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Chemicals 4.0

Industry digitization from a business-strategic angle

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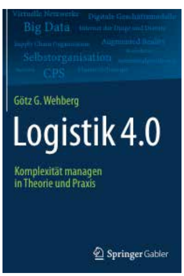

Content

In a nutshell – 11 hypotheses on Chemicals 4.0

To give a quick overview on Chemicals 4.0 and its potentials, we have summarized eleven hypotheses in the following:

1. A range of factors determines competitiveness

Many trends (global market shift, consolidation, etc.) and uncertainties (Euro zone stability, oil & gas price, etc.) determine the development of the German chemical industry. Industry 4.0 is one of them. In order to maintain competiveness in the future, these key factors have to be considered in a joint project with all relevant stakeholders.

2. Chemicals 4.0 has a double impact

Chemicals 4.0 has a strong impact on the industry. It changes operations, businesses and rules of competition. Beyond digitization, however, it also provides solutions for responding to other key trends as a facilitator. Examples are smart solutions for energy efficiency and individual offerings for changing customer behaviour. Chemicals 4.0 accelerates the development of the industry and brings it to the next level.

3. Chemicals 4.0 is more than technology

New technologies such as cyber physical systems, low cost sensors and additive manufacturing are important enablers. However, Chemicals 4.0 needs to be viewed through business-strategic glasses in terms of efficiency and growth. It means tapping new potentials and building new business cases rather than happy engineering.

4. Digitization is not fully leveraged yet

The German chemical industry is keen on digitizing its business. However, many companies are focusing on reproducing existing processes as-is in an electronic fashion (omni-channels, sourcing platforms, HR portals, etc.). Opportunities for developing new operating as well as business models are not being addressed, comprehensively.

5. New Verbund has to be developed

The Verbund strategy has always been a central element of competitiveness. And it will be in the future. However, such competitive edge is not set in stone. Portfolio development strategies have questioned integrated business models. The German Verbund has to develop towards a New Verbund and consider Industry 4.0 technologies, accordingly.

6. Data based operations help to master complexity

Data based operating models do leverage on predictive analytics, resilient network structures as well as self-organisation. Such operations are best prepared to anticipate new market developments. They are most appropriate to efficiently respond to market complexity of the chemical industry with means of flexibility and scalability of resources.

7. Boundaries of chemical companies are shifting

In a Chemicals 4.0 environment, outsourcing becomes much easier, as new technologies support a more seamless integration of contractors and a higher transparency of their performance. As result, make-or-buy decisions are shifting towards both a higher number of facilities being serviced by contractors as well as a larger scope of activities taken over.

8. Chempark operators need to provide Industry 4.0 infrastructure

Site operators are requested to provide proper infrastructure solutions for smart operations as well as on-site connectivity. They have to support transparency as well as self-organized coordination through the Internet of Things. They have to facilitate synergies as well as flexibility on an arms lengths basis and through business objects.

9. Digital business supports individualization

Digital business models provide growth opportunities with means of a long tail of customized products and services as well as a differentiated pricing. Open innovation has to support the development of digital business models. This is especially true for market-driven specialities, but not necessarily excluding asset-driven commodities.

10. Just any kind of online presence is not good enough

Many chemical companies want to leverage on the Internet just somehow. To systematically develop a digital business, however, comprehensive strategy and specific digital services are needed. For instance, chemical companies have to position as aggregator or fight against it with means of individualized offerings and pricing.

11. There is no Chemicals 4.0 silver bullet

Compared to other sectors such as Financial Services, the impact of Chemicals 4.0 within the industry will materialize in small steps and in the mid term. It develops in an evolutionary fashion rather than a "big bang". The German chemical industry has to define and organize its evolution path, accordingly.

1. The 3Ps – Predict, prioritize and pursue Chemicals 4.0

More than anything else, two questions drive the current discussion within the German chemical industry: How to maintain global competitiveness of the German chemical industry? And how to make use of Industry 4.0, accordingly? This publication wants to respond to these questions by outlining the way to digitization of the industry from a business-strategic angle.

The current digitization of the German chemical industry is below average.[1] It is clear, however, that the impact of Industry 4.0 will be significant. Industry 4.0 has to be considered, urgently, and needs a systematic approach. Against this background, this publication is summarising the following three guiding principles:

Predict – Understand the impact of Chemicals 4.0.
Prioritize – Prioritize the levers to get the maximum out of it.
Pursue – Implement Chemicals 4.0, comprehensively.

Of course, Chemicals 4.0 is not the only trend that determines competitiveness. However, Chemicals 4.0 is doing both driving digitization as well as facilitating a proper respond to many other trends of the industry.

In order to manage expectations properly: This publication is a kind of first draft rather than a final answer, which means we will further work on this topic, add more examples and refine it. It builds on teamwork rather than one-man exercise, which means we have to give credits to the stakeholders who have contributed. And it represents a business-strategy point of view rather than an engineering perspective, which means it aims at fuelling the discussion of the CEO agenda.

For the beneficial discussion, I would like to say a special thank you to Stefan Feld, Dr. Werner Kreuz, Dr. Sven Mandewirth and Dr. Stefan Silber as well as Dr. Wolfgang Falter and Dr. Thomas Herp. Also, I have to thank my lector Susanne Kramer. Without all of their support, this publication had not been written.

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[1] TNS, Monitoring-Report Wirtschaft DIGITAL, Munich 2015.

2. Industry 4.0 and a New Verbund

2.1 Business strategy instead of happy engineering

Industry 4.0 is currently being discussed extensively within the German chemical industry. However, is this something new or just a new label for some well-known solutions? IT has always been important, hasn`t it? And what about the chemical industry? Does Industry 4.0 also apply to this sector with its different nature of production? Or is it limited to Automotive and Manufacturing? In order to understand the impact of Industry 4.0 for the chemical industry it is best to discuss this concept from a market perspective, not just from a technical point of view. Other countries such as the USA with the Industrial Internet Consortium (IIC) show high ambitions too. If Germany wants to keep its pioneer role in Industry 4.0 as well as its lead in Chemicals there is not so much time for "happy engineering".

It is clear that chemical markets become more complex. Industry trends like global demand shift and commoditization are the drivers of this development, which the chemical industry has to respond to. In addition, uncertainties such as political instability and pandemics as well as "wild cards" such as terror attacks and infrastructure breakdowns challenge the value chain of the chemical industry. Twenty years ago, studies showed that such development causes significant higher need for coordination within the chain.[2] If Chemical companies do not respond properly a lack of integration as well as competitive disadvantages will be the result, conclusively.[3]

Against this background Industry 4.0 provides the opportunity to drive integration and strengthen competitiveness of chemical companies. Industry 4.0 means to managing value added networks, flexibly and comprehensively, while leveraging on new technologies such as cyber physical systems (CPS), cloud computing, low-cost sensors and additve manufacturing.[4] CPS and other technologies are thus a necessary precondition, however, applying these technologies alone is not necessarily sufficient in terms of its commercial viability and strategic fit. While a kind of happy engineering was motivating the Industry 4.0 discussion at the beginning, it is important that its value added and competitive impact will be focused for the future. Moreover, the specific characteristics of the chemical value

[2] Warnecke H.-J., Die Fraktale Fabrik, Revolution der Unternehmenskultur, Berlin u. a. 1992; Wehberg G., Logistik-Controlling, in Jöstingmeier B. et al., Hrsg., Aktuelle Probleme, Göttingen 1994, S. 73–134; Wildemann H., Die Modulare Fabrik, 4. Aufl., München 1994.

[3] Klaus P., Jenseits der Funktionenlogistik: Der Prozessansatz, in: Isermann H., Hrsg., Beschaffung, Produktion, Distribution, Landsberg/Lech 1994, S. 331–348; Wehberg G., Logistik-Controlling, in Jöstingmeier B. et al., Hrsg., Aktuelle Probleme, Göttingen 1994, S. 73–134.

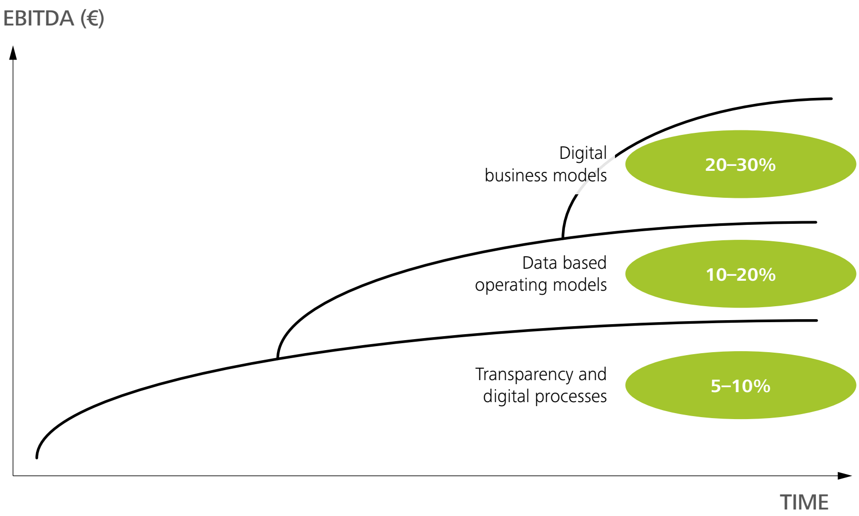
[4] Wehberg, G., Logistik 4.0, Berlin/Wiesbaden 2015.

chain have to be considered. The chemical industry is typically characterized by a continuous production, opposed to a discrete production of other industries such as Automotive and Manufacturing. Furthermore, the business of chemical companies is characterized by high asset intensity as well as high logistics and energy cost.

2.2 Three approaches to digitization

In the following, we will highlight three approaches of the Industry 4.0 for the chemical industry. It is the successful transformation of the chemical industry that Chemicals 4.0 stands for, in line with these three approaches. These are transparency (incl. digitization of existing processes), data based operating models as well as digital business models (Fig. 1). The logic of the three approaches has been developed based on the experience of many industries being digitalized. It can be transferred to the chemical industry as long as specific industry characteristics are being considered.

Fig. 1 – Approaches and potentials for the digitization of chemical companies[5]



[5] Wehberg, G., Die Triple Long Tail-Strategie, (www.TripleLongTail.com) Köln 2015.

The approaches shown in Figure 1 do add to each other and are cascaded which means digital business models require data based operations as well as transparency. While new digital business models show the highest financial impact many chemical companies are still in the transparency stage today.

For the chemical industry, Chemicals 4.0 is a new management concept that leverages on Internet technologies, comprehensively. It is the answer to what Industry 4.0 means for the chemical industry, however, not limited to it. It also provides support for responding to other challenges, like CO2 emissions and German "Energiewende". This multi-solution character makes Chemicals 4.0 so relevant and brings it on the CEO agenda of chemical companies. It brings chemical operations and businesses to the next level. Moreover, it potentially enforces selected key trends such as individualization of customer behaviour and market consolidation. Therefore, Chemicals 4.0 is an accelerator of market dynamics of the industry.

What does this mean for the German Verbund strategy? Focused business models are increasingly replacing integrated ones. The current portfolio development of the chemical industry – due to the global demand shift, commoditization, market consolida-tion and so forth – challenges the traditional Verbund. Here, Chemicals 4.0 offers the concept of a New Verbund. In addition to the central management of vertical and horizontal synergies, a more self-organized coordination through the Internet of Things (IoT) gains traction and facilitates synergies as well as flexibility on an arms lengths basis and through business objects. The Verbund develops from a focus on site synergies to value chain networks, and from corporate boundaries to virtual partnerships, accordingly.

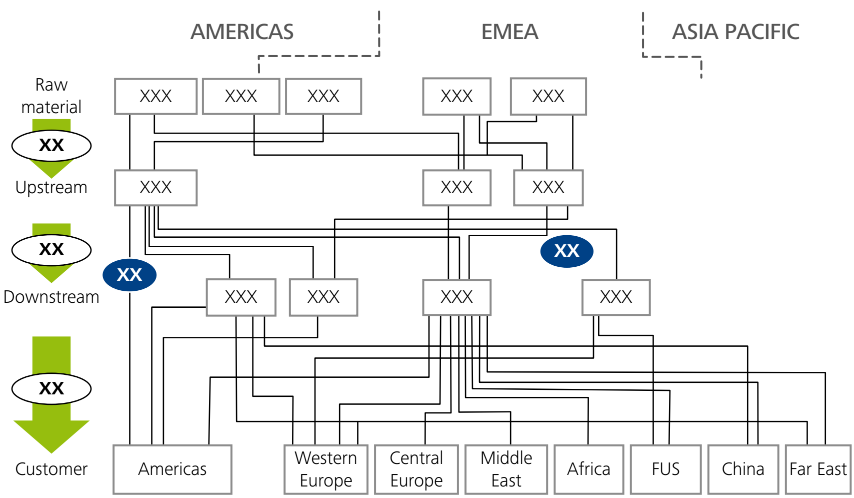
3. Enhanced Verbund transparency

For driving digitization of chemical companies, it is first of all self-evident to facilitate relevant processes in an electronic fashion and to increase transparency as well as efficiency by doing so. This kind of digitization has already been happened in the past decades and is still ongoing within the German chemical industry. Examples are EDI standards of Order Processing, omni-channels of Sales, employer portals of HR, sourcing platforms of Procurement and so forth. However, the technologies of Industry 4.0 offer new possibilities for going even over and beyond the current status. Sensor technology has become low-cost, cyber-physical systems are connecting everything and connectivity based on cloud computing has increased significantly. There is an additional Industry 4.0 potential for creating even more real-time transparency in chemical operations. This allows to facilitate continuous improvements in terms of automation of processes as well as alignment of interfaces. Having said that, transparency in the Verbund of chemical operations is relevant on three levels: the overall network, inter-sites as well as on-site.

3.1 Overall network level

On an overall network level, chemical companies typically do have complex relationships with suppliers as well as customers on a global scale with intense logistics and high regulation requirements such as customs. Figure 2 provides a sanitized example of a global production network of a Speciality chemical company.

Fig. 2 – Example production network of a Specialty chemical company (in tons, sanitized)



The example shows the network of just one business unit, but represents already a complex structure of production steps, sites, companies, countries, regions and relationships. Developing real-time transparency of such network with means of Industry 4.0 technology allows to tracking and tracing customer and production orders on a day-to-day basis. From a strategic point of view, it supports managing the global demand shift and network adjustments associated with it. And it also provides the basis for continuous network improvement, for example:

- Closing and/or relocating existing sites
- Moving selected production steps or assets
- Dedication of certain production lines to rush orders
- Deployment of postponement strategies
- Reduction of working capital or inventories
- Developing supplier networks
- Responding to new regulation like TTIP
- Tax optimization of the value chain network
- Outsourcing of specific activities such as maintenance
- Offshoring of certain steps of the value chain

Therefore, transparency about the flow of goods as well as information associated with it is a conditio sine qua non. While RFID was a first step for gaining transparency along the value chain, new technologies of the Industry 4.0 allow further progress on a comercially viable basis.

3.2 Inter-sites level

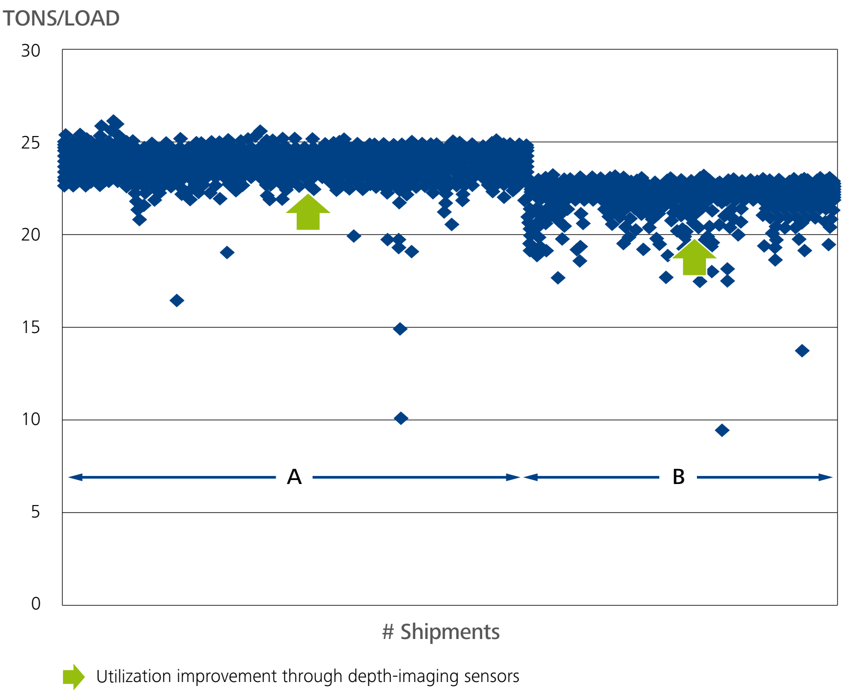
Transport-sourcing

On an inter-sites level, many chemical companies have outsourced transports of materials, semi-finished and finished goods already, as a response to commoditization and cost pressure. Traditionally, the typical way of outsourcing is to select one transport service provider for a predefined region and thus to cover shipments for this region. More advanced transport-sourcing practices for contracting service providers suggest to auction services on a lane-by-lane basis rather than strategically source it for entire regions. Low-cost sensors together with transport management software help to do this even in a real time mode. Against this context Industry 4.0 technology is a facilitator and helps organizing sourcing platforms with means of business objects and on-demand procedures.

Logistics operations

Moreover, Industry 4.0 technology helps to enhance logistics operations. For example, load capacity utilization of transports is being monitored and increased. For doing so, two depth-imaging sensors have to be installed above the loading space in order to perform 3D measurement of the defined area and release trucks as soon they are fully loaded. Such sensor appliances have already been field tested by logistics service providers. In many instances, this allows to improve utilization factors and decrease related cost by around 5–10 percent. Next to commercial viability, sustainability advantages and CO2 emission reductions in particular are also beneficial. Figure 3 illustrates an example of a transport utilization plot of a chemical company between sites.

Fig. 3 – Example plot of transport utilization between sites (sanitized)



Further logistics operations that are being supported are picking, transport packaging, container lending, loading ramp management and route planning amongst others. For instance, RFID or other sensor technology helps to identify waggons that are being provided and charged by rail transport operators. If chemical companies do not monitor and send such waggons back on time, this comes at a high cost. Sometimes, improvements are as simple as that.

3.3 On-site level

In addition, the chemical industry is capital and energy intense. The effective utilization of production assets as well as its energy efficiency are crucial success factors on-site.

Operational Facility Effectiveness

Utilization of chemical production is determined by downtime, performance and quality of production. Industry 4.0 technologies help to monitor these underlying drivers properly. As soon the bottlenecks of production are transparent, a rigorous de-bottlenecking and OFE (Operational Facility Effectiveness) management create value to the chemical company by increasing output or avoiding capital expenditures for capacity expansion.

Figure 4 shows an example for the OFE analysis of a production facility in Specialty Chemicals. Downtime, performance and quality data are collected via sensors or separate interfaces and consolidated in real-time. Given the actual effectiveness of 92 percent, there is significant room for improvement. In this example, the analysis suggests that root causes for OFR losses are a reduced speed of the production process, a fire in the workshop, process waste and raw material issues. As far as behavioural route causes are being identified, OFE cockpits are supporting visual management on the shop floor.

Although, for many chemical companies OFE management is not new, low-cost sensors bring it to the next level. Bringing it from a paper-based to an online connectivity helps as it facilitates participation and small learning loops of production staff amongst others. Moreover, the review of run-time availability at 100 percent often is an eye-opener.

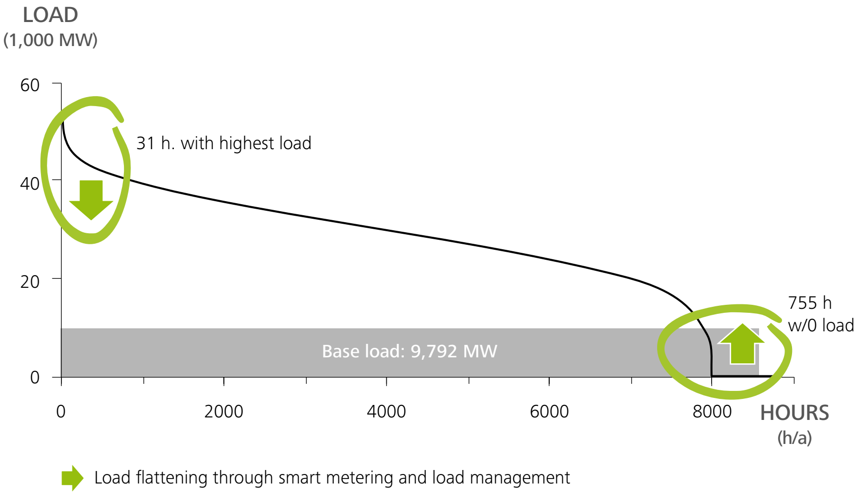
Fig. 4 – Example OFE diagram of a production facility (in tons, sanitized)

Energy efficiency

Energy efficiency is no new topic for the German chemical industry, but driven by the German energy regulation ("Energiewende") as well as volatile oil and gas markets since many years. Structured sourcing of energy, recycling through heat exchangers, energy efficient facility management, leverage of tax exemptions where possible, all this is well known and fully leveraged in many such companies. More advanced energy practices, however, go further. They leverage on the emerging market of service providers for energy efficiency and the difference of capital cost associated as well as demand management amongst others. Specifically, the combination between energy load management as well as production planning and control (PPC) creates value if peaks in energy consumption are being avoided. Production has the highest energy share of corporate consumption. Figure 5 provides an example of a sorted load profile captured via smart meters, accordingly.

For both instances, outsourcing as well as green production, an intelligent PPC including smart energy solutions is a facilitator as it helps to track the performance of service providers as well as peak consumption. Besides energy efficiency, the efficient use of other resources as well as feedstock is being supported.

Fig. 5 – Example of a sorted load profile (in MW, sanitized)



Chempark operations

Given the German Chempark landscape, site operators like Currenta are requested to provide proper infrastructure solutions for smart operations as well as on-site connectivity, accordingly. Considering the high cost of assets, logistics and energy of chemical companies, the investment in Industry 4.0 technologies for creating sufficient real-time transparency pay off in many cases. However, all investments need to be evaluated case-by-case. Although it is a value driver per se, transparency alone is not sufficient to respond to the increasing complexity of chemical markets. Here, data based operations enter the stage.

4. New Verbund operations – data based operating model

The New Verbund in terms of a data based operating model goes beyond transparency and leverages on big data as well as on a flexible organisation. This kind of operating model does not just reproduce the status of processes digitally. It develops it with means of new technologies in a qualitative way. By doing so, it responds to complex market requirements and prepare for unforeseen events even more appropriately. DHL, for instance, has improved its resource planning by recognizing that flu waves in Germany cause sickness of employees, which then surf and shop online and cause a higher demand for CEP services as well as flexibility of resources.[6] Besides pattern recognition, resilient networks as well as self-organization characterize data based operating models.

4.1 Pattern recognition

Big data and predictive analytics

The amount of data that are digitally saved and available online is increasing significantly over the years.[7] From approx. 10 Exabytes in the year 2000, the corresponding data volume grows to expectedly 10.000 Exabytes by 2020. This is where the expression "big data" comes from. Also, the capacity to gather and analyse data expands heavily. The global number of connected objects, for example, will grow from 10 bil. (primarily mobile devices) to some 100 bil. in the upcoming 10 years while the industry share within that number over-proportionally increases from about 25 to 50 percent.[8] Data based operating models aim at leveraging these new possibilities of data gathering, saving and analyses in order to generate value by better understanding, forecasting and managing the behaviour of suppliers, customers and competitors in the chemical industry amongst others. Conclusively, the data based operating model does not aim at collecting as much data as possible but using the right information. For the same reason, it is important to focus at improvement potentials of operations as a starting point, rather than data availability.

In chemical markets a comprehensive analysis of all relevant information in very detail often is not possible. Because of its market complexity and its dynamics in particular, too much analysing is paralysing. Instead of detailed research of all data in scope recognizing relevant patterns is more appropriate. Patterns recognition reflects on the basic behaviour of a system

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[6] Kückelhaus, M., Big Data in Logistics, Bonn 2013; Innovation Center DHL, Bonn 2015.

[7] Hilbert M., López P., The World's Technological Capacity to Store, Communicate, and Compute Information, in: Science, 332 (2011) 6025, S. 60–65.

[8] IHS Technology, (technology.ihs.com) 2015.

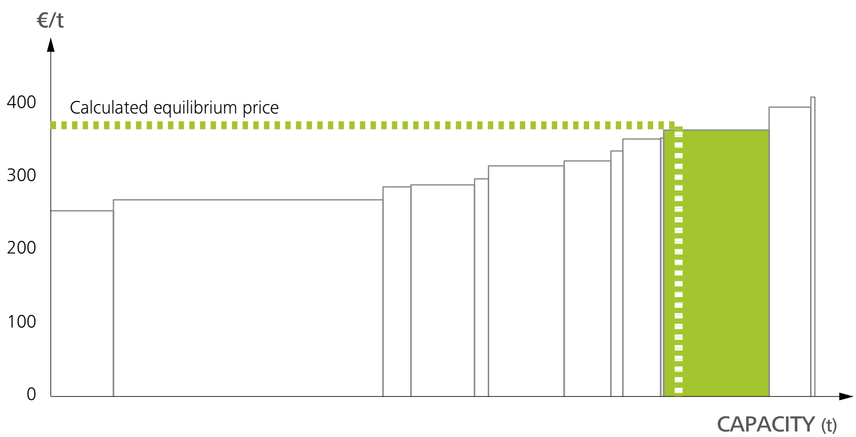
in order to predicting the future (predictive analytics).[9] It refers to probabilistic rather than deterministic methods.[10] Therefore, business intelligence software such as HANA from SAP and SPSS from IBM do offer comprehensive statistics. At the same time, skills in predictive analytics alone are not sufficient but need to liaise with operational know how of the chemical value chain to really be effective.

Having said that, chemical companies have to make themselves familiar with relevant patterns as to both strategic factors as well as operations:

Strategic decision making

Predictive analytics help to understand market behaviour from a strategic angle. They refer to pricing, service and product specifications, and channel as well as lifecycle management amongst others. Here, predictive analytics become a facilitator for understanding customer behaviour and driving customer intimacy as well as innovation. It is also supporting investment decisions by forecasting demand and understanding its underlying drivers. Capital expenditures in the chemical industry, therefore, primarily depend on supply-demand scenarios, which Figure 6 provides an example for.

Fig. 6 – Example for a supply-demand scenario (sanitized)



9 Ulrich H., Probst G., Anleitung zum ganzheitlichen Denken und Handeln, 3. Aufl., Stuttgart 1991; Weick K. E., The Social Psychology of Organizing, New York u. a. 1969.

10 Hereto and to the following Wehberg G., Logistik 4.0, Berlin/Wiesbaden 2015.

Supply-demand scenario analyses aim at explaining the industry game of a certain segment of the chemical market. Besides demand, supply curves are explaining the current and future price level of a market in an equilibrium state. Supply curves are being built by mapping the competitive field of plants and unit cost associated. Next to the identification of the underlying drivers, it is beneficial for understanding inter-relationships with investment decisions of competitors.

From an operations standpoint, at least four application fields are relevant to predictive analytics: Production, Maintenance, S&OP and Procurement.

Optimization of production output

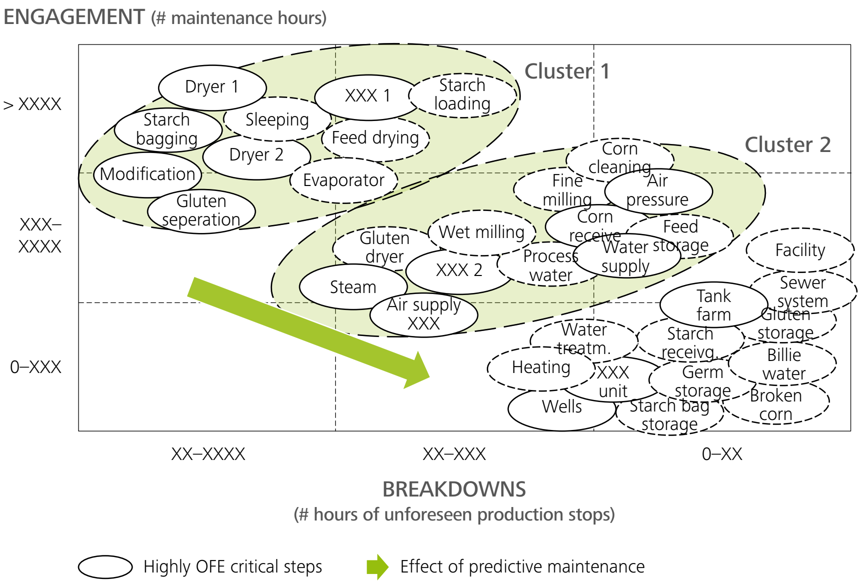
First of all, why predictive analytics help to secure quality of products? Process optimization in the chemical production often is empirical just because chemical reactions are rather stochastic than deterministic and materials are not always fully standardized (e.g. the targeted proteins within bio-technological processes). Typically, a range of factors does influence the output of the chemical production process, amongst others the concentration, temperature, volume and quality of materials as well as speed, lengths, intensity and technology of the process. This is especially true but not limited to the combined production of by-products with elastic output. Under such circumstances product quality is characterized by an equation with multiple factors as input. And different equations of by-products depend on each other. Although the degree of automation of the chemical industry is already high, Industry 4.0 technology in terms of embedded sensors measure relevant factors even more comprehensively. While finding the factor-combination that offers best product quality and highest commercial viability requires a lot of experience, it has to be supported by big data. Predictive analytics is thus a facilitator for product quality in the chemical industry.

Predictive maintenance

Secondly, the quality of production facilities determines maintenance efforts. Predictive maintenance leverages on low-cost sensors and pattern recognition to better understanding the life cycle of production facilities and its maintenance needs, opposed to time-based maintenance. This ensures that resources are applied to the critical elements of the plant's operations on time. And it makes asset simulations much easier. This is especially true for moving parts in production such as pumps, compressors or other motors, however, basically relevant to all facilities that need maintenance.

Figure 7 shows an example for a maintenance intensity matrix of a starch producer that provides relevant information. Turning unplanned shutdowns into planned shutdowns is an important lever for improving commercials of maintenance as well as utilization of production. Bayer together with Evonik, they are currently checking out hundreds of valves in production to better understand their lifecycle, enhance production control and feedback to suppliers for potential construction improvements.

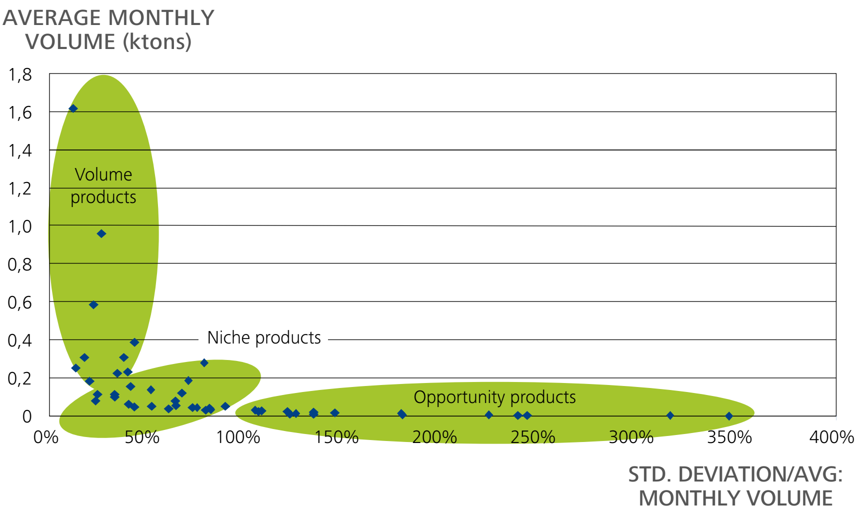
Fig. 7 – Example for a maintenance intensity matrix of a starch producer (sanitized)



Predictive S&OP

Thirdly, pattern recognition helps to understand the development of chemical markets by identifying patterns of customer behaviour or enhancing forecast accuracy with means of a predictive S&OP.[11] Figure 8 shows a segmentation of the product portfolio of a Specialty Chemicals company. Taking into account both the volume as well as volatility of demand, chemical products have to be categorized for volume, niche and opportunity products. While the demand of volume products is easy to predict, the focus of predictive analytics is on niche and opportunity products whose demand is volatile and typically includes rush orders.

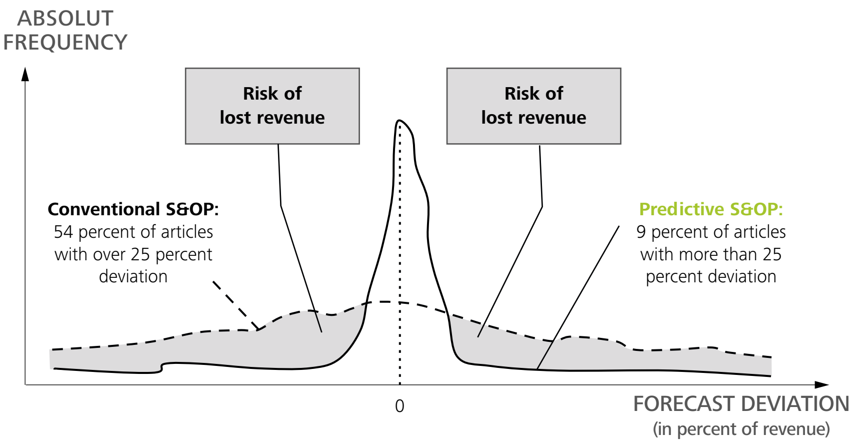
Fig. 8 – Example segmentation of the product portfolio of a Specialty chemical company



[11] Wehberg, G.: Logistik 4.0, Wiesbaden 2015.

Predictive analytics, then, is trying to identify relevant patterns in terms of underlying drivers of such demand within the chemical industry. Integration with customers` operations often is not good enough, so that in this case chemical companies have to consider end consumer behaviour as source of volatility. Figure 9 shows an example of the effects of predictive S&OP, accordingly. Another example for predictive market analysis is Agro Chemicals, where production considers weather forecasts amongst others. And in Petro Chemicals, production outputs are optimized from a value pricing perspective across several steps of the value chain.

Fig. 9 – Example for a predictive S&OP[xii]



Big data in procurement

Last but not least, predictive analytics drive performance of procurement in terms of both developments of category strategies (e.g. forecasting commodity risks and internal demand) as well as internal sourcing procedures (e.g. supporting material re-classification and reducing maverick buying).

Of course, predictive analytics in operations are not limited to before mentioned application fields. Further applications are potentially relevant in SHE (Safety, Health and Environment), Employer Branding, Customer Loyalty and so forth.

[12] Wehberg, G.: Logistik 4.0, Wiesbaden 2015.

It is extremely helpful if chemical companies predict future changes and prepare, accordingly. In case predictive analytics do not help, flexibility is required even more. Therefor, resilient network structures as well as self-organization are further characteristics of the New Verbund operations. Only the three of them together, pattern recognition, resilient structures and self-organisation, provide sufficient flexibility to respond to very high complexity, properly. The higher demand volatility and the more disruptive the changes, the more value the New Verbund operations bring.

4.2 Resilient networks

In a way, New Verbund operations have to be a "generalist" to cope with complexity. Because a generalist is able to do a lot of things properly and is flexible. Some flexibility comes from a flexible resource planning, adaptive shift models and the development of human resources. Also, an agile IT as well as service oriented architecture help. Another big part comes from resilient network structures, which builds on cooperation with third parties on demand and outsourcing to the right extend.[13]

In the past, many chemical companies have relied on integrated business models with full control along the chain, whereto the idea of a resilient network did not necessarily fit best. As market consolidation and portfolio development move on in the future, resilient networks will become more important with shared values, stronger outsourcing and a flexible geographic design in particular at the heart of it.

Safety fences

Shared values do enhance the flexibility of the network when different behaviours of market participants are being tolerated.[14] For example, BASF is focusing on a culture of entrepreneurship, openness and diversity. The development and maintenance of such open minded and cooperative culture makes a difference in a turbulent environment and Industry 4.0 in particular. The importance of shared values for the chemical industry, however, also derives from the fact that within New Verbund operations the normative management on the one side and the operational real-time area of machines and material flows on the other side are de-linking.[15] In this situation, leadership and steering primary work indirectly, so to speak via "safety fences" which are being set by corporate values and cultural norms in particular. Many chemical companies have to rethink their style of leadership, accordingly.

[13] Hereto and to the following Wehberg G., Logistik 4.0, Berlin/Wiesbaden 2015.

[14] Simon, V., Soziale Unternehmensentwicklung, in: Seidel, E., D. Wagner, Hrsg., Organisation. Evolutionäre Interdependenzen von Kultur und Struktur der Unternehmung, Wiesbaden 1989, S. 339–352.

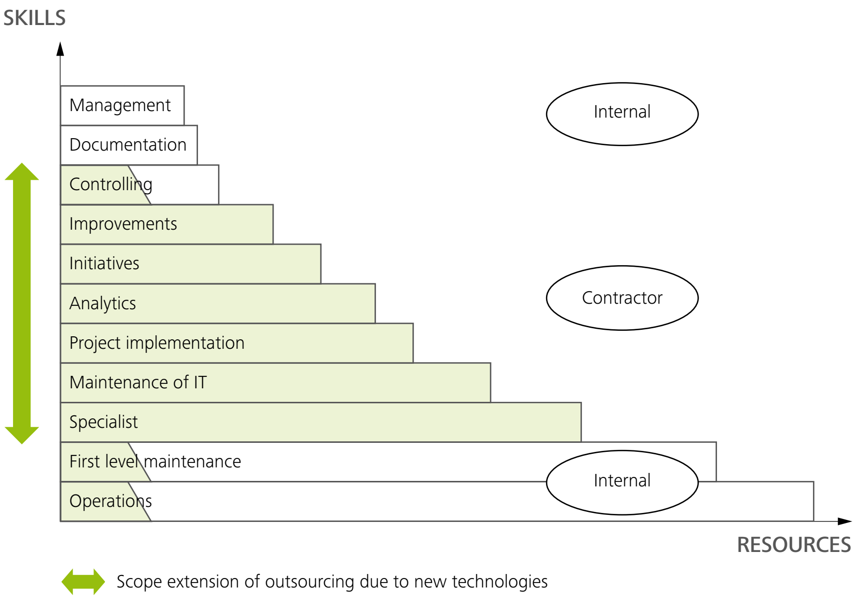
[15] ten Hompel M., M. Henke, Logistik 4.0, in: Bauernhansl T., ten Hompel M., Vogel-Heuser B., Hrsg., Industrie 4.0 in Produktion, Automatisierung und Logistik, Wiesbaden 2014, S. 615–624.

Shifting boundaries of chemical companies

Outsourcing in a Chemicals 4.0 environment becomes much easier, as new technologies support a more seamless integration of contractors and a higher transparency of their performance. As a result, make-or-buy decisions are shifting towards both a higher number of facilities being serviced by contractors as well as a larger scope of activities taken over. Figure 10 shows an example of the outsourcing in Refinery, where the scope is being extended to operators as well as controlling and documentation activities because of this.

Outsourcing is a principle of New Verbund operations that applies to the network design of chemical companies, in particular.

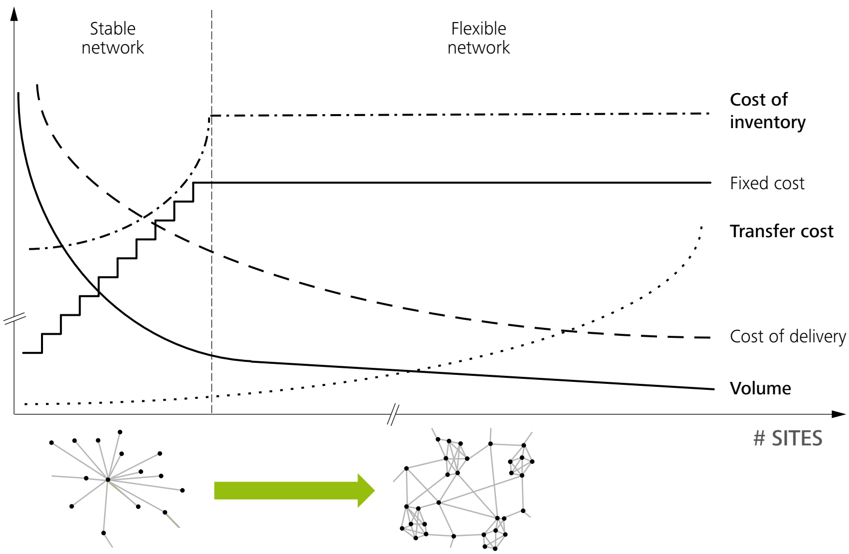
Fig. 10 – Example for the scope of outsourcing in Refinery (sanitized)



Network design by a swarm

The network design of a chemical company is characterized by the geographic layout of its overall value added activities. As per conventional network optimization methods, the primary determinates of such network strategy are resources, work, consumption or transports.[16] Such methods, however, are a bit out-dated when it comes to Industry 4.0. In New Verbund operations, the network design will be formed flexibly and locally. The design is a permanent work in progress. It is not the network as a whole, however, single objects (products, tons, transport means, etc.) within the network that optimize (production lines, routes, sites, etc.) themselves with means of a permanent trial-and-error process. The improvements are being shared with the rest of the swarm or with other objects in terms of learning procedures. The network design of the New Verbund is being built in a differentiated fashion and thus acts in a distributed way with a higher degree of outsourcing, facilitating a high flexibility and scalability of resources (Fig. 11).

Fig. 11 – Flexible network design in the chemical industry 4.0 based on outsourcing[xvii]



[16] Weber, A., Uber den Standort der Industrien, I. Teil: Reine Theorie des Standorts, Tübingen 1922.; Schäfer, E., Die Unternehmung, 10. Auf., Wiesbaden 1980; Stahl, G., Konzeptionsmodelle für zu integrierende Verkehrssysteme – aber welche?, in: Int. Verkehrswesen, 46 (1994) 1/2, S. 43–50; Wehberg G., Ökologieorientiertes Logistikmanagement, Wiesbaden 1997.

[17] Wehberg, G., Supply Chain Management 4.0, Vorlesungsreihe an der IUBH (logistics40.de), 2015.

4.3 Self-organization

Self-organization builds on resilient and flexible network structures for coupling operations processes of chemical companies, effectively and efficiently. The principle of self-organization has already been considered by the concepts of the Fractal Factory of Warnecke and the Modular Production of Wildemann some years ago.[18] Current examples of self-organization are autonomous trucks of Daimler and autonomous parking of Serva. Self-organization, thus, is not limited to production. It basically applies to every step of the value chain including logistics, procurement, innovation and so forth. The more differentiated the product portfolio of a chemical company is the more value self-organization brings to its operations. This is typically the case in the Specialty and Fine Chemicals segment, but not necessarily limited to it. The chemical industry knows self-organisation already from a physical-chemical context of process control. Applying it to organizational processes is not as common as in other industries yet. Having said that, self-organization is characterized by its recursive, autonomous, redundant and self-referential nature:[19]

Self-organization refers to both people as well as objects whereby Industry 4.0 focuses on things and machines. New Verbund operations are characterized by self-organization of specific functions rather than total self-organization. It is still self-organization to a certain extend rather than 100 percent. For this reason, it is always a mixture of people setting a framework and embedded systems executing within that framework with or without staff involved. The scope of self-organisation is being determined by corporate values in particular. Specific control algorithms are defining its behavioural rules. The many times discussed ant algorithm is a metaphor hereof.

4.4 New Verbund functions

Figure 12 summarizes selected characteristics of a New Verbund per function. New Verbund operations provide a better understanding of change requirements and a higher flexibility in particular. In a complex market environment, they realize higher efficiency over and beyond a digital coverage of as-is processes only. This means chemical companies have to operate in a predictive, smarter and more virtual way.

[18] Warnecke H.-J., Die Fraktale Fabrik, Revolution der Unternehmenskultur, Berlin u. a. 1992; Wehberg G., Logistik-Controlling, in Jöstingmeier B. et al., Hrsg., Aktuelle Probleme, Göttingen 1994, S. 73–134; Wildemann H., Die Modulare Fabrik, 4. Aufl., München 1994.

[19] Wehberg G., Logistik 4.0, Berlin/Wiesbaden 2015.

Fig. 12 – New Verbund operations for the chemical industry[20]

Function	TRADITIONAL VERBUND		NEW VERBUND	
	Key focus	Maximum savings	Key focus	On top savings
Logistics	• On site synergies • Multi purpose logistics assets • Initial value chain integration	60%	• Self organized and leveraged • CPS, Cloud based and virtual • Predictive S&OP	10–20%
Energy	• Upstream integrated • Fossil energy • Base load focus	30%	• Leveraging market liquidity • Including renewable and smart • Demand side management	5–15%
Maintenance	• Time based services • Partly outsourced • Frame contracted or insourced	10%	• Predictive and sensor based • Performance related • Scalable and on demand	3–10%
Procurement	• Strategic sourcing • Supplier development • Limited compliance	15%	• Category strategies • Crowd sourcing • Learning Procurement IT	5–15%
Technology	• Push and product focused • Organically • Chemistry and Physics	10%	• Pull and eco system extended • Open innovation • Applications and combinations	10–30%
HR	• Optimization and processes • Resources • STEM* capabilities	20%	• New competences and business • MINT talents • Smart and customer centric	5 – 10%
Clients	• Customer requirements • One face to the customer • Initial value chain integration	30%	• Customers of customers • Crowd based customer service • Predictive demand	10–20%

* Science, Technology, Engineering and Mathematics

[20] Basis: acatech, Arbeitskreis Smart Service Welt (Hrsg.), Smart Service Welt – Umsetzungsempfehlungen für das Zukunftsprojekt Internetbasierte Dienste fur die Wirtschaft. Abschlussbericht, Berlin 2015; Thomas Bauernhansl, Michael ten Hompel, Birgit Vogel-Heuser (Hrsg.), Industrie 4.0 in Produktion, Automatisierung und Logistik, Wiesbaden 2014; Norbert Malanowski, Jan Christopher Brandt, Innovations- und Effizienzsprünge in der chemischen Industrie?; Ralf Reichwald, Frank Piller, Interaktive Wertschöpfung, 2. Aufl., Wiesbaden 2009; Götz Wehberg: Logistik 4.0, Wiesbaden 2015.

In order to summarize more specifically: Logistics has to become self-organized, outsourced and connected in order to address synergies across sites, steps of the value chain, product lines and businesses. To effectively manage market complexity, future demand has to be properly anticipated on a day-to-day basis with means of predictive analytics and an improved S&OP. Energy management has to leverage on enhanced market liquidity of primary energy, renewables and energy services while driving demand management within operations via smart solutions. Maintenance has to anticipate needs, reliably, and proactively act to support effectiveness of production facilities even better. Contractors have to be involved more systematically, on-demand and performance-based rather than time-based. Procurement has to learn with respect to compliance, leverage on crowds and develop category specific strategies. Just doing strategic sourcing is not good enough anymore. Innovation management of chemicals companies has to become pull oriented and eco system extended rather than focusing on product development only. Value added services as well as digital services become a main field of interest with consumers participating in terms of open innovation. HR has to develop real talents with a focus on Chemicals 4.0 rather than managing resources only. And client management in terms of sales and marketing needs to better understand end consumers in order to capture real market needs and predict customer behaviour from a strategic point of view. In many cases, it has to leverage on crowds to operate customer services more efficiently.

Overall, Chemicals 4.0 brings operations of the chemical industry on a next level. Before implementing it, however, many chemical companies have to address potentials that are associated with the traditional Verbund and other best practices. These companies have to ask themselves, whether they want to develop stepwise or attack, aggressively. They have to answer this question for each operations function, separately. In average, the efficiency gains of New Verbund operations reach between 10 – 20 percent of the bottom line. In contrast, new digital business models (New Verbund business) create growth opportunities on top of that.

5. New Verbund business – digital business model

Which kind of growth opportunities through new products, services and capabilities Industry 4.0 offers for the chemical industry? To answer this question it is helpful to understand the core of Industry 4.0 and its underlying technologies. So, what is the real innovation of it from a customer perspective? First of all, digital business models typically do have common characteristics across industries (Fig. 13).

These characteristics, however, do not all apply (to all segments of the chemical industry) to the same extend. So the question is, which kind of digital business model characteristics are more relevant to the chemical industry than others?

Fig. 13 – Selected characteristics of digital business models across industries[21]

	NON DIGITAL	DIGITAL
Market & portfolio	• Competition within industry • Imitation of competitors • Patents as USP • Focused portfolio	• Convergence • Inspiration through B2C • Data and SaaS as USP • "Long tail" offering
Corporate resources	• High value added • Production teams • Bundled resources • R&D team • IT suites and licences • Discounts	• Virtual networks • Democracy of "Makers" • "Swarms" and "crowds" • Open innovation • Service oriented IT • Freemium

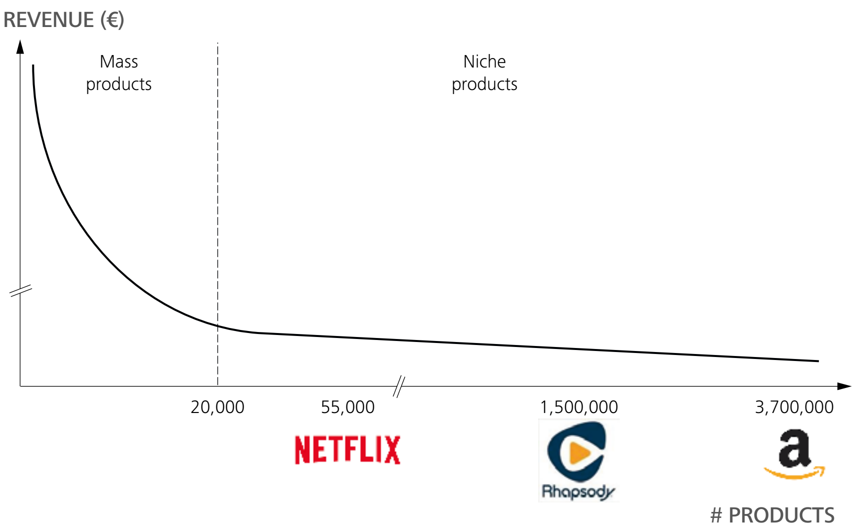
21 Wehberg, G., Industrie 4.0, Vortrag an der Universität zu Köln vom 24. September 2015 (logistics40.de), 2015.

5.1 Customized chemical products in the long tail

The 98-percent rule

An important characteristic of Internet technologies like CPS and Cloud is to lower cost of transaction.[23] Cost to leverage on markets are decreasing. For this characteristic, digital business models are especially suitable to market niche products.[24] For this reason, the classical 80:20 rule (80 percent of revenue with 20 percent of products) does not apply to digital businesses such as Amazon, Netflix and Rhapsody. This kind of cross-industry examples show evidence that a so-called 98-percent rule does apply instead. The 98-percent rule says that a range of niche products generates a significant share of revenue and profit (Figure 14). Amazon has approx. 3.7 million book titles compared to a large book shop with some 100,000 titles. Netflix offers ca. 55,000 movies compared to a conventional video rental service with approx. 3,000 DVDs. Rhapsody provides some 1.5 million music titles compared to Walmart with some 55,000.

Fig. 14 – Long tail of niche products[xxiv]



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[22] Wehberg, G., Supply Chain Management 4.0, Vorlesungsreihe an der IUBH (logistics40.de), 2015 auf Basis von Anderson, C., The Long Tail, Nischenprodukte statt Massenmarkt, München 2007.

[23] Coase, R. H., The Nature of the Firm, in: Economica, 4 (1937) o. Nr., S. 386–405; Williamson, O. E., Economic Institutions: Spontaneous Order and Intentional Governance, in: Journal of Law, Economics & Organisation, 7 (1991) 7, S. 159–187; Williamson, O. E., The Economic Institutions of Capitalism, New York 1985.

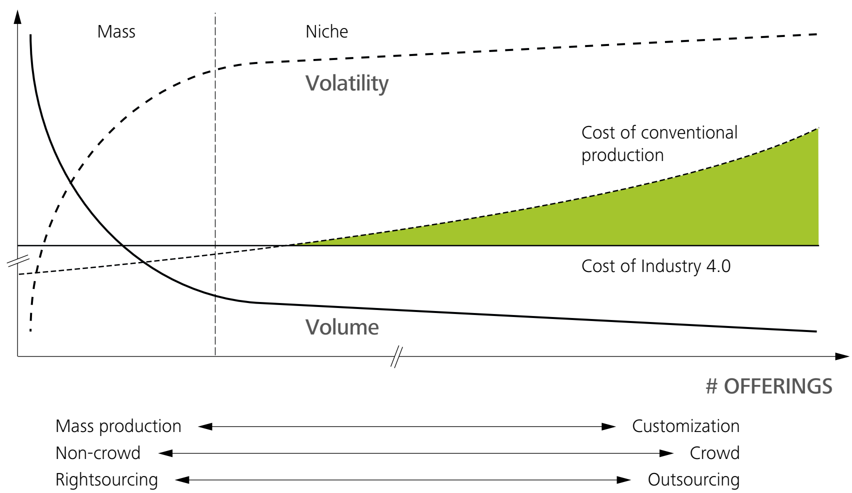
[24] Hereto and in the following Anderson, C., The Long Tail, Nischenprodukte statt Massenmarkt, Munich 2007.

And so forth. The ABC curve of revenue, then, shows a very long tail of niche products that contribute. The digital world allows a significantly higher variety of offerings and individuality of demand. The low transaction cost or low cost of search, trial and delivery facilitate such broad offering of digital business models while maintaining its commercial viability.

Customization and chemical production

New technologies of Industry 4.0 like additive manufacturing and batch sizes of N=1 do enforce this trend even more. They are also the reason that such characteristics of digital business models are not limited to online retailing only. The customization of products is an important homework to the entire manufacturing industry in the upcoming years, and for the chemical industry in particular. Flexible production planning & control in terms of real-time optimization of multi-functional production assets in small loops are supporting it. Also, dedicating certain production capacities to opportunity products and repositioning the de-coupling point along the value chain help.[25] In this context, Industry 4.0 technologies allow complexity cost of customization to remain stable and controllable rather than growing over-proportionally. Because, the long tail of the product portfolio typically is characterized by a volatile demand (Figure 15).

Fig. 15 – Volatility of demand and other characteristics of long tail value added[26]



[25] Wehberg G., Logistik 4.0, Berlin/Wiesbaden 2015.

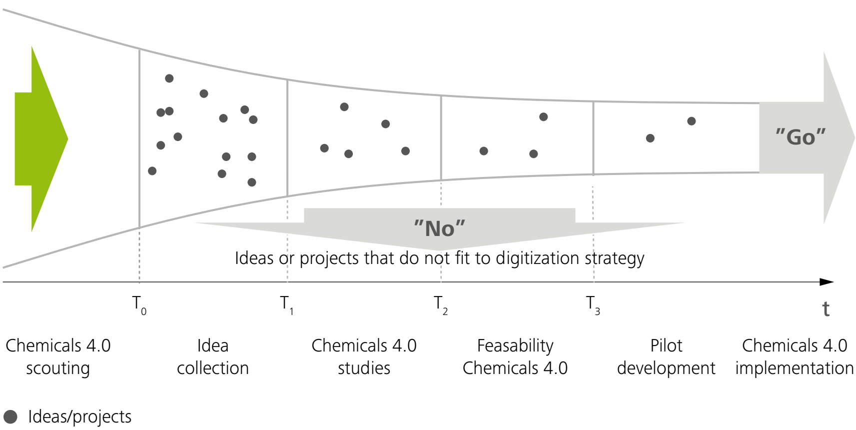
Within the chemical industry, the customization of products is of high relevance in the segment of Speciality and Fine Chemicals, but not necessarily limited to it. Here, production processes are typically heterogeneous and organized in lines or workshops for batches. Production assets are small, with filter centrifuges, membrane filtrations, candle filters, dryers, mills, crystallizers and reaction containers amongst others. The production of these segments has the character of scaled chemistry labs opposed to the large-scale flow production of Petro and Base Chemicals, with synthesis gas units, acetylene extractors and crackers amongst others.

Complexity in terms of an individualized product portfolio creates a lot of value for chemical companies. Health Care companies provide personalized medicine. Home Care companies customize laundry detergent beyond basic needs like “colour” and “bio”. Personal Care companies think about what makes skin whitening more personal and how to individualize swaddling clothes. They all market special ingredients either via traditional channels, the Internet, directly, or both. In Automotive, for example, first tier suppliers like Bosch drive innovation for both OEMs as well as end consumers. Ideally, such ingredients do have high brand recognition on an end consumer level, like the “Intel inside” for laptops. Industry 4.0 technologies, thus, are a facilitator for the customization of chemical products in terms of New Verbund business.

Open innovation and crowd production

Next to the chemical company itself, also customers and end-consumers have to be involved into the customization process of chemical products, when assembling product components or producing such products even themselves in terms of crowd production.[27] So, will there be any kind of 3D labs in the future, analogue to 3D printers that are already available for end consumers? And even before production, the crowd in terms of open innovation[28] drives the development of new chemical products. Chemical companies like BASF do offer creator spaces for customers, end consumers and/or suppliers amongst others in order to leverage on this potential, comprehensively. In this case, chemical companies have a personal avatar as innovation partner to their customers, which feeds an innovation funnel (Figure 16) with their ideas and selects, systematically, or even guides them through. The product long tail has impact on the entire value chain, accordingly.

Fig. 16 – Innovation funnel for Chemicals 4.0 (illustrative)



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26 Wehberg, G., Supply Chain Management 4.0, Vorlesungsreiche an der IUBH (logistics40.de), 2015.
27 Anderson, C. , Makers, Das Internet der Dinge: die nächste industrielle Revolution, München 2012.
28 Reichwald, R., F. Piller, Interaktive Wertschöpfung, 2. Aufl., Wiesbaden 2009.

5.2 Long tail of individualized services

Many chemical products are facing commoditization. The offering becomes increasingly exchangeable from a customer point of view. In such market segments, competition is looking for secondary offerings, services and applications in order to defend against price pressure and make a difference.[29] There are basically three service clusters to do so, basic services, value added services and digital services (Figure 17).[30]

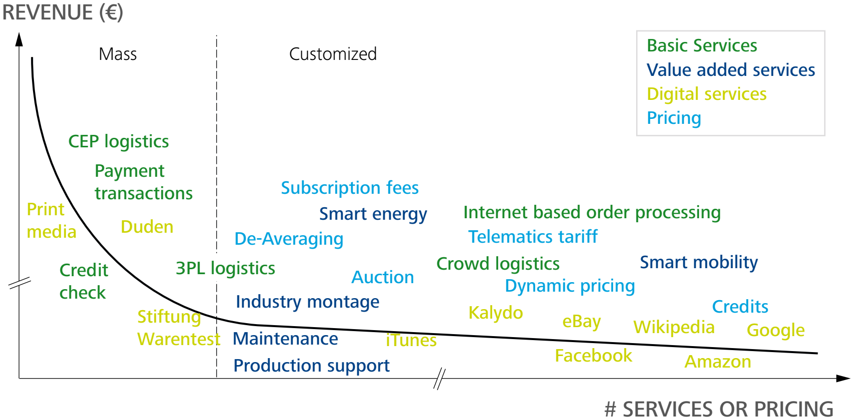
Basic services

Basic services provide elementary functionality that is required anyway for delivering chemical products, but execute it in a better way from a customer standpoint. Examples for basic services are tracking & tracing of deliveries as well as predictive maintenance of chemical facilities on customer site. Considering digital technology, basic services make a difference as long it is to market on time. The substitution of EDI by Internet protocol based communication, for instance, makes a difference in the chemical industry. While EDI has become a standard, it is not necessarily open enough to cover the complexity of data required for multi-dimensional and multi-lateral relationships such as production schedules and market forecasts. The use of standard Internet protocols such as XML or HTML makes much more digital relationships possible and commercially viable.

[29] Göpfert, I., Wehberg G., Ökologieorientiertes Logistik-Marketing, Stuttgart, Berlin, Köln 1995; Meier, R., F. Piller, Systematisierung von Strategien zur Individualisierung von Dienstleistungen, Arbeitsbericht Nr. 24 des Lehrstuhls für Allgemeine und Industrielle Betriebswirtschaftslehre der Technischen Universität München, 2001.

[30] Wehberg, G., Die Triple Long Tail-Strategie, (www.TripleLongTail.com) Cologne 2015.

Fig. 17 – Long tail of services and prices (cross-industry examples)[31]



Value added services

Value added services offer additional functionalities or applications. Starting point for the development of new value added services is the customer and the service worlds relevant to him, like mobility, energy or health. From a cross-industry perspective, BMW is a good example for re-positioning as a mobility service provider and leveraging on connectivity appliances. Chemical companies potentially learn from other process industries such as Energy and Steel. E.ON is not selling only Kilowatt-hours anymore, but providing comprehensive solutions for energy efficiency and security of energy supply. ThyssenKrupp is not selling only steel application systems anymore, but comprehensive logistics in terms of Material Services.

Take logistics as an example. It is certainly most relevant for chemical companies and their customers. But is it fully leveraged yet? Besides new logistics services such as consignment stocks and customs support, chemical companies start to realize that the service level is an import lever for differentiation. Ideally, "priority A"-customers get an A-service level while B-customers get a B-service level, which often is not the case.

[31] Wehberg, G., Industrie 4.0, Vortrag an der Universität zu Köln vom 24. September 2015 (logistics40.de), 2015.

And what comes next, over and beyond logistics? Chemical companies have to better understand where they add value for their customers and actively develop value added services rather than chemical products only. Building networks and leveraging on analytics capabilities as well as Internet connectivity help to facilitate value added services of chemical companies, however, knowing-your-customer comes first.

Digital services

Last but not least, digital services of the Chemical industry include so called filters, tools and aggregators, which are supporting the search, production and usage of offerings via Internet.[32] A chemical product might be exchangeable from a customer point of view. If it is easy to find in the Internet by using appropriate filters (for example because it pops up at Google at the top of the search list), however, this makes a difference. Similarly, good product references in the Internet function as a filter as they influence customer perception and bring together supply and demand.

Aggregators collect and ensemble a broad number of offerings and make it available for any third party customer. Aggregators create market liquidity by doing so. Wikipedia is an aggregator for knowledge of everybody, Google for promotion of smaller advertisers, eBay as well as Kalaydo for material goods of end consumers, and so forth. Aggregators are not limited to digital products, accordingly. In the chemical industry, aggregators for major product categories already exist, such as Chemfidence, Spotchemi and Elemica amongst others. However, such platforms typically have not reached full channel dominance in the past. New technologies and cost pressure change this. So the question is, will the chemical industry fully leverage on Internet technology in the future? And what about further categories or services? Today, many companies believe that it is good enough to build any kind of Internet platform, and to call this digitization. However, a digitization strategy has to be much more differentiated for specific segments, needs and applications amongst others.

Obviously, digital services do fulfill a double function when supporting the marketing of customized basic as well as value added services and facilitating differentiation against competitors at the same time. While aggregators democratize sales by making sales possible for anybody, tools democratize production. Corresponding crowd services from other industries are Kaggle for algorithms, Booking.com for customer services and ArtistShare for financing. Although first examples for filters, aggregators and tools exist in the chemical industry, the future evolution of such digital services will impact competition of distinctive market segments, significantly.

[32] Anderson, C., The Long Tail, Nischenprodukte statt Massenmarkt, Munich 2007.

Drivers of customization

Before mentioned services, basic, value added and digital applications, have to be individuallized with the help of the transaction cost advantages of the Internet. They become individual by considering selected characteristics of the engaging customers. Other than product production, customization of services is not realized by individualizing physical specifications. It is realized within the process of service generation instead. Correspondingly, drivers of such customization are associated with assets, processes and results of services (Figure 18). Internet technologies help to measure and manage these drivers, effectively. In particular, increasing connectivity and measurability supports a trend of contracting services on a performance basis. Performance based services do promise a specific result. Performance based maintenance, for instance, guarantees a minimum availability as well as run time of production assets and has to be customized through predictive analytics appliances. Such strategy of service customization makes service a weapon in competition of chemical companies.

Fig. 18 – Drivers of service customization

ASSETS	PROCESSES	RESULTS
• Capacities • Capabilities • Data & know how • Resources • …	• Frequencies • Weights • Volumes • Numbers • …	• Value added • Reliability • Cycle time • Cost • …

Similar to individualized products, the customization of services is being supported by both modular sub-services as well as outsourcing to business partners. This facilitates delivery on demand and scalability of respective infrastructure. While outsourcing possibilities in part depend on the existence of respective aggregators, upstream, the build-up of aggregators provides special opportunities to position in the chemical market. On the other hand, aggregators are a threat to chemical companies if the dominant purchasing criteria for standardized end products is pricing. Conclusively, chemical companies have to decide whether they want to position as or fight against aggregators with means of individualized offerings and pricing. Doing nothing is not an option, because in this case chemical companies are being reduced to technology providers or contractors without customer contact. In the 3PL segment, for instance, service providers will market transport capacities in an automatic fashion via Internet platforms in the future. For Schenker and others, this means they need to double check whether building such broker platforms for third party access is an option. Henkel, for example, is currently investigating whether a platform for "flat rate" subscriptions of fast moving consumer goods like Persil is an option. And paint and coating suppliers are now running paint shops. From a cross-industry perspective, quite some aggregators do manage the customer interface, however, don't have any assets any more. Like Uber does not have any cars in its balance sheet, and Amazon does not have any own product. This leads to the question if the chemical industry is coming up with asset-light business models that primarily focus on innovation and customer access, and production becomes outsourced by contractors in the future?

Comprehensive solutions

As service worlds are gaining traction, the chemical industry has to develop such services rather than pure products. A typical way of digital businesses to setting up market entry barriers is to combine and integrate services with products as comprehensive solution. Watchever, iTunes and Viewster combine video-streaming content with TV boxes. Oral-B combines an electronic toothbrush with an app for individualized brushing instructions. And DeLonghi`s Primmadonna Elite coffee machine provides an app for individualizing coffee. In order to build on these analogies, the question for chemical companies is how to play or support the role of iTunes, Oral-B or DeLonghi in the future? As a second-tier supplier, how to contribute to individualization by developing suitable video content, tooth paste, coffee beans or coffee filters? In other words, how to close the loop between supplier, solution provider and individual customer behaviour? Furthermore, which additional services or customer interfaces have to be developed and integrated? How to connect the user community, for instance, via display of the TV, toothbrush or coffee machine?

Chemical companies have to further think about combinations of chemicals, process technology and value added applications. They have to leverage on shared data with means of predictive analytics and offer access via cloud. This avoids that customers do have access to the data base itself and sharing a critical mass of data is becoming a unique selling proposition as well as setting market entry barriers.

5.3 The Triple Long Tail©

Besides a long tail of individualized products and customized services, a pricing long tail generates value (Fig. 19). These three dimensions together is what defines the so-called Triple Long Tail© strategy.

Fig. 19 – Strategy of the Triple Long Tail©[33]

	TRIPLE LONG TAIL©		
	PRODUCT LONG TAIL	**SERVICE LONG TAIL**	**PRICE LONG TAIL**
Scope	• Digital products • Non-digital products	• Basic services • Value added and digital services	• Value and cost based pricing structures
Value lever	• Customized product • Margin mark-up	• Customer retention • Proper cost allocation	• Value price • De-Averaging • Dynamic Pricing
Precondition	• Low transaction cost • Right/outsourcing • Flexible PPC	• Low transaction cost • Right/outsourcing • Scalable resources	• Cost control • Knowledge of customer value • Price algorithms

Cost de-averaging

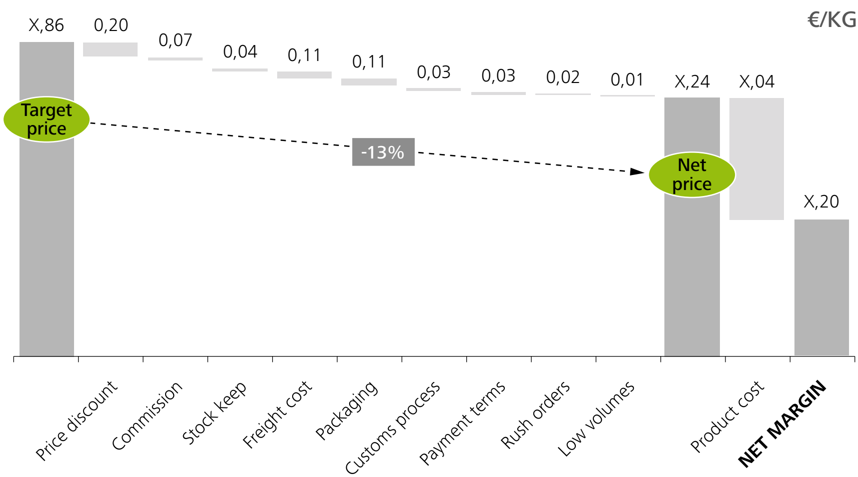
Having said that, proper cost allocation and price differentiation are crucial success factors of digital business models. Of course, even before industry 4.0, a proper cost allocation generates significant value for chemical companies. But customization amongst others creates even more complexity cost and, conclusively, such cost need to be allocated properly for cost types, centers and offerings. This means, potential averaging of standard cost has to be dissolved in terms of de-averaging. For doing so, the drivers of customization function as cost drivers that have to be considered within the ERP system. For logistics for example, SAP is currently trying to facilitate this kind of interface by developing S/4 HANA with Simple Logistics. Bottom line improvements are possible where under-allocation of cost supports mark-ups in pricing. At the same time, an over-charge of cost must not trigger price decreases.

[33] Wehberg, G., Supply Chain Management 4.0, Vorlesungsreiche an der IUBH (logistics40.de), 2015.

Figure 20 shows an example of a typical net price waterfall analysis of a Speciality Chemical product, which has to take diverse service cost into account. In this case , the de-averaging exercise provides evidence that the targeted price and net price significantly differ from each other. The client`s actual profitability, thus, is much lower than originally shown in SAP. And the pricing potential is high, accordingly.

For price increases are backed up by an evident cost driver logic, the sales organization is being supported properly. This is important because in B2B businesses like Chemicals price negotiations often have a kind of "open book" character. The sales support for companies like BASF, Evonik and Lanxess is sustainable as soon as pricing tools reproduce a proper allocation of complexity cost as a continuous process. As far as long tail products and long tail services are being purchased from third party suppliers, chemical companies need to have effective system integration on a plug-and-serve basis through business objects. Bottom line, some five percent price increase causes significant margin improvements in most segments of the chemical industry.

Fig. 20 – Example of a net price waterfall analysis (sanitized)[34]



[34] Wehberg G., Logistik 4.0, Berlin/Wiesbaden 2015.

Value pricing

The higher the customers benefit of products and services the more important his willingness to pay and the value from a customer standpoint. While value pricing in the B2C business is typically based on conjoint measurement analyses, in a B2B environment business cases help. Examples for value pricing are dynamic pricing and online auctions. Dynamic pricing as of Amazon or eBay aims at realizing targeted price positions against competitors by using search engines of the Internet, which help to find competitive offerings. Price algorithms, then, update prices in real-time. Online auctions already exist for many commodities. eBay is auctioning entire houses through tendering procedures. In addition, many companies create even more competition by organizing online auctions on the supplier side. Expectedly, such auctions become more relevant for B2B offerings in order to enforce value pricing. Having said that, individual pricing is an approach to value pricing that is even more mature. Cross-industry examples for individual pricing are telematics tariffs, credits and subscription fees.

The strategy of a Triple Long Tail is certainly one extreme of a digital business model, so to speak the pure doctrine. Instead of a black-and-white, shades of grey will apply in many cases. Furthermore, not all businesses have to be transformed comprehensively in this way, which means digitization cannot replace the traditional way of doing business. In this case, the Triple Long Tail will be introduced in addition to the established business model of mass products and services as well as comparably standardized pricing. Over time, revenue and profit shares are being shifted from the traditional to the digital business, accordingly. Besides having the right blueprint of the targeted business model, a proper timing is a crucial success factor. Dependent on market segment, the potential bottom line impact of digital business models reach over and above 20 percent. This is especially true, but not necessarily limited to Specialty Chemicals as well as Fine Chemicals (Figure 21).

Fig. 21 – Relevance of the Triple Long Tail© per market segment

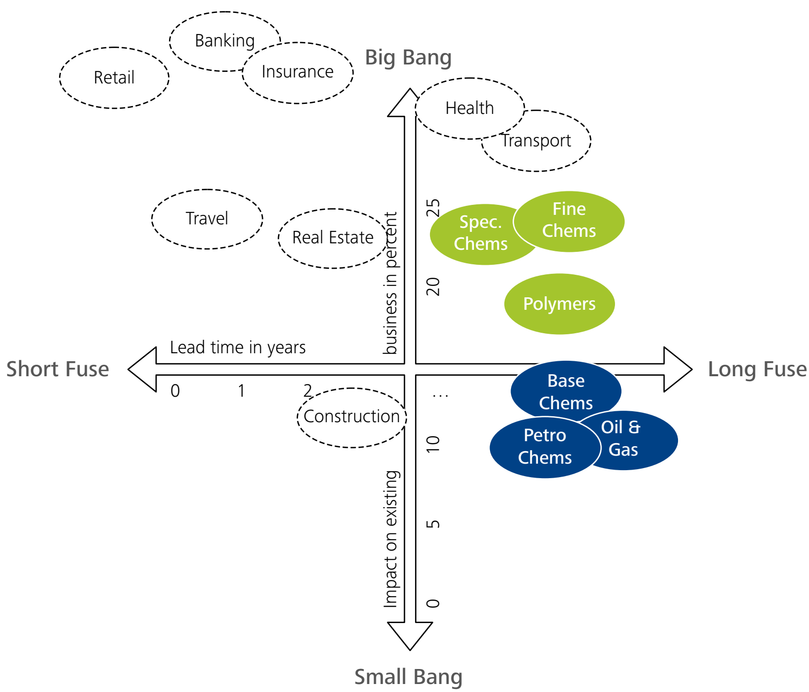
TRIPLE LONG TAIL©	Oil & Gas	Petro Chems	Base Chems	Speciality Chems	Poly-mers	Fine Chems
Product individualization				✔	(✔)	✔
Service customization	✔	✔	✔	✔	✔	✔
Price differentiation	✔	✔	✔	✔	✔	✔
Potential (% of Ebitda)	10–20			>20		

✔ High relevance (✔) Some relevance

No Chemical 4.0-silver bullet

Considering the before mentioned digital business models, Chemicals 4.0 provides a signifycant potential to disrupt the industry. Compared to other sectors such as Financial Services, the impact of Chemicals 4.0 will materialize in small steps and with a long fuse in the mid term. Chemicals 4.0 will develop in an evolutionary fashion (Figure 22). In other words, there is no Chemical 4.0-silver bullet of the chemical industry. Chemical 4.0 helps, but it will not serve plug-and-play solutions on a silver plate. Also, there wont be a "big bang" effect with respect to potentials in many segments. The German chemical industry has to organize its evolution path, accordingly, and work continuously in order to developing itself. Each segments and business has to find out how disruptive its future will be. The innovation focus will shift towards developing new operating as well as business models, in addition to conventional R&D. Accountabilities for a New Verbund have to be considered within the company. And new capabilities have to be built. It is clear that the impact of the New Verbund is not limited to bottom-line improvements.

Fig. 22 – Disruption map of the chemical industry (next to other industry examples)[xxxv]



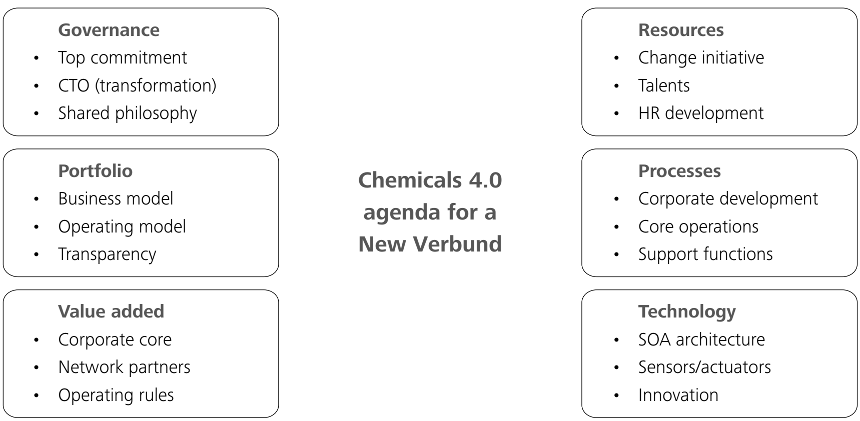
[35] Other industries refer to Heads!/DeloitteDigital, Überlebensstrategie „Digital Leadership" 2015.

6. Next steps to making the New Verbund happen

The German chemical industry has a very successful track record as a global industry leader. While the lead position is being challenged, there is a range of key trends and uncertainties that will define Germany`s role in the future. All these factors have to be considered for pursuing a joint project together with industry leaders, the German Government and further stakeholders. Particularly, Chemical 4.0 is at the heart of a proper response and thus needs both political as well as management attention. Politics has to facilitate IT security standards and high-speed data infrastructure amongst others. Executives have to drive digitization in terms of data based operations and new business models.

In order to achieve real momentum and attack the topic, comprehensively, the digital transformation has to be initiated systematically. The Chemicals 4.0 agenda, thus, has to consider a proper governance, offering portfolio, processes, capabilities and human resources as well as IT infrastructure amongst others (Figure 23). Only a holistic approach makes sure chemicals companies make sufficient use out of the New Verbund opposed to covering the topic for alibi purposes.

Fig. 23 – Chemicals 4.0 agenda for a New Verbund (selection)



Given the innovative character of Chemicals 4.0, we need to follow up with this topic in order to leverage on lessons learnt from its implementation. Concepts have to be refined and sharpened, solutions to be proven and early successes to be communicated to strengthen momentum. Maintaining the leadership role of Germany`s chemical industry will not come from nothing, but take significant effort of all stakeholders.

As we suggest, let`s do our very best and see where we get. There is no choice anyway!

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