How digital transformation is reformulating the chemicals industry

The convergence of rapid technological advancement and economic change is creating challenges—and opportunities
In today’s digital economy, you either disrupt—or you get disrupted.

As one of the largest and most diverse business sectors in the world, the chemicals industry is a strategic supplier to virtually all segments of the economy. However, the majority of companies specialize in a select few product lines, making the chemicals industry an especially competitive, operationally unique and environmentally challenging field.

To be a disruptor in the chemicals industry, organizations must act now to prepare for a very different tomorrow based on some pervasive global trends, as below:

- Rapid technological change is enabling companies to produce to need, creating greater price volatility for incremental supply.
- Global base chemical capacity continues to increase while demand growth versus gross domestic product (GDP) is forecasted to decelerate, which is fundamentally altering traditional business economics.¹
- Value chains are fragmenting as technology disintermediates traditional supply chain networks.
- Mergers and acquisitions (M&A) are favored over capacity growth: in 2016 alone, there were 16 M&A transactions valued over USD1 billion, the highest level in the last six years.²
- Businesses are creating competitive advantages from sustainability as part of their overall strategy.

“In the new world, it is not the big fish that eats the small fish, it’s the fast fish that eats the slow fish.”

— Klaus Schwab, executive chairman of the World Economic Forum

¹ Global base chemical capacity continues to increase while demand growth versus gross domestic product (GDP) is forecasted to decelerate, which is fundamentally altering traditional business economics.
² Mergers and acquisitions (M&A) are favored over capacity growth: in 2016 alone, there were 16 M&A transactions valued over USD1 billion, the highest level in the last six years.
These trends are forcing chemical companies to re-examine core business capabilities and invest in the development and scaling of new digitally-enabled business models.

To accelerate clients’ digital transformation journey, IBM drives major technical innovations by taking an industry-focused approach to research and development (R&D). We also help clients to use digital transformation as a catalyst for revamping core business capabilities within their organization.

Digital transformation is necessary to adopt technological innovations that address industry imperatives

Business leaders in the chemicals industry face a stark choice: either digitally transform your business, or watch as it decomposes around you.

Relentless technological innovation and convergence are impacting industries across multiple fronts. For years now, global CEOs have recognized that technology, more than any other single force, is affecting their organizations.¹

<table>
<thead>
<tr>
<th>Segment</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Commodity chemicals</td>
<td>Organic and inorganic chemicals, plastic resins, and dyes and pigments, such as ethylene, polypropylene, LLDPE and HDPE. Primary uses include feedstocks, intermediaries into products, such as plastics, shampoos and fibers. Commodity chemicals account for approximately 50 percent of the industry’s output.</td>
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<tr>
<td>Pharmaceuticals</td>
<td>Diagnostics, prescription drugs, vaccines, vitamins and over-the-counter drugs for human and veterinary applications. This subsector also includes biotechnology products. Strategic investment in companies, facilities, and research and development is especially important for this subsector.</td>
</tr>
<tr>
<td>Specialty chemicals</td>
<td>Complex designer chemicals that are used to make glues, dyes, adhesives, sealants, water treatment chemicals, plastic additives, catalysts and coatings. These chemicals are performance-oriented and typically include customer and technical servicing as an aspect of their sales. Specialty chemicals account for approximately 35 percent of the industry’s output.</td>
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<tr>
<td>Agro chemicals</td>
<td>These play a crucial role in the farm economy and food processing sector. Thanks to modern agriculture, farmers have doubled the production of world food supplies since 1960, tripled the output of foods like cooking oils and meats, and increased per capita food supplies in the developing world by 25 percent.</td>
</tr>
<tr>
<td>Consumer products</td>
<td>Soaps, detergents, cleaners, toiletries and cosmetics. While consumer products are an established segment of the industry, technological innovation and product development are important due to short product lifecycles.²</td>
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Table 1: Getting to know the chemicals industry
Whether producing highly specialized products or distributing commodity products in bulk, organizations are under increasing pressure to adopt new technologies that can generate greater value. These include research and development, integrated operations, sales and marketing and end-to-end supply optimization. The same industry imperatives are prevalent across the chemicals industry, as follows:

- **Drive enterprise productivity, cost reduction and operational excellence** by establishing an efficient, variable cost structure and operational agility to quickly sense and respond to the market.
- **Improve core competency and enhance the customer and employee experience** by driving topline growth with differentiated high-value offerings, the timely introduction of innovative specialty chemicals and new customer engagement models.
- **Maximize asset utilization and optimize supply chain** by fostering a resilient and faster supply chain to proactively address changes in the market dynamics.
- **Accelerate product innovation and application** by leveraging customer insight and product knowledge as well as research to enhance product portfolio and offerings.

**Data is ubiquitous, yet insight is elusive**

Nearly every business, regardless of industry, is pursuing a strategy to become digital. Companies of all sizes are adopting analytics, mobile and social technologies with the objective of capturing the economic value of the world’s newest natural resource: data.

Fortunately, the chemicals industry is well ahead of most industries in terms of digitization and data-generating capabilities. The proliferation of connected devices and related Internet of Things (IoT) technologies are already driving significant disruption by connecting related industries.

For example, the quickly developing agriculture IoT helps ensure accurate and timely communication of real-time weather forecast data related to dynamic agricultural processes like planting, harvesting and chemical applications.

The challenge arising from this rapid increase in IoT devices is the sheer volume of data being created, making it more difficult and time-consuming to spot patterns. And because sensor data is structured, the tremendous value of unstructured data from free-format text on lab notes, professional papers, video and social media goes untapped.

But there is a solution: cognitive systems.

New classes of cognitive systems that understand, reason and learn, in combination with intelligent automation and blockchain networks work to transform operations, compliance, security and engagement across every industry. Cognitive systems help to deliver individualized and secure client experiences.

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**20%**

*Compound annual growth rate of IoT sensor unit volume between 2016 and 2022*

*Reduction in maintenance costs by using cognitive analytics to mitigate emergency work orders*

*Improvement in mean time between failures for IoT-enabled equipment*
IBM® Watson™ is IBM’s enterprise-grade augmented intelligence. With Watson ingesting IoT data streams, opportunities and hypotheses can be developed quickly for improving outcomes at every state of the product lifecycle—from designing, building and operating to sales and marketing.

Watson—with its own set of APIs and Bluemix cloud solutions—is part of the IBM platform-as-a-service (PaaS) portfolio, which now includes more than 50 services.

**Cognitive is key to unleashing the value of data**

By enabling cognitive technologies through Watson APIs and software-as-a-service (SaaS) solutions, businesses are already achieving impressive outcomes, from improving customer engagement to driving profitability and growth.

**Sales and marketing**

**Understanding the chemical business-to-business-to-consumer (B2B2C) sales chain using social analytics**

Scientists at The Dow Chemical Company are listening to more than 22,000 social media conversations to quickly identify new solutions that use the company’s advanced polymers and bring them to market faster. With analytics from IBM, these engineers can anticipate consumer demand for new products. These insights are enabling them to improve everything from running shoes to seals for car windows.

“In our research, IBM came across as a major player in nearly every aspect of the IoT market with clear leadership for its IoT platform, software and systems integration.

IBM’s investment to bring its Watson cognitive computing technologies to the IoT is clearly gaining traction with companies around the world which are launching their own IoT solutions.”

— IDC: IoT Talks; IDC’s 2016 Global IoT decision-maker survey launch
R&D
Analyzing taste through language and tone
Watson understands how the chemistry of different ingredients work together and what tastes people prefer. IBM Chef Watson™ combines this knowledge to create new flavor compounds. For example, Cognitive Cooking with Chef Watson, written with the Institute of Culinary Education, contains more than 65 recipes. It was named by Gourmand International as one of the most innovative cookbooks in the United States.

Scaling expertise
Capturing the firm’s collective knowledge
Woodside Energy, Australia’s largest petroleum production company, taught Watson to think like an engineer. Now employees anywhere in the world can access 30 years of expertise and locate technical data to make quicker, smarter and more fact-based decisions by asking Watson questions in natural language. Watson helped reduce the time spent searching for expert knowledge by 75 percent after ingesting millions of files, decision logs and technical evaluations from across the company that would have taken any single individual more than four years to read.

Maintenance and reliability
Transformation across manufacturing plants
A major global chemical company implemented cognitive IoT advanced process controls for the functional design and management of ethylene crackers. The result is an increased margin of USD 0.10 per barrel of feedstock processed.

“We taught Watson to think like an engineer. Watson taught us to think like a thousand engineers.”

— Woodside Energy

Figure 2: Enabling cognitive technologies in the chemical industry
Blockchain can help transform supply chain networks in the chemicals industry

Given the nature of the chemicals industry, there will always be multiple suppliers throughout the value chain. Today, each supplier maintains their ledger in compliance with their policies and procedures. For that reason, most business transactions are inefficient, expensive and vulnerable due to their redundant nature.

Blockchain allows the contract for asset transfer to be embedded in the transaction database. Once a contract is validated and deployed, its execution is guaranteed. All transactions against the ledger require consensus across the network, where the provenance of information is not subject to misinterpretation and accessible to all participants. Transactions are immutable and cannot be changed.

As one of the world’s leading innovative companies, IBM has a deep understanding of the regulatory issues for chemicals companies and what is required to move this next generation digital transformation forward. In the future, as blockchain-enabled business transactions become more sophisticated, business and industry networks could evolve into self-governing cognitive business networks, reducing the cost of the costs of payment transactions by an estimated 30 percent.5

Much more than a technology to automate business transactions, blockchains create a new model for trust by establishing transactional relationships between businesses with smart contracts, certifications and digital compliance.

“In the next two years, we think this could reduce costs, certainly on payments, by 30 percent.”

— Blockchain News, October, 2016

IBM is developing blockchain solutions that are open, scalable and contain security features that are critically important to building business networks, such as the ability to register participants with proof of identity. IBM demonstrates this commitment by being a leading contributor to the Hyperledger Project—the Linux® Foundation’s open-source project developing the permissioned blockchain fabric that meets these needs and more.

\textbf{IoT + Watson + Blockchain = realtime visibility of energy pricing to enable optimal production sequencing by shifting production cycles to leverage differential pricing.}

IBM helped one of the world’s largest energy companies evaluate process setpoints using cognitive analytics, then communicate those results to production facilities via IBM Blockchain to provide:

\begin{itemize}
  \item Security
  \item Permanent record of commands
  \item Validation of value exchange
  \item Visibility by network participants
\end{itemize}
Digital transformation in action
Here are some examples of what digital transformation in action looks like in supply chains and in product development:

Example 1: Supply chain
Consider the digital transformation of a supply chain as an example of how a chemical company can prioritize its investment in digitization of all or any part of the business.

Traditional supply chain
- Information flows from the IT system of one organization to another IT system typically with a batch process push.
- Information flow is validated by an intermediary participant in the value chain, adding cost and delay.
- Technology changes require significant manual intervention.

Digitally-transformed supply chain
- **Real-time information** is pulled by partners participating in a value ecosystem through API calls.
- Data availability is **IoT-based** or event-driven.
- **All participants** have access to the same information at nearly the same time.
- Adaptation to change requires less manual intervention thanks to **cognitive systems**.
- Intervention with processes or physical devices by the force of **cyber-physical systems**.
- Web-based (intranet and Internet) **textual knowledge** can be quickly integrated with structured information to create a holistic view.
- **Speech or natural language**-based interaction ability with a corpus of knowledge makes it faster and easier for humans to find solutions and drive innovation. The system works as an advisor to and extension of a supply chain center of excellence.

Figure 3: Digitally-transforming the supply chain
The traditional method of product development uses a highly iterative approach that is heavily dependent on design heuristics, experimental studies and expert judgments. This process is time consuming and expensive. Process and profitability considerations are often an afterthought, which results in rework, added cost and time.

The digital transformation approach of chemical product development is characterized by:

- The mathematical or computerized prediction of molecular properties, which removes a significant burden from lab-based experimentation.
- The inclusion of knowledge residing in laboratory documents, internet-based articles, and academic journals that scientists use to form opinion or find solutions. Cognitive technologies such as IBM Watson can be trained to scan through this unstructured data and establish relationships between chemical elements, compounds and mixtures. The scientist or chemical product development team can interact with this system using natural language to extract what they need quickly and effectively.
- The fact that the product development process is not only optimizing for chemical properties but also considering other aspects of time to market, ability to sell and ability to produce such as cost of manufacturing, profit objectives, demand forecasts, and helping ensure process change from an early stage. This integrated approach accelerates time to market and increases the probability of success once the product is introduced.
- The speed of adaptation to changes (such as an increase in the cost of an ingredient) grows with higher automation and digitized product development.
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**Figure 6**: Envisioning possibilities.

*Source*: IBM Institute for Business Value analysis

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**Accelerate your digital transformation journey with IBM**

Digital transformation for chemicals businesses will require significantly more diverse engineering skills than traditional approaches. IBM is uniquely positioned to help you grow your chemicals business through our deep industry expertise acquired through years of project execution coupled with strategic partnerships with other leading technology providers.

IBM provides services to accelerate your digital transformation — from a one-day design thinking workshop to a multi-year customized consulting engagement. We collaborate with you to bring together business insight, advanced research and technology, cognitive and cloud capabilities that deliver distinct advantage in today’s rapidly changing environment.

Contact one of our experts today to get started on your digital transformation journey by visiting the Chemicals and Petroleum Industry website: ibm.com/chemicalspetroleum

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**Key questions**

- How does your organization deal with disruption?
- How agile is your organization when navigating new challenges as they occur?
- How can your workforce better embrace new ways of working and new strategic priorities?
- How can your organizational leadership conceive of what customers want even before they want it?
Author

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David Womack is Global Director of Strategy and Business Development for IBM Chemical and Petroleum industries. He is responsible for identifying new market opportunities and leading alliances with key partners. He is an author of several industry studies and research projects, and speaker at industry conferences. Prior to IBM, he was the COO of a management consultancy in the downstream, chemicals and power generation industry, and started his career with Exxon. Connect with David on LinkedIn or reach him at dmwomack@us.ibm.com.

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For more information

IBM Chemicals and Petroleum website
ibm.com/industries/chemicalspetroleum

Watson IoT Platform
ibm.com/internet-of-things/platform/watson-iot-platform

IBM Blockchain ibm.com/blockchain

HyperLedger Project hyperledger.org

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