. It is very important for chemical companies to adopt a coordinated and integrated model while moving towards cloud computing systems to enhance their ability to tap new business opportunities, optimize customer engagement models and enable differentiated delivery.

Today chemicals companies that were the first to adopt cloud computing have overcome their early stage concerns about the reliability and integrity of such systems which deal with very sensitive data and IP. Some of the other concerns for the industry had to do with the management control of their technology ecosystem to specific cloud vendors and the possibility where their technology changes will be based on the vendor's technology status. Perhaps the biggest worry would be that of losing the niche differentiation as the cloud computing system is typically *one to many* system.

The chemical industry will find it more challenging to shift totally to digital platforms and it is more likely that they will adopt hybrid models which will enable them to balance the advantages of existing systems with that of digital systems. Many of the present concerns are being addressed through all the four forms of cloud computing systems: Platform as a service (PaaS):platform level; Software as a service (SaaS):application level; Infrastructure as a service (IaaS); infrastructure level and Computing based Solution (BPaaS): business process level.

References

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