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A Perspective on Chemistry and Society

A Column on the Occasion of the 75th Anniversary of CHIMIA

SCS Division of Industrial and Applied Chemistry

Passion and Perspectives for Swiss Chemical Manufacturing

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Dr. Bernhard Urwyler studied organic chemistry at the Organic Institute of the University of Basel and obtained his doctorate 1990 at the Physical Chemistry Institute of University of Basel with research in Photochemistry. He started his career at Ciba-Geigy AG 1990 in the research labs in Klybeck and moved 1995 as team leader of a chemical development lab of Novartis AG to the Agro chemical development centre in Münchwilen. With the formation of Syngenta, he took in 2000 the role of a production manager in the production at Syngenta crop protection, Monthey SA. He then held several leading positions within chemical production at Syngenta crop protection, as site manager at Syngenta Aigues-Vives in France and from 2012 as head of production at the largest production site of Syngenta in Monthey. In his current position, since 2020, he is Integration Manager at the newly acquired Syngenta production plant at Muttenz. From 2004 to 2020 he was a member of the SCS DIAC board and from 2016 to 2020 president. Bernhard Urwyler will retire on 1.4.2021 but continue to work part-time in his own company 'Urwyler ChemPro GmbH'. Since 2020 he also became a member of the board of directors of Dottikon Exclusive Synthesis Holding AG.

MEGA Trends

Chemical production in Switzerland has been significantly shaped by time-changing MEGA trends over the last decades. These trends have strongly influenced the strategy of decision-makers in large and medium-sized chemical companies and will continue to do so in the future.

Is it therefore sufficient to analyse these mega trends of the past to make long-term predictions about the industrial development of tomorrow, *e.g.* for upcoming siting decisions with associated investments?

The demand for chemicals is growing proportionally with the rapidly growing and aging population. It triggers the aspiration to get access to more food diversity, but also to more pharmaceuticals and consumer commodities.

Overall, the chemical manufacturing industry shows a steady growth with a significant increase in imports and exports from 2016 onwards. Main driver is the pharma industry (Fig. 1).

The shaping trends of yesterday, today, and tomorrow do not have the same impact on all chemical production sectors and should therefore be interpreted in a differentiated manner. Nevertheless, the major changes in industrial chemistry have also had a strong

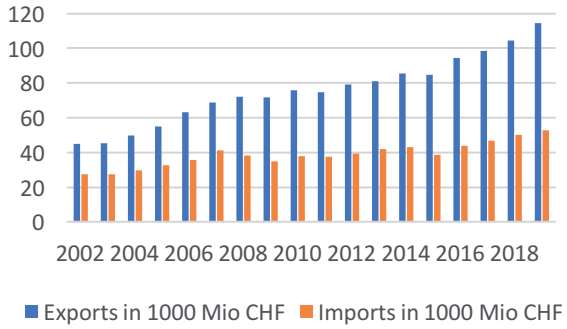

Fig. 1. CH import and export of chemical-pharmaceutical products 2002–2019. (Source: www.bfs.admin.ch)

impact on the SCS (Swiss Chemical Society), and especially on the DIAC (Division of Industrial and Applied Chemistry). If we split MEGA trends of past 30 years into yesterday's, today's and tomorrow's trends, the following pictures appear:

Trends of the Recent Past

In the period 1990–2010, globalisation was in full swing. India, then China and Russia gained interest among Western investors.

Markets for chemical products grew at double-digit rates, especially in China, where important state subsidies led to an aggressive pricing strategy with corresponding growth in China.

In parallel the flow of goods was optimised further thanks to the World Trade Organisation (WTO), and thanks to bilateral, or regional commercial agreements. This facilitated the trade of raw materials and intermediate products, including patented active ingredients.

Large Western chemical companies shifted large parts of their production to the East ('go east strategy'), mainly to China and India. Finished products, such as antibiotics or pesticides, were increasingly produced only at a few locations for the global market. This led to a concentration of chemical manufacturing to fewer locations producing at lowest costs. Large volume productions of basic chemicals in Switzerland and Europe dropped dramatically, as illustrated by the example of chlorine production in Switzerland. Consequently, chlorine and caustic soda producers planned to reduce capacity. Both commodities were and remain important basic chemicals for 60–70% of all chemical processes. Their availability is the backbone of all chemistry, as is widely acknowledged. In 2019, European capacity was 9.4 million tonnes of chlorine but demand fell as a large proportion of PVC and other fine chemicals were relocated to Asia. The withdrawal of chlorine and caustic soda production in CH came very quickly after the start of the new millennial.

The Oslo-Paris-Commission (OSPARCOM)[1] had already recommended at the beginning of the 1990s to shut down all chlorine production facilities in Europe that produced with the amalgam process, or to replace them with membrane processes by the end of 2010. Without coordination within the EuroChlor group or the production companies in Switzerland, production units were closed, one after the other; Syngenta Monthey in

2002 and the 'Schweizerische Sodafabrik' (Solvay) by 2004. Only CABB Chemicals adapted their chlorine production to membrane technology to comply with the new standards and environmental requirements, however, they only produce for their own use and their required capacity. Chlorine now had to be sourced from Germany and France *via* two main ports of entrance; Basel and/or Geneva.

The issue of transport safety for dangerous goods, especially chlorine, triggered a violent controversy with the consequence that only ten years later, *i.e.* in 2015, the canton of Geneva submitted a 'Standesinitiative' to stop all chlorine transports in CH.[2]

The withdrawal of production volumes had a significant impact on the exchange of know-how and caused a reduction in the number of innovations in applied and industrial chemistry.

DIAC was affected by this and experienced a reduction in its membership. In parallel, the EPFL, for example, has increasingly invested its resources for education and research in biotechnology instead of chemical engineering. At the same time, more and more finished products in the field of plastics, dyestuffs, active ingredients, or drugs that had lost patent protection, moved to India or China.

Current Trends

The loss of know-how accelerated with the departure of Western chemical production to China or India. Their chemical manufacturing has become progressively better and, in many cases, even reached Western standards.

Already by 2010, public pressure increased for a proper remediation of contaminated soil and no longer usable areas, caused by the chemical industries.

With this growing pressure from the public, investors began to evaluate the sustainability of a company, also because environmental remediation requires a lot of capital. Several environmental scandals accelerated this trend. Another trend was that bigger pharmaceutical companies, *e.g.* Novartis, Roche, Astra Zeneca, *etc.*, were gradually separating themselves from conventional 'small molecules' production, so that they can focus more on biological macromolecules and invest more in research and development,

Environmental organisations were gaining more influence on political decision-makers, as shown by the example of chlorine transports, where the canton of Geneva has launched its initiative to 'Stop the transport of chlorine to protect the population and the construction of housing'. Negotiations with the SBB and the Federal Government are still underway and the outcome is uncertain, but for the chemical manufacturing this represents a further factor of uncertainty and is not a promising development.

Trends of Tomorrow

The five megatrends 2020–2030 mentioned in *www.thegeniusworks.com* in 2019 were:[3]

1. Economic power shift (from G7 to emerging economies E7), with increasing polarisation between USA and China.
2. Climate change impact and natural resource capacity, *e.g.* increasing scarcity of oil or drinking water
3. Increase in technological breakthroughs with 'Artificial Intelligence'.
4. Demographic and social transformation.
5. Increased urbanisation.

A new, sixth, emerging trend, is the growing risk of pandemics, such as the current Covid-19 pandemic. Together, these trends will contribute to a significant slowdown in globalisation and, at the same time, accelerate socio-political pressure for more sustainability and 'greener' chemistry, also in industry.

New market protectionist demarcation is also taking place in safety and environmental protection requirements (such as the REACH regulation, which has been in force for some time, where now the Chinese variant: 'Order No. 7' (MEP) and the new 'Order No. 12' (MEE China), represent similar regulations. The aim is to improve the protection of human health and the environment from the risks that can arise from chemicals and at the same time to increase the competitiveness of its own chemical industry, *i.e.* in the EU and in China. All these directions are leading to more regulation and to an increasing influence of the government on the economy.

The trend towards complete globalisation has reached its limits. Thus, global production, sourced from one location, bears high risk in the event of conflicts (*e.g.* in the case of further polarisation between China and USA).

Remark: China MEP Order 7 was issued in Jan 2010 by the Chinese Ministry of Environmental Protection (MEP) and came into force on 15. Oct 2010. This regulation is comparable to EU REACH regulations and is also known as 'China REACH'. In mid-Dec. 2020 it was changed to China MEE Order 12 – The Measures for the Environmental Administration Registration of New Chemical Substances. The Chinese Ministry of Ecology and Environment (MEE) issued Order 12.[4]

As long as production is not able to be more sustainable and in compliance with environmental and safety guidelines, social and political pressure from environmental organisations will further increase, also in China and India, and there is a risk that entire industrial regions will be shut down, as was recently the case in China (see the consequences of the explosion disasters in Tianjin in 2015[5] and the severe explosion in the Chinese chemical factory of Jiangsu Tianjiayi Chemical Co in the city of Yangchen in 2019[6]). Both are among the worst industrial catastrophes in China and caused the closures of many chemical industry parks in the province.

Western chemical manufacturing was suddenly cut off from the supply chain of important raw materials, intermediates, and actives from one day to the next, which triggered a change in the trend.

New Opportunities

The need for process research and development capacity in Switzerland increased rapidly, to the advantage of agile, flexible, and fast-acting chemical productions.

In addition, research and development of new molecules for pharma and crop protection, but also new innovations in speciality chemistry are tending toward more complex and higher active molecules. More chemical steps are required for the finished product, in smaller volumes, as they become more effective in the case of pharmaceutical and crop protection active ingredients. In other words, where 4 to 6 steps were sufficient in the past, 10 to 25 steps or more will be required tomorrow.

The example of Dottikon Exclusive Synthesis, as a 'Specialist for Hazardous Reactions' offers exactly in this segment chemical development and first production volumes. Together with the demand for agility, flexibility and reliability, this market segment is growing in a way that compensates for the decline in production activity of the large pharmaceutical companies.

Even Syngenta, which belongs to Chem China, is investing in new production facilities in Switzerland, such as the Monthey (VS) plant and the newly acquired Muttenz plant. The latter was taken over by Syngenta after a production relocation at Novartis. This takeover led to a sustainable win-win situation for both companies, where thanks to the continuation of a well-maintained production facility at the Pratteln BL plant, jobs and assets could

be preserved. The owner's logo has changed from Novartis to Syngenta, but the assets and people have remained (Fig. 2)

Fig. 2. The logo has changed but the assets remain the same. A good example of sustaining assets.

Even the large volume producing chemical industries have good chances in these new trends as long as they can score with sustainability, better environmental protection and safety as the examples DSM (vitamin production), Ems Chemie (speciality plastics), Lonza (specialities and biologics), Firmenich (flavours and fragrances), Givaudan (flavours and fragrances), *etc.,* show.

Companies that did not identify the trends of the time, or saw them too late, had to close or were taken over, for example, CIBA in 2008, or Rohner in Pratteln in 2019.

New Stars in the Sky

Good research and development at our Federal Institutes of Technology, universities and other institutes with applied chemistry, bring new innovations to applications in close collaboration with industry. Many start-ups have emerged from research at our institutes, some of them inventing highly specialised new chemicals or processes to meet the growing demand for sustainability. Almost all private equity is now focusing on sustainability. And there are good cases in point, such as novoMOF, AVA Biochem BSL AG, or other examples described in CHIMIA 10/2020, 'The Swiss Startup Ecosystem: Innovation in Chemistry and the Life Sciences'.[7]

I am convinced that the following conditions will guarantee the preservation of applied chemistry and chemical industry in Switzerland:

1. Production facilities must be designed sustainably, with a high standard in safety and environmental protection.
2. Benefit from close collaboration with R&D institutes and open access to manufacturing-related and applied development.
3. Ensure good education in chemical research and development and in chemical engineering, including general technical apprenticeships in the field of applied chemistry (laboratory technicians and chemical and pharmaceutical operators).
4. Assure optimized plant maintenance by maintaining a balance between preventive and curative maintenance, leading to maximum reliability in production for the benefit of customers.
5. Maintain agile and flexible production facilities that can adapt rapidly to changes and thus to the fast-changing market.
6. Digitalization and usage of new technologies to increase efficiency.
7. Never give up on 'continuous improvement'.

I am sure that the vast majority of chemical producing companies in Europe and Switzerland produce on average much more sustainability than is the case in the E7. Every year the pressure for more sustainability will increase and, as recently proven by China's authorities, this leads to decisions that could strongly destabilise the market and unexpectedly interrupt supply chains.

Future Vision for the Role of the SCS DIAC

Where DIAC contributes significantly, and must continue to do so, is in providing the network for the manufacturing industry.

The DIAC brings together a network of applied and industrial chemistry and organises symposia, lectures, and plant visits to link applied innovations from R&D with production to make them available and inspire new innovations.

What has always been practiced in research and development has been applied only sparsely in chemical manufacturing, or hardly at all because of intellectual property restrictions.

Understandably, there was a lack of open exchange of new innovations in production. Newly developed technologies in applied chemistry are rarely patented and therefore not published.

This is unlikely to change in the short term. But through a network and the associated looking over the fence or the exchange among different related disciplines, this often results in the determining key for the vital new innovations in production. *e.g.* in Operational Excellence (OpEx), Industry 4.0, BigData or SusChem, *etc*.

New ideas and innovation only deliver added value if they are brought to commercial application. The DIAC must drive the passion for an extended network across the individual disciplines to generate this high added value in industrial and applied chemistry.

In a first step, this will be realised at the next Freiburg Symposium in April 2021 with the promising title: 'Industry 4.0, Current and Future Trends in Chemical Production'.[8]

Sharing best practice and knowledge in the symposia lectures across the network will keep the interest high, (Fig. 3). This guarantees the sustainable existence of our industrial chemistry in Europe and thus of Switzerland and finally the DIAC.

Fig. 3. DIAC's annual meeting held at Metalor Technologies SA in Marine Epagnier in 2019.

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[3] https://www.thegeniusworks.com/vault-entry/megatrends-2020-2030-by-peter-fisk/
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