



Achieving the next frontier of chemicals excellence
Digital maturity model to help ease the transition

EXECUTIVE SUMMARY

The chemicals industry is going through a transformation. Many existing and emerging trends are shaping the future of the industry, which include increasing competition, a shift in economic power, disruptive innovations in end markets, changes in feedstock, accelerating commoditization, sustainability, digitization, and Industry 4.0. These key developments which are determining the future of chemicals broadly fall into three key themes: 'Growth and innovation', 'Performance and cost optimization', and 'Sustainability and circular economy'. The potential of digital to expand the efficiency and productivity frontier for each of these themes is substantial, given the state-of-the-art developments happening in networks and sensors, data availability and processing, and advances in engineering and material technologies.

However, despite laying out the potential and scope of a digital transformation among various themes, industry executives must rethink their business models to take advantage of digital technologies. They must think about how to: (1) Realign their business model to benefit from new technologies; (2) Define the roadmap about how their companies can deploy these advanced technologies in their day-to-day business; and, (3) Accelerate the deployment of those digital technologies across all the business functions. To meet all these objectives, executives need a Digital Maturity Model – a model which would help see chemicals companies where they are placed currently and where they aspire to go on the digital journey. This model, which we describe in detail lays out the potential digital maturity stages of a chemicals company. It portrays strategic choices and the action steps in each of the five dimensions that should be considered for increasing digital effectiveness momentum. These five dimensions include: 'User experience', 'Talent enablement', 'Asset reliability and performance', 'Material system innovation', and 'Ecosystems'. Digital initiatives in each of these five dimensions determine the digital maturity (and thereby the strategic choices) of a company. Conversely, if a chemical company is already undertaking these digital initiatives, the framework can help assess where exactly the company is on the digital maturity spectrum and what additional steps it can take to reach its intended destination on the digital transformation journey.

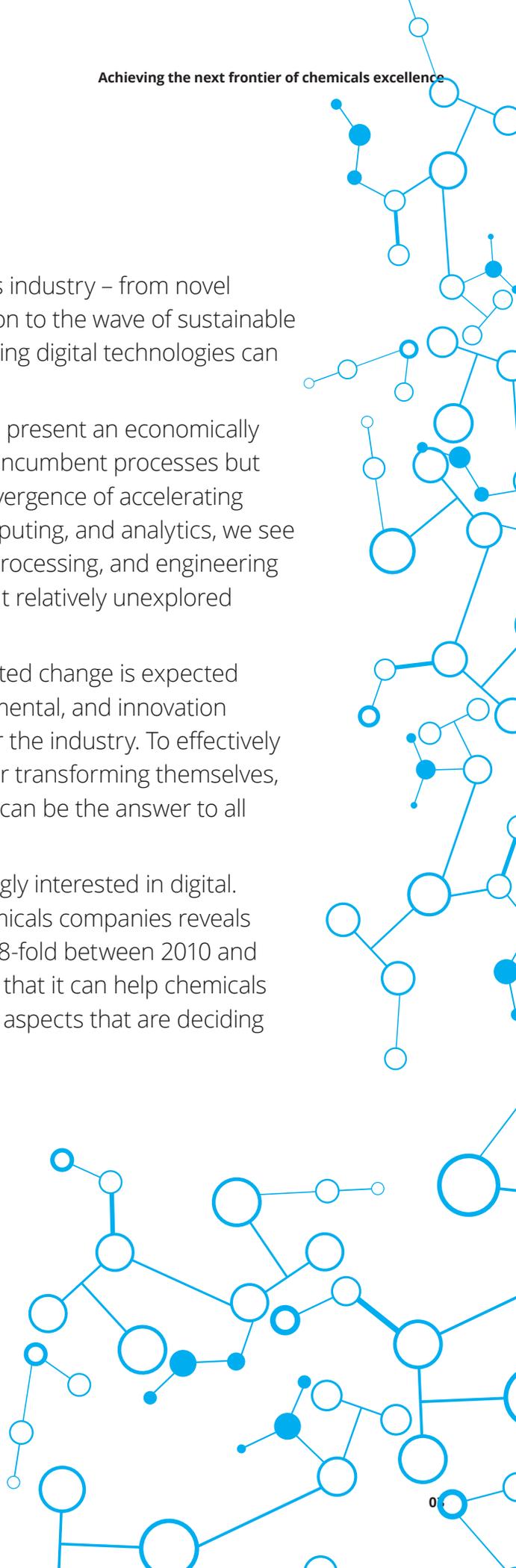
INTRODUCTION

Profound changes appear to be underway in the chemicals industry – from novel process technologies changing the chemicals trade equation to the wave of sustainable production, reuse, and recycling of plastics. Strategically using digital technologies can help enable and accelerate these transformative leaps.

Today, compared to the past, digital tools and technologies present an economically feasible solution to not just extract more efficiencies from incumbent processes but also design novel products and processes. Due to the convergence of accelerating improvements such as advances in sensors, cognitive computing, and analytics, we see significant progress in three areas – data availability, data processing, and engineering and materials research.¹ Yet, there remains an immense but relatively unexplored potential to use digital technologies.

As the industry moves into the future, the pace of accelerated change is expected to only quicken. Changing paradigm due to social, environmental, and innovation expectations is transforming the competitive landscape for the industry. To effectively anticipate and adapt, chemicals companies should consider transforming themselves, by changing the way they operate and do business. Digital can be the answer to all these and much more.

It is not that chemicals companies are not getting increasingly interested in digital. Text analytics done on the 10-K reports of leading US chemicals companies reveals that mentions of “digital” related keywords have increased 8-fold between 2010 and 2017. This increased interest in digital is shaped by the fact that it can help chemicals companies to achieve the next frontier of excellence in key aspects that are deciding the future of chemicals.



Strategic pillars deciding the future of digital in chemicals

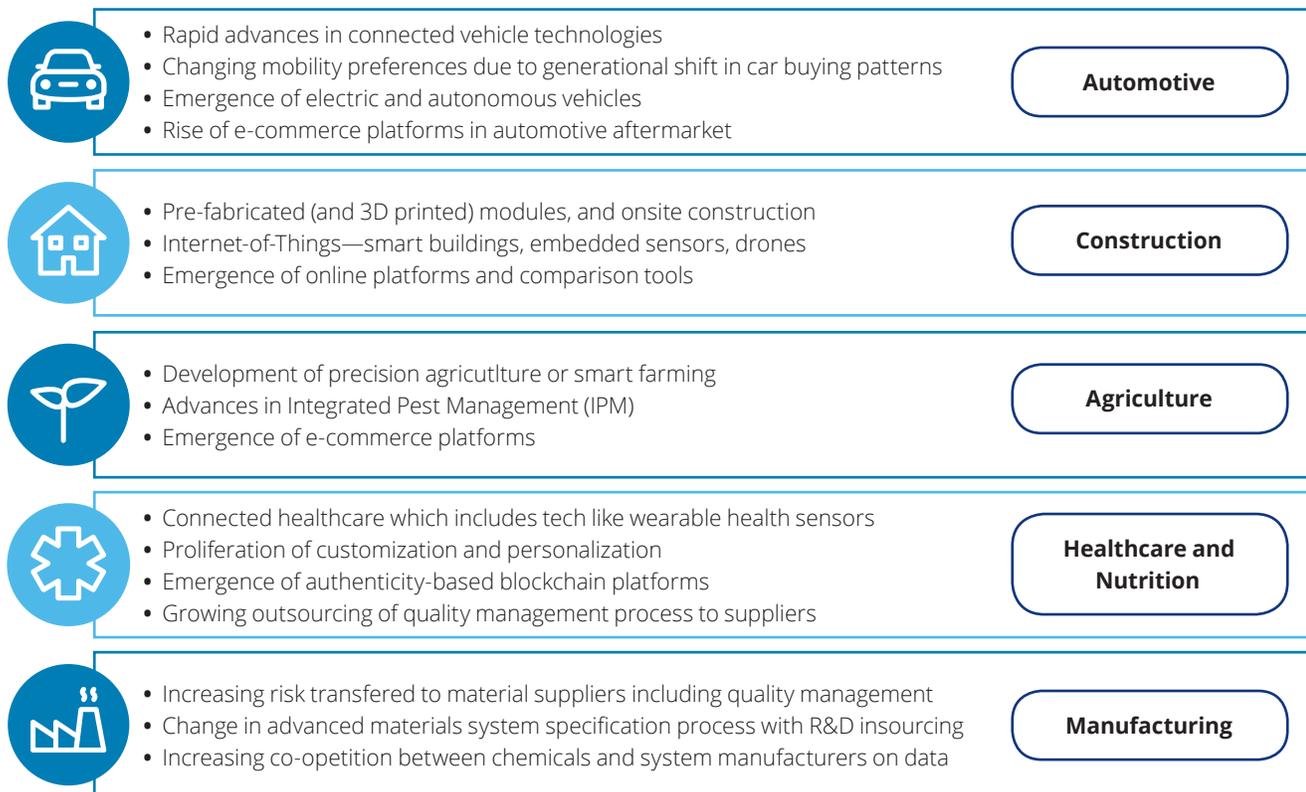
These key aspects, what we call the three strategic pillars, are the levers around which chemicals companies will play to their full potential in the future:

1. Growth and innovation: Developments in digital technologies, such as lower data-storage costs, high-performance computing, and advanced analytics, will help drive innovation and reduce the time required to discover and commercialize new materials². Moreover, chemical manufacturers are becoming increasingly aware of disruptions in key end-use industries such as automotive, construction, agriculture that can impact their business (see figure 1). These disruptions are creating both opportunities and challenges for the chemicals industry. For example, while relatively novel technologies like additive manufacturing, currently being demonstrated but not fully commercialized in many applications from engineering parts to house building, might create a need for new materials, at the same time, they may reduce the consumption of traditional chemicals and materials.

It is these indirect or direct disruptions caused by digital and exponential technologies across value chains and end-use sectors that are prompting most chemical enterprises to relook at and reevaluate their future growth strategies. Also, with many such disruptions creating a mixed bag of benefits and disappointments, many chemical enterprises are increasingly looking at using digital value-added services to supplement their existing product offerings.

2. Performance and cost optimization: Use of digital technologies to optimize plant performance is not new to the chemicals industry. These digital technologies, including the Internet-of-Things (IoT), have helped chemicals manufacturers to automate key chemical engineering processes, integrate machines, monitor performance, and predict equipment failure. However, optimizing performance is not just restricted to the application of digital technologies. Process manufacturing technologies have enabled the repeated use of byproducts of one

Figure 1: Trends in disruptions across key end-use industries impacting chemical manufacturers



Source: Deloitte analysis based on various sources.³

chemicals process into another, driving energy-efficient reactions, including the use of catalysts and helped build distillation columns that utilize less energy and generate fewer waste gases.

The next stage in the application of digital to optimize performance should go “well beyond the plant” and should readily “integrate with physical assets.” New digital technologies like Blockchain and predictive analytics can be integrated with existing IoT infrastructure to enable track-and-trace capabilities that can lead to fine-tuning of production yields in response to fluctuating demand of end-products and prices of feedstocks.

In addition, new process technologies like crude-oil-to-chemicals (COTC) have already been deployed in some refinery-scale petrochemicals plants. The effective integration of digital with physical assets becomes even more critical for these upcoming, state-of-the-art plants.

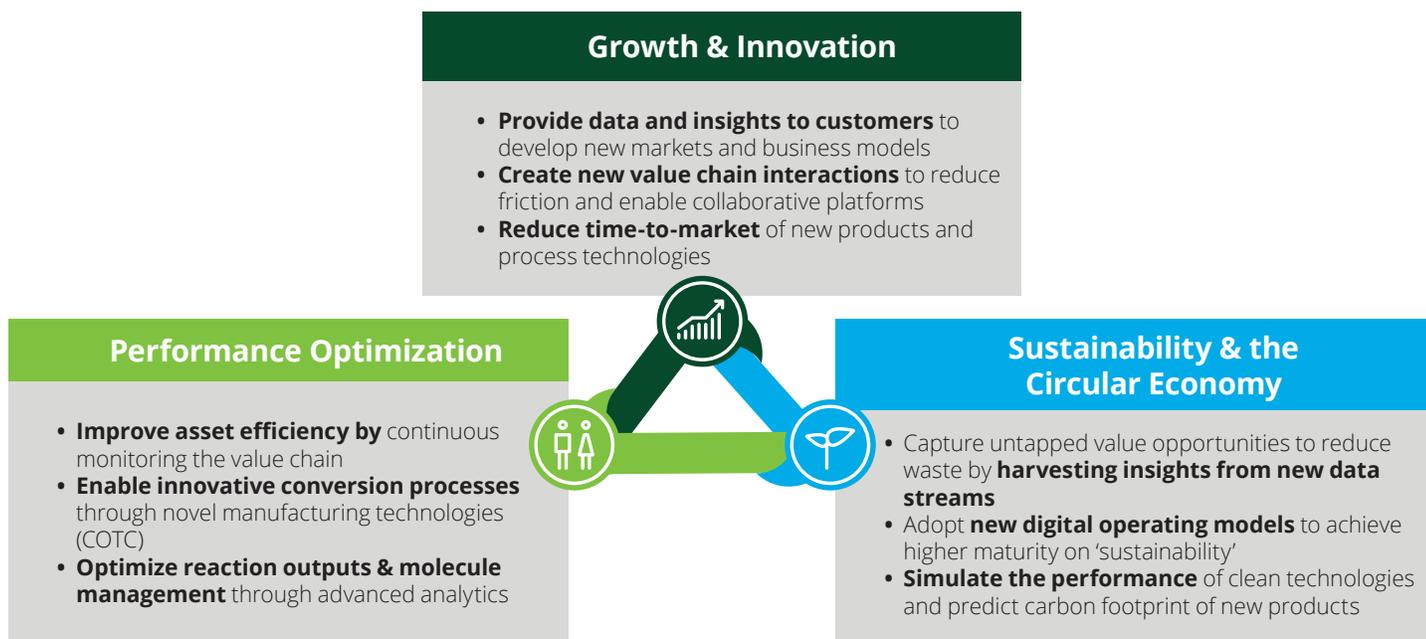
3. Sustainability and the circular economy: The chemicals industry is embracing the drive towards a circular economy to demonstrate its overarching commitment to sustainable materials management. To address regulatory restrictions on

single-use plastics and microplastics, chemicals companies are working with their clients to introduce new products, invest in recycling technologies, as well as incorporate renewable and recyclable materials in their growing product portfolio. To meet these goals, all stakeholders within the downstream value chain should come together and find sustainable solutions which can be outcomes of product innovation, technology commercialization, and redesign mindset – with chemicals manufacturers in the midst of it.

The role of digital in making companies realize the full potential of sustainability practices is still in its infancy. However, it is here that digital tools and technologies could have the highest potential to reap the rewards. For example, crowdsourcing platforms powered by digital are already being used to ideate and come up with innovative solutions or products which have a lower carbon footprint throughout their life cycle. In the future, by integrating blockchain technology and machine learning algorithms, the actual environmental footprint of the new product or solution can be tracked, traced, and predicted.

Figure 2 summarizes the growing role of digital in each of the three pillars that we have described above. It provides an overview of where and how digital tools and technologies can make an impact.

Figure 2: Role of digital technologies in strengthening each of the three pillars



Source: Deloitte analysis

A Digital Maturity Model (DMM) to address digital, ease investment decisions, and focus on high-impact initiatives

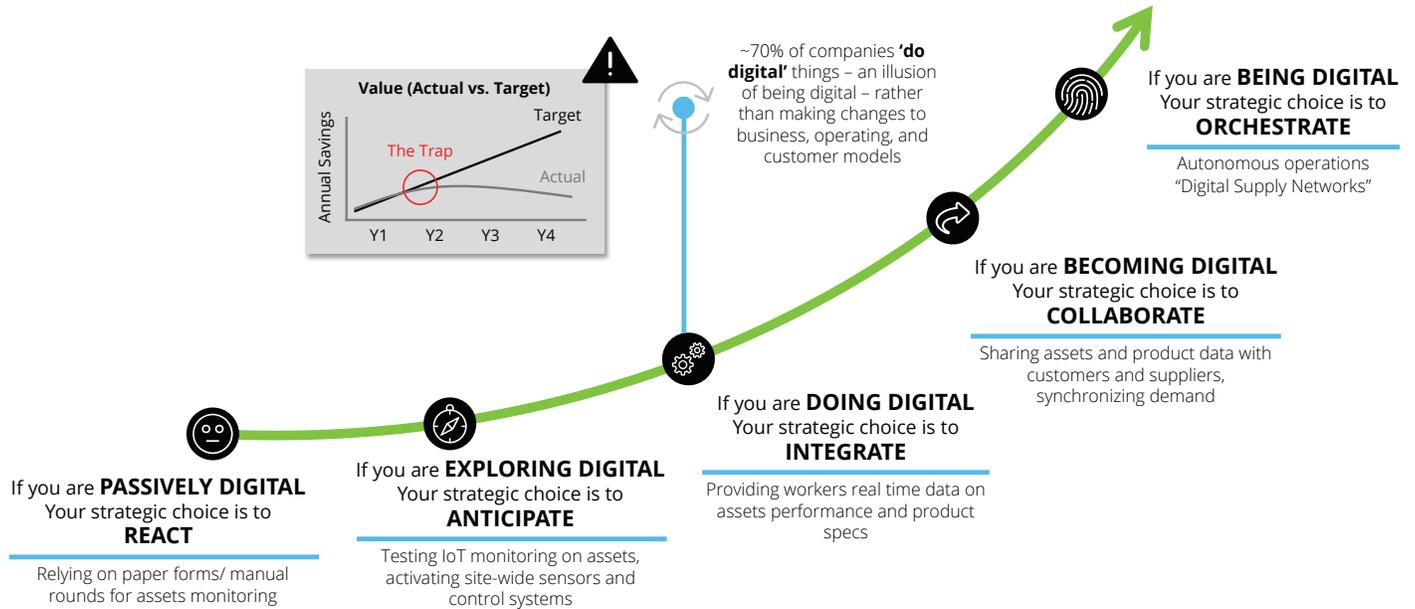
In the past, chemicals companies have typically implemented digital initiatives in siloes within the organization. This siloed approach to digital transformation has led to slower processes, higher costs, and uncertain benefits.⁴

To get the full advantage of digital transformation, an enterprise-wide digital strategy is often needed, which percolates down to customizable parts suiting the needs of individual business units. This digital strategy should also tie into the digital maturity model – where the organization is right now and where it aspires to be once the digital transformation is done (see figure 3).

We understand that digital transformation is a journey involving a complex ecosystem of capabilities. Digital transformation is not just about implementing more and better technologies but also involves aligning culture, people, structure, and tasks.

The DMM can be used in each phase of this transformation to help identify the gaps, establish critical areas to focus on, and determine starting points. It does not replace an overarching transformation framework but is meant to serve as a guide for businesses to step out from the digital maturity trap – where ‘siloed’ approach to digital transformation is generally leading to marginal improvements.

Figure 3: Digital maturity model for chemicals companies

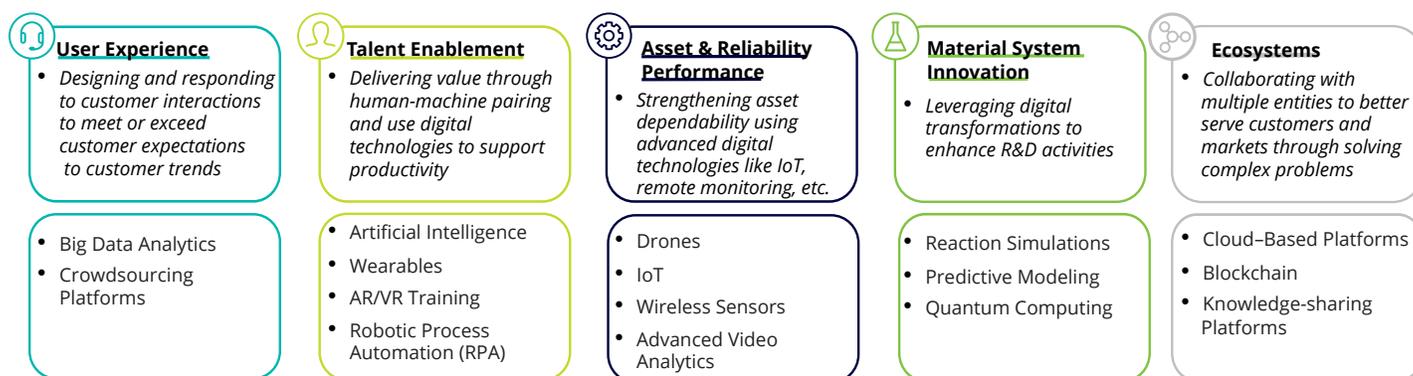


Source: Deloitte analysis

The DMM evaluates digital capabilities across five clearly defined business dimensions to create a holistic view of digital maturity across the organization. These key dimensions include:

- 1. User experience** is the practice of designing and responding to customer interactions to meet or exceed customer expectations and, thus, increase customer satisfaction, loyalty and advocacy.
Customer experience helps drive growth. Today, many business-to-business (B2B) customers are using digital tools, and they expect the same self-service capabilities as the leading e-commerce platforms provide. And even though digital tools facilitate improved customer service, delivering outstanding customer experience involves more than using new technologies. Sinopec Chemical appears to have sensed this and is setting up a new interactive online platform called "one client one portal". This platform is designed to cover all direct sales customers, as well as connects all plants and functional departments of Sinopec Chemical. Apart from enabling advanced customer services such as inventory reminders, logistics tracking, and product footprint tracking, the platform allows client complaints or feedbacks to be directly reported to relevant plants and functional departments.⁵
This dimension also includes the use of big data analytics and crowdsourcing platforms to glean relevant customer insights using which product or service excellence and differentiation can be achieved. For chemicals companies which aspire to be placed on the "Being Digital" stage, optimizing the entire value chain integration by harvesting new insights from end consumers can be of paramount importance. An example would be that of market listening integrated with predictive analytics - an approach which Dow Chemical uses to identify cross-selling opportunities using their custom-developed recommender engine.⁶
- 2. Talent enablement** involves delivering value through human-machine pairing, where robots assist humans in manual tasks and employees use digital technologies to support productivity and effectively complete tasks. Such digital technologies include Artificial Intelligence (AI), wearables, Augmented Reality (AR), Robotic Process Automation (RPA), etc. These cognitive tools can not only free-up the workers' time so that they can direct their efforts to more important jobs but can also speed up the execution of repeatable tasks. For example, incorporation of AI and other machine learning algorithms in R&D knowledge management systems can help scientists and researchers to devote more time to the actual R&D work.⁷ Similarly, the confluence of AR, wearables, cloud computing, and machine vision has enabled some chemicals companies to train their field workers in standard operating procedures, emergency preparedness, and plant familiarization. This has helped in not only enhancing worker safety but also in real-time maintenance and repair in case of equipment failures.⁸ At the highest stage of digital maturity, talent enablement using digital can augment management capabilities by creating collaborative platforms such as digital assistants for data-driven decisions.
- 3. Asset reliability and performance** concerns with strengthening asset dependability using advanced digital technologies like IoT, remote monitoring, etc. New wireless-enabled sensor technologies and drones have enhanced the functionalities of IoT infrastructure within plants and allowed workers to remotely monitor them for gas leakages, tank emissions, and regular inspection of plant equipment.⁹ Use of digital twins, holographic images, advanced video analytics, and image processing technologies have also enabled live-feed analysis, real-time detection, and reporting of 'outlier' events. At the highest stage of the digital maturity cycle, chemicals companies should own and operate an autonomous plant that can be monitored remotely - using AI to optimize assets and make decisions to optimize the entire value chain. In addition,

Figure 4: Five dimensions of the proposed digital maturity model



using digital technologies that are installed and spread across assets within a plant, chemical companies should connect all the information to simulate scenarios, predict outcomes, and take corrective action.

A case in point is Air Products & Chemicals which developed a “patented, web-based, predictive-monitoring and fault-diagnostic platform” called ProcessMD, that was designed to monitor asset health in real-time and provides its engineers a multi-tiered view of operations.¹⁰

4. Material system innovation involves leveraging digital transformations to enhance R&D activities. While the scientific method remains at the heart of the innovation process, the convergence of inexpensive computing power, improved physics-based modeling, and advanced learning algorithms is accelerating the adoption of a digitally-enhanced scientific method.

In recent times, simulations using advanced computing techniques are finding increasing takers due to the pressure of inventing more and faster. Some companies have started investing in quantum computing startups that could enable them to reduce the time-to-market of new products by performing complex simulations.¹¹ However, the use of quantum or supercomputing is just one of the aspects. BASF, for example, has adopted an integrated approach to digitizing R&D, which also involves a strategic focus on data science, and inter-connected knowledge systems.

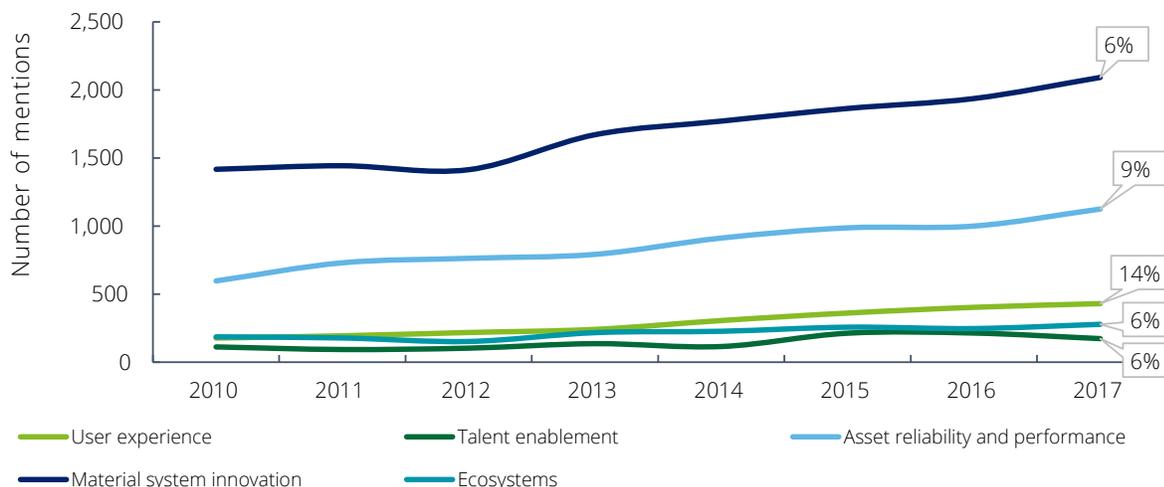
Another example would be that of Carbon, a California-based digital manufacturing company, which is working at the intersection of hardware, software, and molecular science. Carbon's vision is to develop light, traceable, high-quality parts produced at scale by leveraging additive manufacturing technology.

5. Ecosystems involve collaborating with multiple entities (companies, universities, national labs, etc.) to better serve customers and markets through solving complex problems. In an ecosystem, suppliers, manufacturers, distributors, other players, and end consumers use digital technologies to jointly develop solutions that no single entity could do individually.¹² Moreover, ecosystems enable collaboration to innovate new solutions, commercialize new products, and share information such as demand forecasts to better manage supply chains. Open communication and collaboration using cloud-based platforms and blockchain technology can enable real-time visibility into shipment logistics, and thereby lessen the reaction time. Use of integrated platforms among entities in the value chain to share R&D knowledge of to-be commercialized products can expedite the time to introduce new products and weed out workflow inefficiencies.

For example, Valmet and Kemira have entered into an agreement to build an Industrial Internet ecosystem in an effort to bring “the know-how of the two companies in utilizing process data to improve the customers' processes.”¹³

Strategic focal points: Results from text analytics

Text analytics done on 10-K reports of top US-based chemicals companies reveal quite a few interesting trends. The mentions of the keywords across all five dimensions have increased over the years with the highest rate of increase occurring in the case of ‘User experience’ and ‘Asset reliability and performance’. At the same time, the highest number of keyword mentions have happened for ‘Material system innovation’ and ‘Asset reliability and performance’. This indicates that while asset-related aspects have remained on top-of-the-radar for chemicals companies, the role of customer-centricity and innovation in driving growth and profits has increasingly dawned upon them.



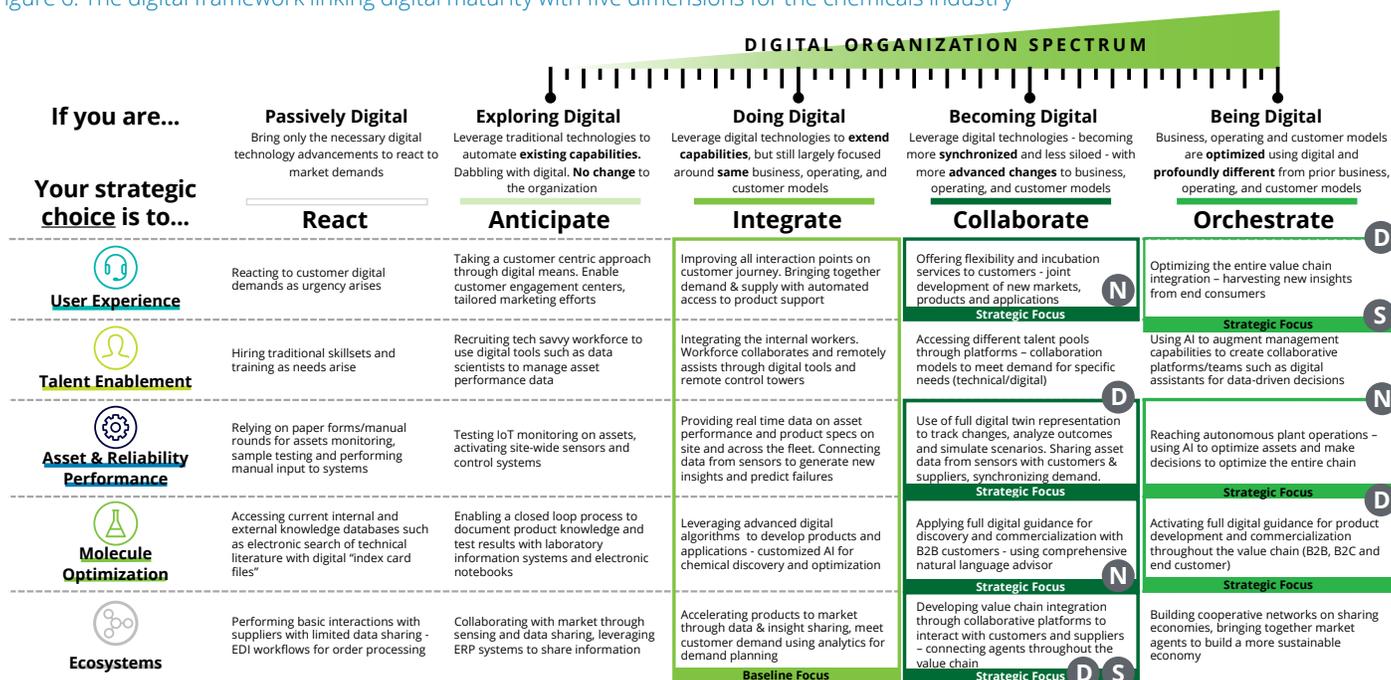
Note: Percentage data in callouts refer to CAGRs (2010-2017) of number of mentions for each of the dimensions.
Source: Deloitte analysis of 10-K reports of leading US chemicals companies.

Chasing the link between digital maturity and the key dimensions

So far, we have seen the digital maturity model and the five dimensions across which the digital play is increasingly occurring, in isolation. However, there is a strong linkage between the digital maturity stage and strategic choice and what specific tactical steps chemicals companies should consider under each of the five dimensions (see figure 6).

Although the Digital Maturity Model remains constant, the level to which an organization needs to be mature in each dimension is dependent on its business strategy, business model, and operating model. That is, it depends on which business model an organization chooses and how it defines its unique business strategy and operating model. Any organization should start by considering these components in a top-down approach and refer to them alongside the DMM.

Figure 6: The digital framework linking digital maturity with five dimensions for the chemicals industry



Note: N = Natural Owners; D = Differentiated Commodities; S = Solution Providers. For definitions and more details, please refer to: [Winning in evolving times: Strategic imperatives for chemicals companies](#).

Source: Deloitte analysis

A chemical company, for example, can ask of itself: based on its strategy, business model, and operating model, what are the target digital maturity levels and priorities across the five dimensions? And what are the broader business changes that need to be considered in planning a digital transformation?

The Digital Maturity Model provides a view across all capabilities, helping chemicals enterprises to prioritize focus areas and improve in line with their overarching digital ambitions. Chemical companies can use these business priorities in parallel with the DMM to drive actions and initiate digital transformation in their organizations.

For example, if a company's business growth strategy is highly dependent on emerging markets, then it is essential to own a mature customer platform to immediately establish customer intimacy and engagement as well as a connected supply chain. For instance, Dow

Chemical's Water Solutions business unit is now offering a mobile ordering and tracing system based on its private WeChat portal, where orders can be placed and tracked. Also, customers can also request a brochure, sample or contact sales and technical support on this portal to get the most up-to-date product information.¹⁴

However, depending upon the segment to which a chemicals company belongs to and its current digital maturity, the specific tactical steps might differ. Hence, it is important that chemicals companies not only use this maturity model to assess their current standing on five dimensions but also where they want to be. In the latter case, which is more aspirational, companies can get an overview of the specific tactical steps to reach their intended destination with respect to digital transformation.

Conclusion: The path ahead

Often, in the race to launch the next big digital initiative or implement the latest digital technology, chemical companies can fail to realize their level of preparedness – primary among which is the need of an accommodating culture which promotes flexibility and learning. The digital journey will likely come with challenges that may seem daunting at first. However, how companies respond to these challenges will determine the winners and losers on the digital playground. A properly designed and optimally deployed digital transformation strategy may represent one of the biggest-ever opportunities for the chemical industry, primarily when it is driven by a clear business strategy. In deciding where to play and how to win, there are a host of questions to ask, such as:

- What are the new growth markets and how to reach them digitally?
- How to strengthen existing customer relationships and help build new ones?
- What is the best way to increase brand value?
- Where to extend the company's value proposition to customers?
- How to accelerate the commercialization of innovation?
- How to attract, recruit, and retain the best talent?
- Which new capabilities (data science, marketing, consumer awareness/engagement, multidisciplinary science, etc.) are needed to support lasting value creation?

By embarking on digital transformation, chemical companies can become more agile, innovative, responsive, and efficient. The adoption will likely create more intimate relationships among chemical companies, their customers, and end markets. This collaborative approach powered by the digital will likely help chemicals companies tackle the issues of tomorrow more holistically. The Digital maturity model, highlighted in this paper, can serve as the backbone for such a collaborative approach, empowering firms to navigate, select, prioritize, and integrate the right digital initiatives.

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