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CHEMICALS

Digital in chemicals: From technology to impact

What are the major opportunities from digital in chemicals, and what must leaders do to capture them?

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There is a lot of excitement about the potential of digital[1] in chemicals, just as there is about digital across society in general. We believe that digital will have a significant impact on many areas of the chemical industry, with the potential to change value chains, lead to higher productivity and more innovation, and create new channels to market. Given all the excitement about digital, it is essential to separate the substance from the hype and carefully evaluate what this will mean for the industry.

Let's take a step back and review the changes that are underpinning digital. The generation, collection, and storage of data have never been so cheap, and this is happening just as computational power is reaching unprecedented heights and at lower costs. At the same time, the digital mind-set of society has expanded, spurring a willingness to engage with digital technology as well as much higher expectations for the quality of user interfaces and level of service.

The combination of these factors has opened up new avenues for the chemical industry. Companies can use advanced analytics to extract management-relevant information from the large amounts of unstructured data that they generate. This information can then be used to improve how plants are run and to make better-informed and speedier decisions across the full range of a chemical company's business processes. In the wider world, the chemical industry is an essential supplier to myriad other industries, and so the ways these industries are being changed by digital is in

turn translating to opportunities and challenges for chemical companies.

The key issue for chemical-company leaders is to understand more clearly where the impact of digital will hit the industry and what it will imply for their companies. Drawing on extensive work with leading chemical companies, proprietary research, and our digital know-how, we describe in this article the interplay of digital with the chemical-industry value chain and its subsectors, how digital could affect the industry's business processes, and the steps that industry leaders need to take.

How will digital affect the chemical industry, and where can the biggest impact be expected?

There are three main ways in which digital will affect the chemical industry. The first is using digital-enabled approaches to improve companies' business processes, which we call functional excellence. Second is the potential for digital to affect demand patterns in end markets, with implications for the chemical industry's value chains. The third is where digital developments lead to changes in the business models through which chemical companies capture and create value for customers.

Reaching a new level of functional excellence

Chemical companies' business processes, including manufacturing, marketing and sales, and R&D, present opportunities for performance improvement based on data capture and interpretation. Functional excellence has generated significant productivity improvements over the past two decades. Digital provides the means to unlock a new level of productivity enhancement.

Manufacturing operations present one of the biggest and most readily accessible areas of opportunity, and this cuts across all segments of the chemical industry, from petrochemicals to pesticides. We see the potential for a three- to five-percentage-point improvement in return on sales from employing digital in production operations. Most chemical plants continuously generate an enormous amount of data but discard most of it. Instead, managers should collect the data and interpret it to reveal ways to achieve higher yields and throughput, lower energy consumption, and more effective maintenance.[2] For many companies, these are potentially easy wins that can be achieved using existing IT and process control systems, while companies that expand the types of data they collect may be able to capture further gains.

The contribution to profits can be substantial. A major polyurethane maker applied advanced analytics to half a billion data points that it collected from the main production process at one of its plants. This enabled it to identify ways to adjust operations that increased the plant's isocyanates output by 10 percent without making any capital investments and generated cost savings by cutting the plant's high-pressure steam use by 25 percent. A leading specialty-chemical company went a step further at one of its main plants: it used advanced analytics to model its production process to a new level of accuracy, and then used the model to provide detailed, real-time guidance through a specially designed app for the plant's operators on how to adjust process parameters to optimize performance. Just one month into the implementation, output at the plant—already the company's most profitable—increased by over 30 percent and yields increased by six percentage points, thus saving on raw materials, while energy consumption fell 26 percent.

Besides this advanced-analytics-based opportunity, there are other digital-enabled advances that may create significant value in the manufacturing operations area. Examples include the use of

Digital will affect the chemical industry in three ways: first, by improving chemical companies' business processes and furthering functional excellence; second, by changing demand patterns in end markets; and third, by making possible new business models chemical companies use to serve their customers.

automated guided vehicles, such as self-driving forklifts, and the use of robots to fill big bags. These advances should reduce costs and improve process stability and safety performance. At the same time, deploying an automated and centralized plant performance-management system should make it possible to steer operations better and to react faster when corrections are needed.

For many subsectors of the chemical industry, this opportunity extends beyond production to the entire *supply chain*, including inbound and outbound logistics and warehousing. Advanced analytics will make possible more accurate forecasting, leading to improvements across the entire sales- and operations-planning process. This will also make possible better scheduling of batch production, shorter lead times, and lower safety stocks with a higher level of flexibility. Integrated "no touch" ordering and scheduling systems will help to stabilize production planning even further.

Sales and marketing also offers major value-creation potential through digital.[3] The biggest opportunity for sales and profitability growth lies in digital data-led decision making. We estimate that digital-enabled initiatives in marketing and sales could improve the industry's average return on sales (ROS) by two to four percentage points. Specialty chemicals could see higher ROS gains in the range of three to five percentage points, with chemical distribution seeing one- to one-and-a-half-percentage-point gains.

Digital initiatives in marketing and sales include applying advanced-analytics-enabled pricing systems, generating growth opportunities from data, and using algorithms to predict churn at the individual-customer level and then suggesting countermeasures to the sales force. The impact of these initiatives can be significant. One leading global nutrition player used internal and external data sources to create transparency at a detailed customer-product segment level. Advanced analytics then scanned these millions of lines of data to develop suggestions for additional sales to individual sales reps, with the suggestions delivered via an easy-to-use app. The company saw 8 percent growth in pilot markets, after experiencing no organic growth in the previous five years. A large specialty-chemical company used advanced analytics to reset prices for hundreds of thousands of product-customer combinations in seven core countries, based on individual risk and willingness to pay. By combining analytics, capability building, and change management, the company was able to achieve price increases of 3 to 7 percent, compared to 1 percent increases in previous years.

The second area that we believe will gain importance is customer experience and digital go-to-market channels. Our latest proprietary research shows that 85 percent of B2B chemical purchasers would prefer digital channels when reordering a product rather than interacting with a salesperson. Combining a digital channel with process digitization will create an improved customer experience, while lowering cost to serve. Again, how much of that potential will actually become bottom-line impact will vary, depending on the competitive situation in specific chemical markets.

We also see significant opportunities in *research and development* to create higher-value-added, higher-margin products at a faster pace, in particular in specialty chemicals and crop-protection chemicals. Chemical companies will be able to use high-throughput optimization to develop and adjust molecules that offer more value. They will also be able to deploy advanced analytics and machine learning to simulate experiments, to use digital's predictive power to systematically optimize formulations for performance and costs, and to data-mine information available from past successful and failed experiments. Not least, they will be able to identify the best possible resource allocation to enhance the performance of R&D teams and the innovation pipeline. Many of these practices are already established in the pharmaceutical industry but were largely unaffordable for chemical companies. With the emergence of inexpensive computing power on a massive scale, this is likely to change.

Digital-led disruption in end markets for chemicals

Changes caused by digital have the potential to remake some if not most of the value chains and end markets that chemical producers serve, and this in turn could lead to demand-pattern shifts.

Take the automotive value chain. Digital is obviously behind the rapid advances being made in the development of self-driving cars, but the consequence for chemical producers may not be immediately obvious. One perhaps unexpected effect on chemicals demand comes through the enhanced traffic safety that is promised by self-driving cars. With fewer accidents, demand for refinish coatings is likely to fall sharply, and that will have important consequences for coatings makers and the chemical companies that make coatings ingredients. Should shared self-driving cars displace individual car ownership and reduce new-car demand, then there will be further and much broader consequences for chemical demand in one of the industry's major markets.

Digital-enabled developments in agriculture such as precision farming could also affect chemicals demand. Companies that sell equipment and services for applying crop-protection chemicals and crop nutrients are combining analytics, navigation, satellite imagery, computer vision, and

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machine learning to develop an approach that allows for the application of pesticides and fertilizer to segments of fields as small as one square meter or even individual plants. If their endeavors are successful, the demand for agricultural chemicals could be reduced significantly.

The migration of commerce to online platforms may also touch demand for chemicals. For example, groceries are increasingly being purchased via online platforms, with consumers making their purchase decision without seeing the physical product—with possible consequences for packaging, the petrochemical and plastics industry's single largest end market. As the look and feel of the packaging would become less important in shaping a purchase decision, this could prompt changes in the packaging industry. While decorative packaging would decline in importance, more functional aspects of packaging design could gain importance, such as designs that can fit more packages in a delivery truck or that include a cooling mechanism to prevent spoilage during delivery. Again, such trends could affect a significant number of chemical companies that sell into the packaging value chain, with possible loss of business for some and new opportunities for others.

One further digital-enabled area that is opening up opportunities for chemicals demand is 3-D printing, also referred to as additive manufacturing. The market for polymers and chemicals used in additive manufacturing is growing at 30 percent a year and is set to rise from $0.7 billion in 2015 to $2.5 billion in 2020. It is possible the market will evolve toward tailored polymers and chemicals for different additive manufacturing systems, which could open up innovation and commercial opportunities for companies making photopolymers, high-performance thermoplastics, and other chemicals used in these processes.

Digital and new business models in chemicals

Will digital change the ways that chemicals are sold and distributed, and as a consequence, how value will flow? Will we see a shift from sales of products to sales of services and solutions? Will attackers emerge that disintermediate established producers from their customers, as we have seen with B2C platforms in other industries? Different segments of the chemical industry will have different answers to these questions: as a general statement, while crop-protection chemicals and some specialty-chemical segments are at risk of business-model disruption and some chemical distributors see themselves as potential actors in future possible disruptions, petrochemicals will probably be less affected.

First, business models that remain connected to the product in use might provide a substantial

opportunity in some areas of the chemical industry—for example, through systems that monitor chemical applications in industrial processes. One example drawing a lot of interest is catalysts, where process catalyst manufacturers are increasingly moving toward "performance pay" models, instead of simply selling the product. Staying connected to the catalyst in use allows the catalyst manufacturer to optimize the production process of its customers and presents the opportunity to build a large and valuable knowledge base that can be used to improve catalyst use across its customer base and charge for the service. A number of such models have been in development for more than a decade in parts of the specialty-chemical industry, and there is the potential for an acceleration in their adoption linked to digital. But such approaches will not be applicable for all of the chemical industry: the main focus is where a specialty chemical does a particular job, such as a catalyst or water-treatment chemical.

Second, opportunities for intellectual-property-based business models that generate licensing or consulting fees appear to be emerging. Under this model, a company could charge a fee for providing guidance on how best to use its product, or it could license production of a proprietary molecule to another producer. But examples so far appear to be isolated and as yet unproven.

Third, data- and analytics-led service models are emerging in targeted segments. In agriculture, a company might combine geological, meteorological, and geospatial data with its knowledge of seed, fertilizer, and crop-protection compounds, and rather than selling these inputs, it might seek payment based on the yield or profit that the grower achieved. Other chemical-industry segments that have a strong B2C component in their business system might be facing a similar development.

On the other hand, a number of models that are receiving substantial focus in other industries are much less likely to have impact across most of the chemical industry. Building platforms as channels, which connect third parties, is well established in many industries. But this may be difficult to put in place in the chemical-industry environment where the number of suppliers is limited, their names are known to potential customers, and many chemical producers have proprietary know-how that they will not be willing to share. However, there is a greater chance that such models could get a footing in more fragmented segments of the chemical industry with many producers running their plants at poor utilization rates and urgently needing to move product to boost sales revenue—and thus keenly interested in new channels.

Pursuing digital transformations in chemicals

Based on our experience working on digital with leading players in chemicals and across other B2B industries,[4] we see that successful approaches to digital address the following six requirements:

- *Create a clear target picture.* Senior management needs to define where it sees the company in the future with respect to digital. This needs to happen centrally, and it cannot be pursued bottom-up through the business units. The target picture needs to answer these questions: In which ecosystems and at what position in the value chain do we want to play? What is the greater goal: operating efficiency or increasing revenue? What are the focus areas across the business model, the customer-facing front end, products, and operations?

- *Quantify the impact.* Digital needs to be a business-led topic. Digital tools such as advanced analytics, automation, and customer centricity should be aimed at solving specific business topics, such as entering new markets; increasing plant yield; improving on-time, in-full performance; reducing churn; and increasing margins. This step should answer the following questions: What value

pools do we see? What initiatives are there, what impact do we aspire to, and what are the related costs? How should we prioritize initiatives based on costs and benefits?

- *Define the required capabilities.* While traditional chemical and management skills will still be important, new skills will be required that are not traditionally found in chemical companies. Some of these will require hiring new talent, and some will require training existing employees. What these skills are will depend on the target picture and the prioritized business cases. This effort needs to answer the following questions: What capabilities and talent pools do we need to execute our digital initiatives—including, for example, user-experience design? How is capability building conducted for the broader organization? What is our build-partner-buy strategy for technologies?

- *Design the right organization and governance.* Simply adding new digital talent to an existing and often engineering-focused organization will probably not be the recipe for success. Digital does not come only in the form of apps, algorithms, and tools but also in a new way of working that brings a bias for action, rapid testing, iteration, and often failure. Failed digital transformations are typically not the result of legacy systems but of legacy thinking. The organization and governance need to be adapted to allow new digital approaches to flower. A number of questions must be answered: Which capabilities do we need to own, and which can we get access to through partners? Where do we base the new capabilities—within a central digital organization, or decentralized across the business units? What organizational structure do we need over time? What is the role of the corporate group as the central unit? Should a digital center of excellence be set up, and how? How does the digital organization collaborate with other units and transformation programs? What authority does it have?

- *Build the road map on an agile approach and mind-set.* Traditional technology investment and strategy often relied on big bets, which frequently took years to realize. Leaders today are seeking to prove or disprove concepts in months—not years—creating fundamentally different risk profiles for the journey than might be previously conceived. Among the important questions to answer are the following: Where in our organization (or ecosystem of partners) do we have a truly agile development capability? How will our capabilities, organization, and governance structure reinforce an agile approach and mind-set?

- *Develop a digital culture.* While organization and governance provide the supporting framework, digital also needs the right culture and climate to grow. It is therefore important to think through in advance how to help a digital culture to take root and not only take these steps when organ rejection is setting in. What contextual setup is required for the digital organization to prosper, including values, leadership style, and workplace design? What key performance indicators should be used to measure digital cultural development and digital maturity? How do we communicate with the workforce and with external stakeholders such as customers and suppliers?

Digital in the chemical industry represents a very substantial opportunity, but companies need a strategy to succeed in this new world. Changes are starting to happen and at a pace that is unprecedented, but the impact of change is uneven and significant uncertainty exists. Strategy is the art of making hard-to-reverse choices ahead of time and in the face of uncertainty to create and capture

economic profit. Industry leaders should not shy away from this task but instead develop clear digital strategies based on an understanding of where and how impacts will occur in their sector.

Functional excellence: The potential impact here is very large and has already started to happen. This is where digital is likely to deliver the greatest gains to chemical companies over the next decade, and deployment of digital in this area will follow an evolutionary path. Companies that want to be leaders should be implementing now and rigorously pursuing opportunities to stay competitive.

Disruption in end markets: In certain end markets, digital will trigger revolutionary changes that will be rapid and large-scale. Senior chemical management teams need to be at the ready and should start today to look out for possible risks and opportunities. If major disruption is on its way, every additional day of preparedness that can be captured will be of critical value.

New business models: The impact is likely to be targeted to very specific industry segments and unfold in a more evolutionary than revolutionary way. Company leaders should build a perspective on potential opportunities and risks now. This perspective should be revisited often to monitor leading indicators of change.

What is clear is that the spread of digital will create opportunities for successful early adopters of the new digitally enabled approaches, particularly where these approaches can find a good fit to their specific segment of the industry. Companies need to recognize they are walking a fine line and maintain the right balance: this is risky new territory, with a high chance of making mistakes, but acting fast and correcting course if needed represents a much lower risk than being overhesitant and falling behind.

There is ample evidence that many leading companies are working hard to define and implement new strategies where digital plays a fundamental role. While it would be hard to claim that any chemical company has carved out a significant competitive advantage based on digital at this point, that is likely to change, and it is going to be sooner rather than later. ■

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[1] In this article, we are using "digital" as an umbrella term for all digital-related topics, including new or enhanced ways of operating businesses by using data, analytics, and new digitally enabled technologies, communications, and platforms.

[2] For further discussion about the application of advanced analytics to improve manufacturing performance, see Robert Feldmann, Markus Hammer, Ken Somers, and Joris Van Niel, "Buried treasure: Advanced analytics in process industries," December 2016, McKinsey.com; and Robert Feldmann, Markus Hammer, and Ken Somers, "Pushing manufacturing productivity to the max," *McKinsey Quarterly*, May 2017, McKinsey.com.

[3] For further discussion of digital approaches to marketing and sales in chemicals, see Søren Jakobsen, Kedar Naik, Nikolaus Raberger, and Georg Winkler, "Demystifying digital marketing and sales in the chemical industry," February 2017, McKinsey.com; and Charles Atkins, Maria Valdivieso de Uster, Mitra Mahdavian, and Lareina Yee, "Unlocking the power of data in sales," December 2016, McKinsey.com.

[4] See "What's now and next in analytics, AI, and automation," McKinsey Global Institute, May 2017, McKinsey.com.

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