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Commentary
The road ahead: Digitalization fuels innovation

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Today, chemical companies are facing an increasingly challenging environment. Markets require more holistic solutions instead of focus being solely on the development of new molecules or products. Climate change, resource scarcity, technological advances, and rising customer expectations are forcing chemical companies to adjust to new realities, with the result that many are restructuring, increasing customer focus, and, perhaps most importantly, creating distinctive capabilities that will provide a competitive advantage. These challenges, however, also offer new opportunities for growth. According to a survey by PwC, 71% of CEOs in the chemical industry believe there are more opportunities than there were three years ago, indicating that they are expecting – and gearing up for – a high pace of change.

There has been much discussion about the so-called digitally-based Fourth Industrial Revolution. With the advent of mobile super-computing, artificial intelligence, genetic and neuro-technology, dramatic change is taking place at unprecedented speed. The chemical industry is undoubtedly an important enabler of this revolution, since its contributions in the way of new chemicals, advanced materials or bio-based products to many other industries is often the starting point for developing innovative, high performance product solutions.

Sustainability issues like resource efficiency, waste avoidance, renewable energy and the circular economy, driven by dwindling resources, a growing population and a more aware middle class, are becoming increasingly important. This development requires a paradigm shift in how chemical companies operate. The traditional, incremental approaches to change no longer enable the industry to achieve time-related and technical goals due to increasing regulation, political targets, public opinion and the pace of technological development. These new requirements necessitate more holistic approaches along the whole value chain, extending beyond sectorial or geographic borders. Cooperation between international and interdisciplinary teams will be vital and might even include publicly funded consortia. Today, chemical companies operate in a tightly interconnected ecosystem of various partnerships, including academia, technology providers, start-up companies, suppliers and customers. This ecosystem of collaboration will become even more critical in developing innovative, holistic solutions in the future. Chemical companies must foster flexibility in order to complement internal capabilities with external ones. Chemical Boards and top management teams also need to overcome concerns about intellectual property, data ownership and confidentiality in order to avail the full potential of ecosystem of collaboration. This current ecosystem will increasingly lose its perceived linearity along the product value chain and will comprise a rising network of companies, countries, governments, industrial clusters, financial institutions, delivery infrastructures, logistics and information technology. Digitalization will be the glue that holds this and other ecosystems together.

Although the chemical industry might not be top of mind when the influence of digitalization is discussed, it will fundamentally alter the way it operates. The global chemical industry has reached a crossroads and the catalyst is Big Data and next generation analytics, which will impact everything from innovation and manufacturing to pricing and marketing. This change should be accepted by the industry as transformational.

Historically, chemical companies have been slow to adopt and implement the latest technologies, preferring to focus on core operational and financial improvements such as optimization of assets and yields, operational efficiency and productivity, rather than disruptive ones.

Now, however, with Big Data, real-time analytics and modelling, many chemical companies are starting to develop highly innovative holistic solutions, witnessing a new dawn of collaboration and integration across silos of all manner of internal

departments and external partners. One of the most significant impacts will be how Big Data will enable companies to transform from being organizations that react to changing market demands to ones that anticipate change and help to create it. In chemical research and development, high-end technology and digitalization – including miniaturization, automation with robots and high-throughput experimentation – will create vast experimental data on a 24/7 basis. The connectivity between people and machines will increase, and there will be a transition from experimental design based on human expertise and creativity towards "in silico " predictions, analysis of data by artificial intelligence and new working hypothesis provided by cognitive systems. It will allow the identification of correlations between parameters not necessarily supported by scientific data, but rather based on the unlocked hidden information in data from customers, suppliers and other partners, which are all connected and enable real-time design of new solutions. According to the consulting firm KPMG, the traditional three pillars of a modern business — people, process and technology — should be increased to five with the addition of data and analytics.

These two new pillars will give rise to new types of job profiles and experts sought. Data scientists, digital project engineers, specialists across digital manufacturing, risk security, cloud architecture & infrastructure, control networks (SCADA), robotics and Progressive Web applications are only few examples of job positions currently offered in the chemical industry and other industries. To advance the skills needed in the chemical sector, a combination of recruiting fresh talent from outside the industry - including digitally savvy professionals - as well as recent graduates, plus updating the skills for operational staff already within the industry by targeted training on the job, special coaching and focused assignments to interdisciplinary project teams, is required. Failing to recognise the need to hire cutting edge, technology-relevant talent and benignly ignoring to promote the skills of an existing workforce are the most common pitfalls in unsuccessful transformations. In any industry, people are the most important assets, and when it comes to implementing digital transformation strategies, people are even more important. The trepidation in the chemical sector is that the skills required for this new digital age differ immensely from what has long been the traditional skillset - and they often reside with a younger generation. The required skillset of employees in the chemical industry differs, indeed. However, the traditional skillset with its basis in a sound education in chemistry or engineering sciences will still be indispensable.

Millennials dislike rigid corporate structures and want open collaboration rather than a siloed approached to working. They view the workplace as being built around tasks and projects where teams may have no formal leader, instead leaving decision making to whoever has the relevant expertise, rather than top-down decision making. From a "softer" employment perspective, the power of the chemical employer brand shouldn't be underestimated. In a study undertaken by Cone, a staggering 76% of digitally savvy millennials surveyed were seeking employers with corporate social responsibility (CSR) values that matched their own. As Bob Dudley, CEO of oil and gas major BP and a key representative of the process industry, commented: "The millennial generation don't just want career growth, they also expect to make a positive contribution to society." Therefore, it has become important for major chemical companies to communicate to millennials about how their transformational strategies will lead to a cleaner environment and innovative health solutions.

According to a study by MIT Sloan Management and Deloitte, there is some evidence to suggest that digitally maturing organizations have cultures which actively motivate employees to engage in efforts to encourage risk taking, agility, and collaboration. And, in the survey referenced earlier, Deloitte's research shows that digital technology is likely to contribute to fostering a culture where innovation is promoted.

Organizational agility and fluidity in teamworking and the ability to innovate in a rapid, iterative, "fail-fast", test-and-learn approach is seen as the way forward, rather than the old test-to-destruction method, with cascading layers of approvals.

As a case in point, Clariant, as a leading specialty chemicals company, has already made significant efforts in terms of breaking down traditional constructs, silos, old ways of working and existing structures – some of which are now part of daily work life and others as experimental tools aimed at deriving at new solutions. Interdisciplinary teams are now an integral part of our approach. Our research and development is based on four technology platforms working closely together with the business units, serving the broad range of Clariant's target market and industries. Methods incorporated, such as 'agile working', 'Design Thinking' or 'hackathons', are well understood and already established in other industry sectors - especially within IT. While our employees may originally come from more hierarchical and organizational level organizations, the key hiring prerequisite now is the right mindset in terms of openness to new ways of working together – both with internal and exter-

nal partners. Cooperation within and among interdisciplinary teams and the ability to embrace different opinions will undoubtedly result in the best possible solutions.

In summary, the challenges faced by the chemicals industry are not about re-inventing chemistry. Chemistry is, and always be will be, a key and very versatile enabler for tackling future challenges across a multitude of industry sectors. The more important issue is about maximizing the synergies that chemistry has within any productive ecosystem, in conjunction with other relevant and productive disciplines. Beyond product and process innovation, this includes service and business model innovation, with digitalization driving those developments and tremendously speeding up the process.

Such demands need to be reflected in the scientific education of tomorrow's employees. Required excellence across both basic and expert knowledge - chemistry, catalysis, biotechnology, process technology and engineering science - needs to be progressed through advanced mathematical teaching methods combined with informatics. Systemic thinking and data analysis are competencies that, together with basic knowledge in economics, will complement the traditional disciplines. The establishment of interdisciplinary projects linking the boundaries of chemistry, biochemistry and physics with digital technologies can foster confidence to explore beyond one's own comfort zone and begin to act as heterogeneous teams. In this regard, the intensification of fundamental and applied science in close collaboration with the industry is of particular importance in order to be well trained for the future career challenges in the chemical industry.

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