



**The chemical
industry
reimagined –
vision 2025**

Foundation businesses | Platform businesses | Ecosystem businesses

1. Foreword

Before we disappoint you with our conclusions at the end, let us warn you now: our vision will not be numbers-focused – EY’s crystal ball for 2025 was temporarily out of order.¹ Nevertheless, we see the chemicals industry at the tipping point between a new future and a downgrading to a general purpose utility function for others. Classical thinking about the industry is maxed-out, and by now most of the players are trapped in a prisoner’s dilemma, preventing them from embracing new ways. It’s time leaders in chemicals take their heads out of the sand, open their minds and reimagine their industry by first giving up their industry thinking. In this paper, we will explain the trends we are currently observing, their consequences and how these could impact chemical companies.

2. How our world is changing

Recent publications have tried to forecast numbers for 2025. However, we believe we’d all be better off acknowledging we would be wrong anyway in trying to predict the same. So, we’ve decided not to follow that route. As Roy Amara famously said:²

“We always overestimate the change that will occur in the next two years and underestimate the change that will occur in the next 10.”

This has been proven over and over again; even the brightest minds and companies have fallen victim to this fallacy (see the following table for examples). Even experienced and famous experts aren’t able to accurately forecast. As Philip Tetlock found in his research, in making a forecast *“the average expert was roughly as accurate as a dart-throwing chimpanzee.”*³

The reason for this failure is that, as a business executive, you have to understand the difference between *complicated* and *complex*. Rick Nason nicely elaborates that most business problems are getting more and more complex, making our tried and tested



complicated problem-solving methods obsolete and, as a result, all projections become meaningless.⁴ In a complex system (world), we are no longer able to know all the influencing factors; the relationship between these factors is also not transparent. This means we are not able to define an equation for any prediction that realistically mirrors reality. Abstraction becomes too high-level to produce meaningful output.

Humans are just not good enough in estimating the impact caused by exponential and strongly networked developments combined with too many unknowns, such as we are experiencing in our current age of the fourth industrial revolution. Putting numbers on the future in the hope of ensuring and fulfilling business success is not possible. It’s better to stick with Alan Kay, who said:⁵

“The best way to predict the future is to invent it.”

¹ In the course of our argumentation, we explain why we skipped the number-crunching and forecasting the industry until 2025.

² Later repeated by Bill Gates.

³ Philip Tetlock and Dan Gardner, *Superforecasting: The Art and Science of Prediction* (Signal, 2015).

⁴ Rick Nason, *It’s not complicated: The Art and Science of Complexity in Business* (Rotman-UTP Publishing, 2017).

⁵ Alan Kay, at a meeting of PARC, 1971.

Or, consider these words from Michael Anissimov⁶:

“One of the biggest flaws in the common conception of the future is that the future is something that happens to us, not something we create.”

We know that for engineering-minded people this mindset is new, and the past decades of scientific management and strategic planning driven by MBA educations were different.⁷ These worked well for complicated problems but no longer apply when the system becomes predominantly complex. It’s now about “doing the right thing” and no longer about “doing things right” with number-crunching optimization. The past is no longer a predictor of the future, and this is a challenge for all of us schooled in traditional strategy tools and traditional professional services.

Safety was and remains important in chemicals: getting important things wrong can cause dramatic consequences for humans and nature. But here we are talking about a business sector that is always uncertain, therefore we shouldn’t expect overly precise predictions. Often in today’s business world, these kinds of reports are a form of management insurance, as in: “ABC said ...” Such an approach no longer works; in a dynamic world, you have to take back the driver’s seat with all its consequences otherwise the “train will leave the station before you realize that you should be on it.”

The chemical industry is a heavy asset world, and too many people today confuse digital disruption in technology, media and similar industries with disruptions in asset industries. Industry 4.0 had great ambitions for the manufacturing industry, but degenerated toward a pure efficiency play, neglecting the significantly bigger impact of new possibilities. Just because you can’t calculate the possibilities in Excel doesn’t mean they will not appear. Or as Dilbert nicely phrased it:⁸



⁶ Michael Anissimov, Chapter six of *The Singularity Is Near: When Humans Transcend Biology* by Ray Kurzweil, The Viking Press, 1st edition ©2005.

⁷ Henry Mintzberg highlighted in “*The Fall and Rise of Strategic Planning*,” in the January-February 1994 issue of the *Harvard Business Review*, that strategic planning is doomed to fail.

⁸ Scott Adams, “Dilbert,” <http://dilbert.com/buy?date=2010-12-23>, 23 December 2010, Andrews McMeel Syndication

Example: computers

- ▶ Past:
 - ▶ “I think there is a world market for maybe **five computers**.” – Thomas Watson, President of IBM, 1943
 - ▶ “There is **no reason** anyone would want a computer in their **home**.” – Ken Olsen, founder of Digital Equipment Corporation, 1977
- ▶ Reality:
 - ▶ **308 million** sold in 2014 alone (IDC: worldwide PC market: 1Q15 Update)

Example: mobile phones

- ▶ Past:
 - ▶ “Forecast cell phone penetration in the US by 2000. The consultant’s prediction, **900,000 subscribers**, was less than 1% of the actual figure, 109 million.” – McKinsey, 1980
- ▶ Reality:
 - ▶ **5 billion** mobile users worldwide, with 400 million in the US in 2014

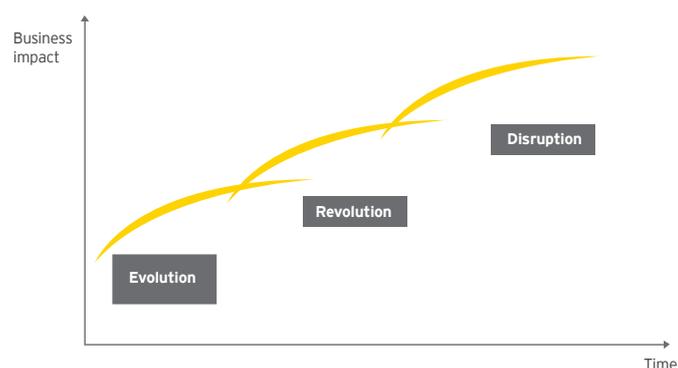
Example: internet

- ▶ Past:
 - ▶ “Almost all of the many predictions now being made about 1996 hinge on the Internet’s continuing exponential growth. But I predict the Internet will soon go spectacularly supernova and in **1996 catastrophically collapse**.” – Robert Metcalfe, founder of 3Com, 1995
- ▶ Reality:
 - ▶ **3 billion internet users** worldwide; **42%** penetration rate worldwide

3. What it means for chemicals

We are certain that the chemicals industry will not disappear because of the fundamental role it plays in more or less every other industry, and the fact that it is strongly asset-based (or have you ever tried to build your personal steam-cracker in your own backyard?). Nevertheless, the chemical industry will be impacted not only from within its own industry but also greatly by its customer industries. Currently, we don't see any game-changing technological innovation on the radar that could change the overall production process, as 3D printing has done in manufacturing. Some areas, such as performance materials, batch-to-continuous reactors⁹ or biosynthesis, could change the dynamics, but this has to be proven on large scale. The outcomes of

Figure 1: Transformation to ecosystems in three stages



molecular patents of the last 30 years are manageable, and we don't see any threat of dematerialization in chemicals, therefore supporting physical chemical products for the next decades. This limits the impact of disruption, the feared and massive disruption that happens when products get dematerialized, such as happened in the music, media and banking industries, when the full exponential powers of digital disruption converged.

However, due to the digital revolution, chemicals will inherently move toward new business and operating models. This will mainly be driven by the disintegration of our classical industries and the formation of ecosystems (see Figure 2: Convergences toward ecosystems). Despite the current mainstream belief

that sheer size and scale is the ultimate success factor, we believe that in an ecosystem future, size will most likely not be key to success as in today's world of economies of scale and synergies. Telecom providers were big in the past, they even held monopoly positions in their markets, but that didn't protect them from being degraded to general purpose infrastructure providers. Big web and technology companies are eating into the margins on which their infrastructure is based. Essential in the new ecosystem world will be how you integrate, which role you play in which ecosystem, rather than the size of your assets. Furthermore, how dynamically you will be able to change, react and adapt to new market thinking and how easy or difficult it will be for your organization to follow, or even lead, will also play an essential role.

Recent chemical industry trends, such as digital supply chain, vertical and horizontal integration with everybody and everything (Internet of Things is calling), big-scale M&As, and the move downstream toward special chemicals, are, in our opinion, short-term scale-ups and optimizations for the current mode of operation, which is "doing things right." They will not ensure the long-term success of a chemical company because they stay within their current scope of industry thinking: seeking new competitive advantages by establishing newer, stronger market-entry barriers,



⁹ For example, Ehrfeld Mikrotechnik Miprowa Reactor

be it low costs or unique values or services. As Rita McGrath elaborates very clearly, this strategic direction has its limits – the end of competitive advantage in the classical sense has come.¹⁰ For “chemical tankers,” this means they are heading toward a storm, because their competitive advantages today are:

- Economies of scale and synergies (big, heavy assets and strongly interconnected production sites)
- IP protection
- Unique access to feedstock, especially oil and gas

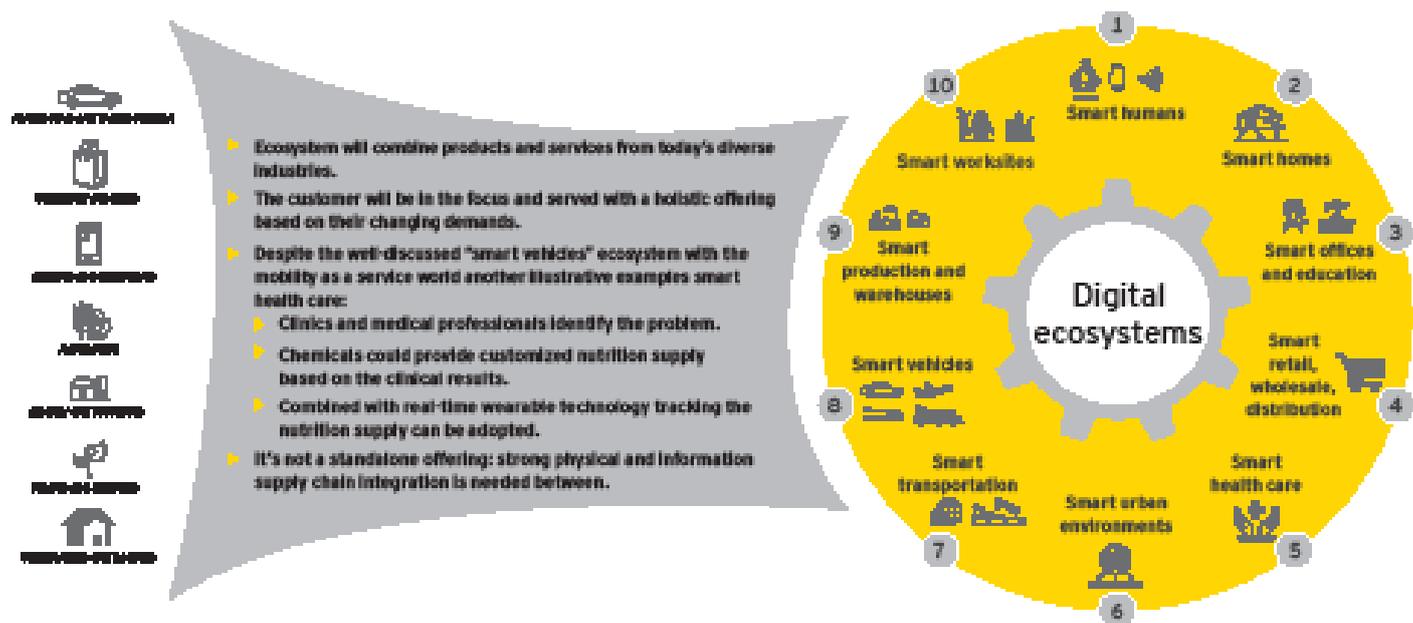
The well-known mega trends, such as urbanization, climate change and sustainability, are very applicable and important; nevertheless, they are only a first step toward a future world for chemicals. Our way of thinking doesn't omit them, but our approach goes beyond thinking in the same box (taking the definition of chemical industry for granted). At a macro-socioeconomic level, we see seven factors:

- Foremost, the classical client industries of chemical companies are converging toward ecosystems (see Figure 2: Convergences toward ecosystems).
- In an ecosystem environment, it is less about your own particular service, solution or product. It's about the overall solution combined from multiple building blocks and generated by joint cooperation

or collaboration and co-innovation. You will act more like a network of players than a value chain of competitors.¹¹ This makes it mandatory to apply new management approaches that are derived more from the complex system theory and copy the behavior of biological systems, like our nerve cells.

- Today's product portfolio of the chemical industry will commoditize at an accelerating pace (see Figure 3: Commoditization), driven also by the fact that the classical oil and gas industry is moving downstream beyond petrochemicals for harvesting new grounds.
- Digitalization will re-shift today's operations and enable a reconfiguration of the industry, jointly with the first factor. Many activities that previously fostered the creation of big chemical conglomerates due to better economies of scale or/and transaction costs are now fundamentally changing, resulting in lower transaction costs (e.g., availability of know-how, complexity of plant operations), which questions today's operating models.
- M&A and the drive toward special chemicals and solutions will not generate the anticipated competitive advantages. As the term special chemicals says, it was about being special, resulting in serving a niche market. Now, having everybody heading downstream makes markets too small to

Figure 2: Convergences toward ecosystems



¹⁰ Rita McGrath, *The End of Competitive Advantage* (Harvard Business Review Press, 2013).

¹¹ Frank Jenner, "Die Komplexität wächst – IT-Visionen in der Prozessindustrie," CHEManager 22/2002.

operate economically and erodes the glorified higher margin that initially attracted everybody. Classical basic economical reactions of demand and supply with an equilibrium price result in more supply because more players go into the same niche but cause falling prices when demand is stable.

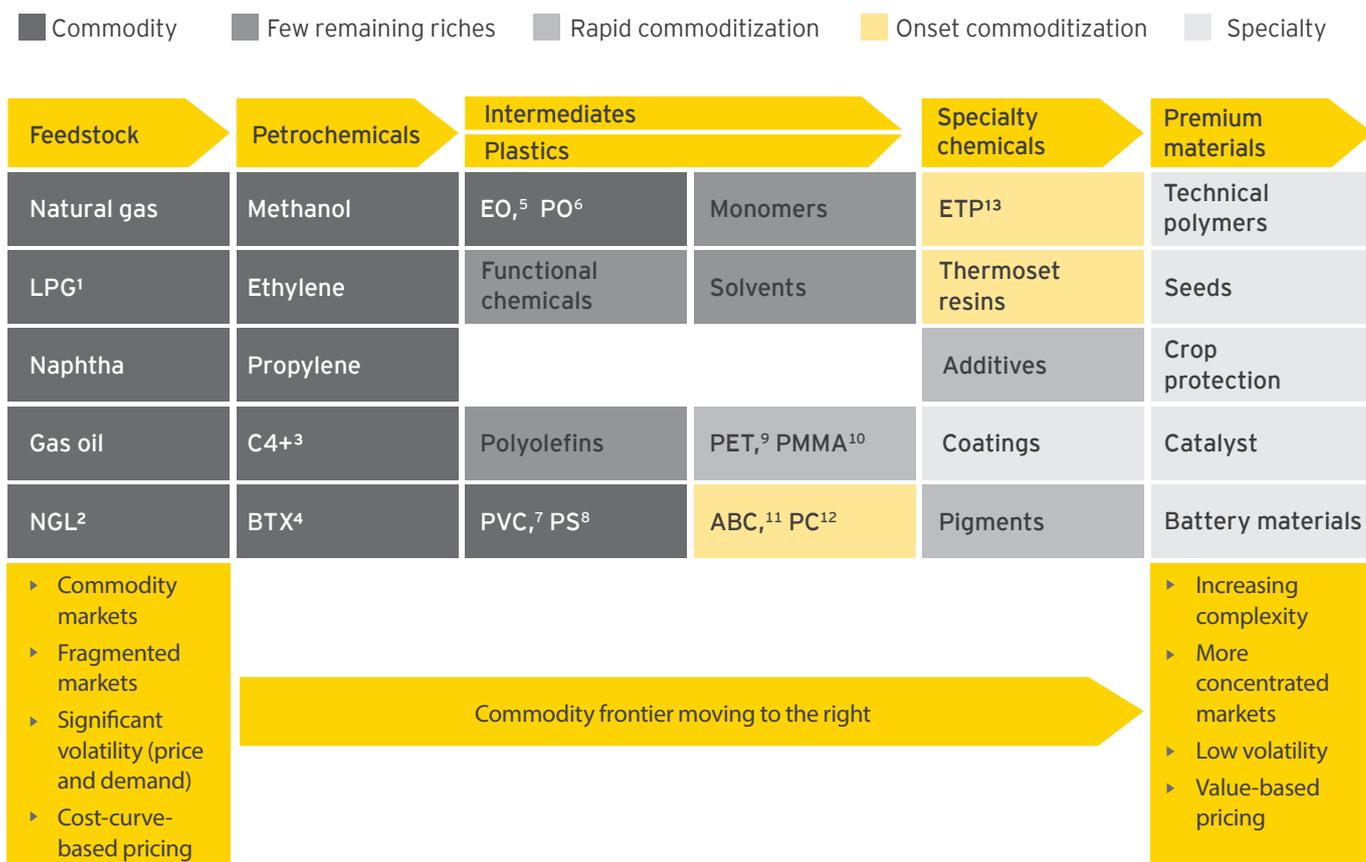
- f. Global trade flows for ecosystem businesses will diminish, reshaping the supply chains of today. For foundational businesses where asset scale stays key, we foresee regional clusters, e.g., in Europe, Asia and the Americas. Today's products will be produced and used within these clusters. Eliminating transcontinental transportation of these chemicals,

since chemical production facilities have risen in the last 20 years in the emerging markets, will result in less ecological impact due to shorter transportation distances.

- g. Innovation, especially in the downstream areas, becomes more and more expensive due to regulations and the maturity of the field. For example, in AgriChemicals, the lead time and the costs are already approaching those levels, triggering an industry consolidation as in the pharma sector during the '80s and '90s.

Figure 3: Commoditization¹²

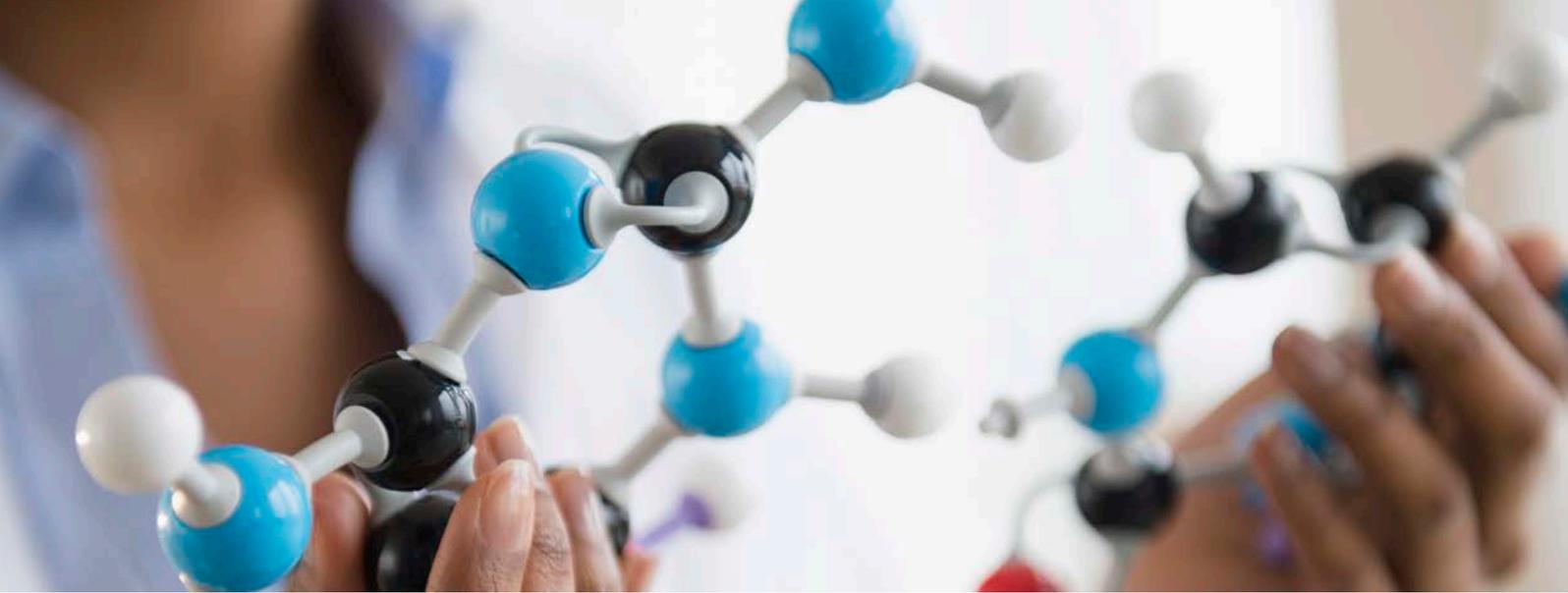
Exhibit 3 – The commodity frontier continues to move the right



¹ Liquefied petroleum gas
² Natural gas liquids
³ Butadiene, butylenes
⁴ Benzene, toluene, xylene
⁵ Ethylene oxide
⁶ Propylene oxide
⁷ Polyvinyl oxide

⁸ Polystyrene
⁹ Polyethylene terephthalate
¹⁰ Polymethyl methacrylate
¹¹ Acrylonitrile butadiene styrene
¹² Polycarbonate
¹³ Engineering thermoplastics

¹² McKinsey: commoditization of chemicals, 2016.



4. Reimagine chemicals: the chemical world in 2025

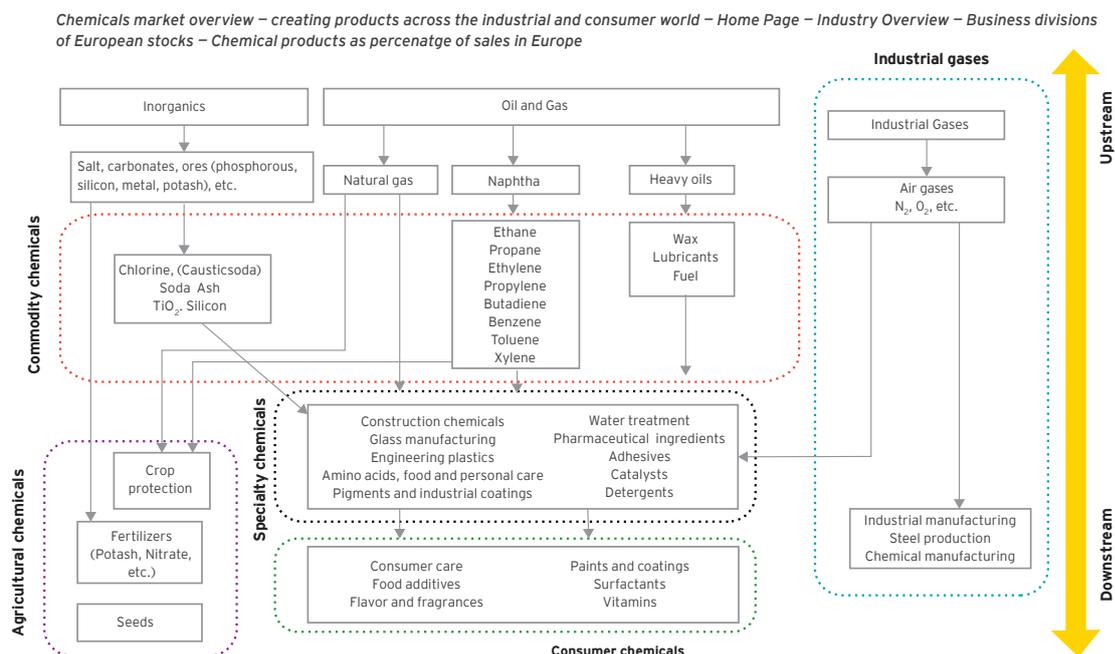
In the future, most of today's chemical industry players will be general purpose production industrial **foundation businesses**, serving slavish multiple ecosystems. They will be trapped, just like the telco infrastructure providers that provide the basic infrastructure for today's hyper-connected world, while other tech giants reap the biggest profits. Based on the general purpose production foundation, a plenitude of **ecosystem businesses** operate within dedicated ecosystems (see Figure 1: Convergences toward ecosystems). Both are intertwined by a third business category of **platform businesses**, which are potentially decentralized, automating most of the work.

4.1 Foundation businesses

Foundation businesses, which definitely include today's chemical value chain up to the intermediates, will be managed based on traditional efficiency thinking methods using the well-established complicated thinking management methods.

Why does this happen? Like the banking industry in the 1990s, chemical companies are often still integrated along the process chain (vertical integration), but the reasons for this are now changing. To some extent, vertical integration is given by the physical production process. Production flow forces integration up to the end of the intermediary process step at least (see Figure 4: Industry structure (UBS) red marked area). As soon the process is started, it will flow, and stopping it or other interactions is hardly possible.¹³

Figure 4: Industry structure (UBS)



¹³ At least as long as current production technology is used. Here, a new way of doing things would also put the downstream part of the chemical industry on a new growth trajectory.

Example:

In near term, the foundation business will already realize a fundamental and radical shift of employees out of traditional back-office functions that is literally driven by further process automations, such as robotic process automation (RPA), followed by machine learning (ML) and, finally, artificial intelligence (AI). This in itself will shake up the chemical industry and many companies will not adapt fast or quickly enough and, therefore, will vanish from the market when others have already established a more than 20% cost advantage.

However, this will not be the end of the game but just the starting point for ecosystem and platform businesses.

This is also the space where most of the heavy assets are used in production, making it a perfect field of play for economies of scale. However, it is also the area with the least know-how needed for production and where no product or service differentiation is possible (propane is propane – full stop), which is why it is currently a commodity business driven by price. Integration beyond this point is generally reasoned with economies of synergies, higher specialization and lower transactions costs.

With today's technology, these transaction costs, especially between the foundation and the ecosystem businesses, can be lowered by using a market transaction compared with an intra-firm transaction. We are now able to efficiently communicate and settle transactions for commodity goods.

You might ask, why now? As so often seen in other industries, today's technologies enable new modes of operation and interaction that which weren't technically and/or economically possible in the past. Without, for example, the computing power at scale and in the cloud operating a platform business, a general purpose production would not be economically feasible.

4.2 Ecosystem businesses

Ecosystem businesses will be the integrators into the ecosystems, containing the downstream parts of today's value chain to the value-adding ecosystem players from vast industries. They will follow the rules of complexity and require not only a new business model but also new ways of management that are more based on complex system management.¹⁴ When talking

about a new business model here we are not referring to the on-trend discussions about solutions instead of products, or providing services in addition to chemical products. To be able to integrate into an ecosystem, it is necessary to leverage the full potential of diverse players by cooperation and joint engineering of a multisided platform business. In these setups, different industries join together. By so doing, they will harvest the value add and be the tech giants themselves. Just take nutrition chemicals and imagine a smart health ecosystem:

Example:

Smart health: In such an ecosystem, hospitals, doctors, health insurance, pharma, fitness, food, and nutrition chemicals could be players who jointly provide the value proposition: healthy life. This ecosystem would be based on this purpose to provide healthy life to the consumers, and the different players would each add their part. Nutrition chemicals could provide supplements tailored to the individual based on the latest medical test results and the known records of personal activity and stress (which might be provided by the fitness player operating a wearable device) to optimally support the body. Looping in the health insurance provider, this could even stimulate the insurance costs the consumer has to handle. Already today we see examples of this: the Italian health insurance company Generali offers policies that are connected to wearables, and consumers can benefit from having an active life. Fitness wearables (e.g., FitBit) that are already connected to the food world to better balance calorie intake and consumption (e.g., MyFitnessPal) provide the consumer with active control of their metabolic life.

Ecosystem businesses are potentially very specific to their ecosystem and, due to the fluid platform type of setup in an ecosystem, it will be a chance also for smaller firms to participate.

Just as the internet provided access to many via a standardized process, the ecosystem will ultimately find a standard that is open to ensure that critical mass is reached (see next chapter). In the abovementioned example, the scenario could go so far that supplements are personalized at home, with a printer-like device that is operated by the nutrition chemical company. *Operated* means fed with the right instructions concerning dosing, automated resupplies as soon as the cartridges empty, or providing cartridges with other ingredient depending on data analytics from the

¹⁴ For more on management approach, refer to Donald Sull's and Kathleen M. Eisenhardt's *Simple Rules: How to Thrive in a Complex World* (Mariner Books, 2015).

ecosystem. This would ultimately transform the nutrition chemical company to an operator of millions of small devices instead of running a few factories only. Here, proximity and agility are more important than scale.

Today, it is unclear which players will initiate an ecosystem and how these ecosystems will be balanced in terms of power. What can be learned from the past is that the monolithic positions of internet and tech giants will be unlikely. Today's customers (B2B) and consumers (B2C) are well aware of lock-ins and are becoming more critical when it concerns the monetization of their information. Ecosystem business builders would therefore benefit from taking a more neutral approach and finding setups where the consumer or customer stays in control of their information. Emerging data market places where consumer or customers monetize their data themselves could be one way of achieving such a setup.

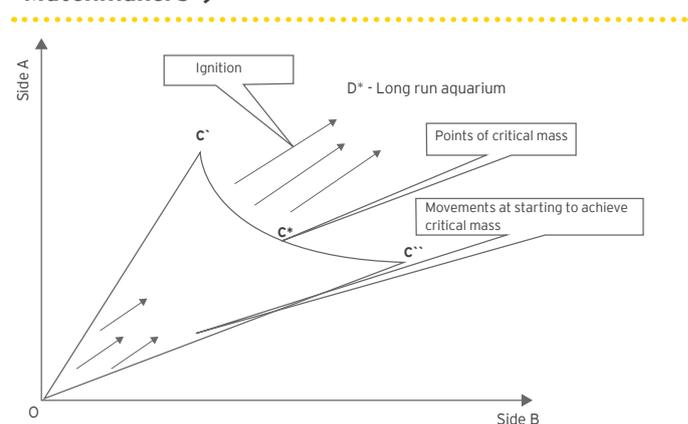
4.3 Platform businesses

Bringing both foundation businesses and ecosystem businesses together results in the establishment of a third category: **platform businesses**. These platform businesses are the glue holding all parts together. Their reason for being is that the glue requires a certain independence from the foundation and the ecosystem businesses to become a trusted partner for business. The fear of lock-in will be significant, especially as the platform will hold most of the transactional data, giving it a very strong position.

Most readers now think of businesses like marketplaces or transactional platforms. This is not wrong, but falls short of the real picture. Marketplaces are very rudimentary platform businesses; in a digital world, a platform business will be more advanced. Marketplaces in chemicals don't have a great past: some started with high ambitions, but have since disappeared. The key reason is that marketplaces foster competition by focusing purely on price, driving everybody out of the market, either by becoming bankrupt or by finding other channels in which to sell. Even so, some platform providers survived while they are mainly based on its founding partners and serves a clear purpose of providing cheap transactional cost between chemical business partners.

However, marketplaces and platform businesses are similar in that they strive for growth based on network effects (direct and indirect), which kick off as soon as the number of consumers and providers on the platform passes the critical frontier (see Figure 5: Critical mass and frontier (based on Evans, "Matchmakers"))).

Figure 5: Critical mass and frontier (based on Evans, "Matchmakers")

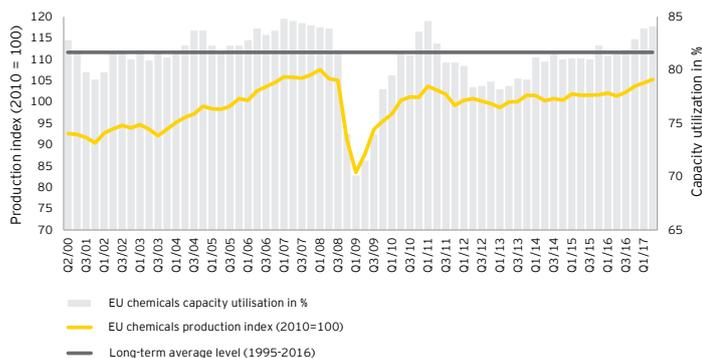


The key role of a platform business will be to ensure a healthy ratio of players on both sides as otherwise the ecosystem will not prove attractive for the consumer. Players can provide a multitude of services (just refer back to the "smart health" example). These can also be complementary services, such as transportation or the previously mentioned insurance. This need for multiple different players with different industry backgrounds also explains why a vertical integration approach only for one company is just not feasible. Such a conglomerate would be gigantic and incur sky-rocketing transaction or management costs internally, thereby resulting in suboptimal operations in all areas.

Foundation players will offer their commodities to the ecosystem business, which then combines and intertwines them into the ecosystem offering. The interaction between the foundation and ecosystem businesses will also be handled via a platform. We see primarily basic end-to-end supply chain services, such as integrated planning, supply and demand synchronization, and optimization of production utilization on this level. The latter is potentially the biggest lever as we are currently already experiencing overcapacity in the basic and intermediate chemical segments (see Figure 6: Capacity utilization in the EU chemical industry). Applying a sharing-economy-style yield optimization service here will ensure that the whole industry operates more efficiently by establishing a merit order curve for production

capacity. Brutally said, the platform will define who will make revenue based on the cost profile. Players with too-high costs will lose market access or will just service demand peaks – which can be a business model in itself, as you can see in the utility market, where peak demand capacity is paid very well.

Figure 6: Capacity utilization in the EU chemical industry¹⁵

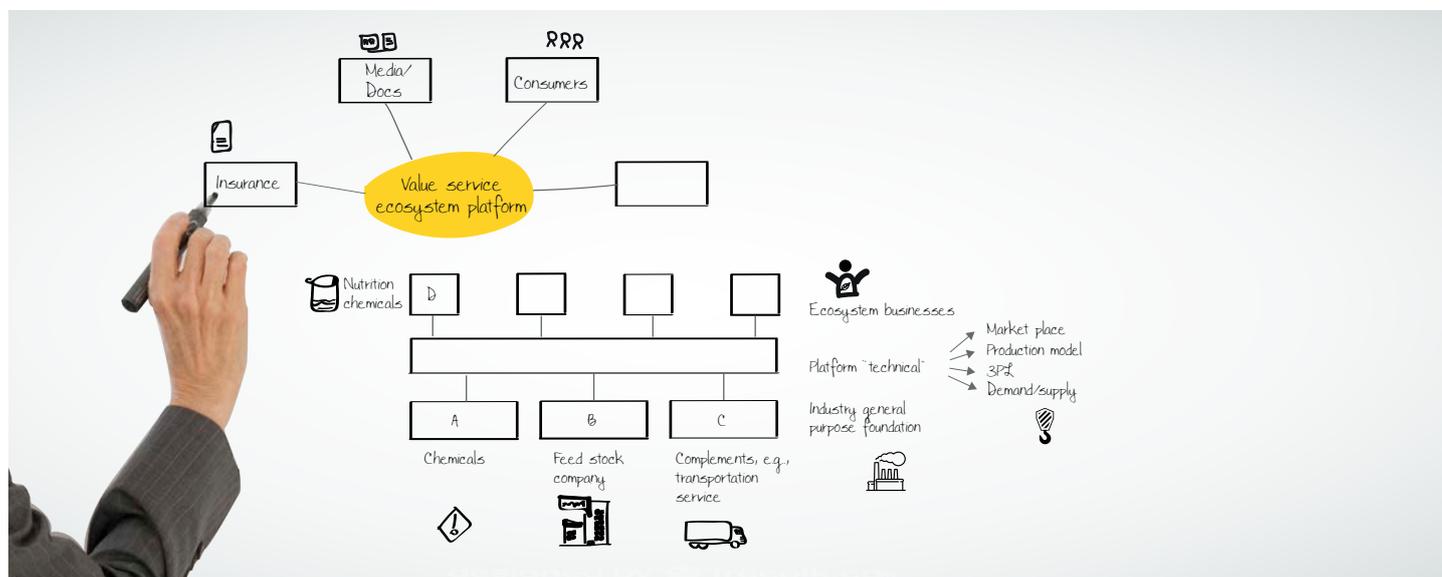


Think of this emerging industry environment as industry stacks (see Figure 7: Industry stack). At the lowest level, you find the infrastructure providers (the general purpose foundation), which can be compared with cloud service providers. On the next level, there will be a technical platform business that serves as a connection between the foundation business and the ecosystem businesses, which themselves will be players in more specialized platforms within each ecosystem. By this, economies of scale will be leveraged where

differentiation is not meaningful (foundation) and specialization by ecosystem integration will be possible.

For today's players in the chemical industry, the key question will be: who takes the position of the platform owner, and how will I react to this? We currently see that in established industries multiple players are trying to establish themselves as the platform owner – in addition to their product and service business – in the hope of harmonizing everyone on their platform. This normally is very challenging as everybody else fears getting locked-in and disintermediated from their customer base. Some industries try to solve this challenge by establishing JVs for operating the platform, which brings a lot of governance issues. With the emerging distributed ledger technologies, the opportunity exists to establish a decentralized platform stack that operates autonomously based on defined rules (e.g., smart contracts). This is owned by nobody, thereby taking the fear out of the game. This will be a highly possible option for the platform between the general purpose foundation and the ecosystem business as the business contracts for these commodity goods are very well defined, which is prerequisite to establishing successful smart-contract-based platforms. As soon as the contracts are incomplete, meaning not all conditions can be specified in advance, a fully automated platform will not work. Such incompleteness is very likely the case in the ecosystem platforms where the pieces need to evolve and reach a commodity-like character before they can be automated.

Figure 7: Industry stack

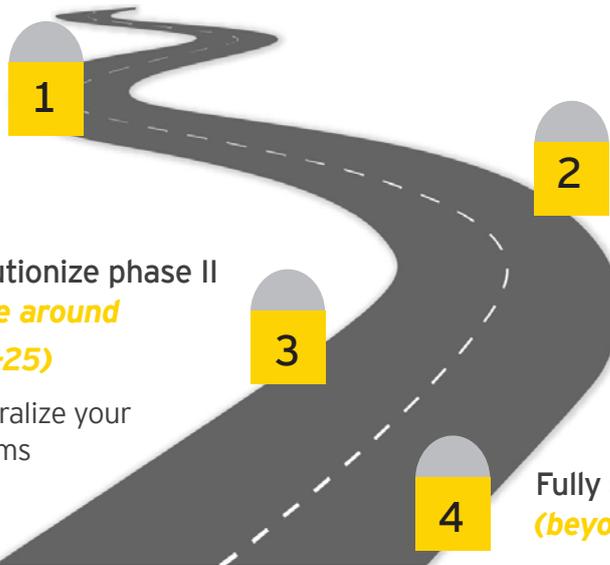


¹⁵ European Commission Business and Consumer Survey

5. Road map

Fix the basics and get digital (*yesterday*)

Digitize operations



Revolutionize phase II
(*go live around 2022–25*)

Decentralize your platforms

Revolutionize phase
(*before 2020*)

- Identify what is foundation and what has ecosystem potential
- Identify the ecosystem to play in
- Identify partners for a platform (breaking the prisoner's dilemma)

Fully disrupt
(*beyond 2030*)

6. Conclusions

The consequence for today's chemical companies will be that their heavy assets and their diverse conglomerates focused on economies of scale and synergies will not provide them with competitive advantages, and if they would, these will not be strategically important as the rules of the game have changed. Therefore, instead of investing in more heavy assets or buying more companies, reimagine slicing your conglomerate into effective operating pieces (connected both vertically and horizontally) and which roles will apply to which pieces in the future. Be open and start cooperating rather than forcing competition. The future will be information- or knowledge-driven; in this world, sharing will be key.

Our vision brings light and darkness for the chemical industry. It might mean head-shaking for some of you, well ... we accept that. Nevertheless, we think we have added value to the discussion through our interpretation and reintegration of previous, current and potential future work.

Our vision lives from "standing on the shoulders of giants"¹⁵ and we are not hesitant to mention all the other great thinkers. It is no value add for the world if we just reinvent the wheel or crunch numbers again just to arrive at a proprietary or copyrighted truth that is slightly different, but still wrong in the long run.

What we aimed for in this document is to name key triggers that will reshape the chemical industry going forward and to derive potential scenarios or visions and describe how the chemical industry might then look as a result.

We encourage you to draw your own conclusions. We would enjoy discussing your opinions with you. Whether we agree or disagree, sharing will advance the thinking and knowledge of us all. Our attitude toward chemicals has become very risk averse – leading to more management than leadership in the industry (remember Dilbert), and this has to end. The future will come to pass no matter what, and we should look forward to enjoying it together instead of focusing purely on the risks.

Sincerely,

Frank Jenner

Christian Neumann

¹⁵Bernard of Chartres

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