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Changes in the chemical industry: the perspective of a catalyst supplier

The chemical industry is going through unprecedented changes, most of which are directed towards downsizing and consolidation. **Colin Gent**, an independent consultant and former head of catalysis at ICI, discusses these changes in relation to industrial catalysis, outlining the underlying business cycles and the interactions between society and industry.

Catalyst companies and other technology suppliers, being an integral part of the chemical industry, are experiencing a period of major change. The current public perception of the chemical industry remains poor, even though many of the products of the industry are directly responsible for the quality of life that we enjoy.

Five or ten years ago there were around 150 catalyst suppliers worldwide, many of them being the technology arm of a larger chemical company with only one or two being companies that dealt exclusively in catalysts. The rationalisation that is taking place in the chemical industry means that some companies have decided to keep and build their catalyst business while others have decided to sell or close. At the end of this process the 150 catalyst companies will probably have consolidated into four or five large groups.

To understand these changes in the chemical industry, we need to examine the underlying business cycles.

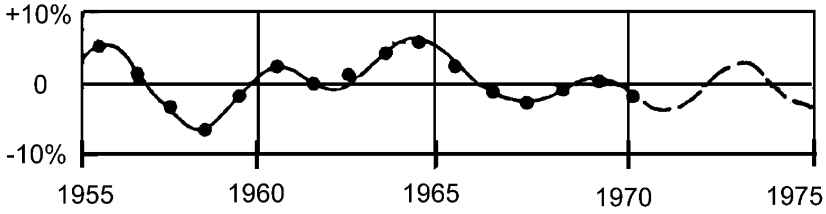

Fig. 1 UK consumption of polythene, showing business cycles.

Business cycles

Business cycles are well known in industry; revival – prosperity – recession – depression, and back round to revival again, as regular as the seasons of the year. In the chemical industry such cycles occur every four to four and a half years, although they are sometimes masked by the overall growth of the business (Fig. 1).

It was first noted by the Russian economist Nikolai Kondratieff, in the late 1920s and 1930s that, from time to time, the cycles of several industries came together in sync and reinforced one other.[1] The effect of an upturn or downturn was therefore much more widespread and consequently had much greater effect. Kondratieff observed these mega business cycles over the previous 150 years. Each cycle had a cycle time of 55 years and had much greater amplitude than the usual business cycle of four to four and a half years.

The Kondratieff cycle, like a business cycle, is divided into periods of revival – prosperity – recession – depression, and back to revival again, but each period lasts about 14 years. Four such Kondratieff cycles can be identified (Fig. 2).

The first cycle started in 1775 and was based on cotton textiles, iron as a construction material, and steam power. It is commonly known as the Industrial Revolution. The second, starting in 1827, was based on the railways, the third, starting in 1885, was based on cars and electricity, and the fourth, starting in 1939, was based on communications and chemicals. In 1994, we were just at the end of this fourth cycle, and poised to enter the revival phase (1994–2009) of the fifth cycle, which will probably be seen to have been based upon computing hardware and software, and possibly genomics.

Those industries that drive the cycle up in the revival phase with many and varied

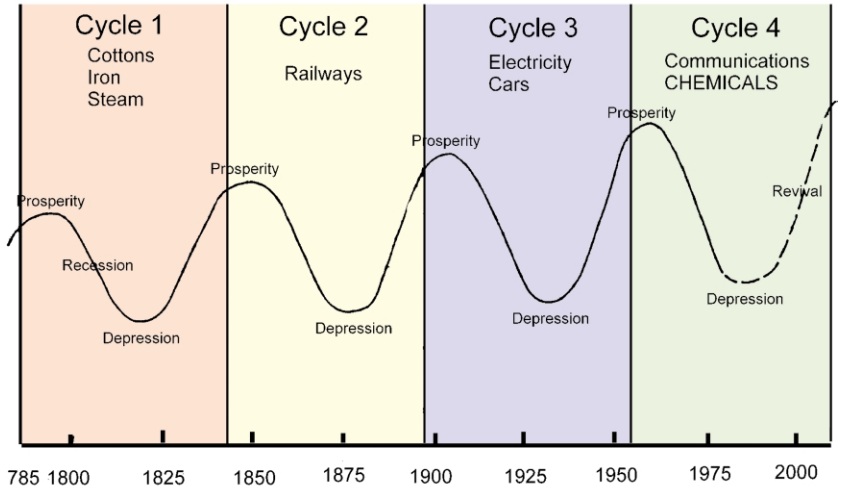

Fig. 2 Kondratieff cycles.

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innovations benefit most at the top of the cycle, but also are just the industries that fall hardest at the end of the cycle, in the recession and depression phases. Since chemicals was one of the industries that drove the fourth cycle up and was a star performer in the 1960s and 1970s it would be expected to fall hardest in the 1990s.

The role of the chemical industry in the fourth cycle

Looking at the role of chemicals in the fourth cycle more closely (Fig. 3), there

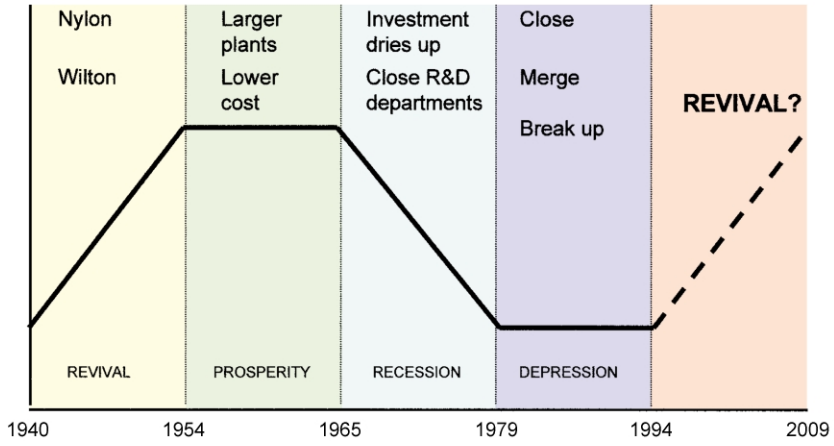

Fig. 3 Fourth Kondratieff cycle.

was a cluster of innovations from the chemical industry during the revival phase (post-World War II until the mid 1950s) which led to a period of considerable prosperity. Major new chemical complexes appeared, such as Wilton on Teesside, and major new products such as nylon and other substitutes for natural materials were produced to great acclaim.

The growth and prosperity phase (1954–1965) led to reduced costs per unit and to further expansion in production,

"Companies only innovate when the pain of depression is greater than the pain of innovation"

until it seemed that everyone was wearing nylon, and every house was furnished with nylon. But the market rebelled and eventually production exceeded demand, and we moved from a seller's market to a buyer's market.

Products became standardised and only minor improvements were offered in the market at a time when the customer was demanding something new. Investment in the chemical industry began to dry up, expensive R&D could no longer be afforded, production units opted for more and more standardisation, demand fell, prices were increased in an attempt to compensate and hold profitability, and that reduced demand even further and lead into the recession phase (1965–1979).

In the depression phase (1979–1994) companies closed, merged, broke up and generally downsized, and unemployment in the industry was high. It is only now, (1994 predicted by the Kondratieff Cycle) that companies begin to feel enough pain to take on the risk of innovation again. Companies only innovate when the pain of depression is greater than the pain of innovation. This is the reason why the chemical industry today always appears to be in a state of flux, and it will remain so until it innovates its way out of the depression.

Kondratieff suggested that there was a connection between innovation and these cycles of prosperity and depression (Fig. 4). Scientific discoveries are made at an approximately constant rate through the cycle, but only taken into commercial use in the revival phase. Only desperate men innovate – made desperate by the commercial realities of depression[2].

The period of revival is associated with a large number of innovations, followed by the creation of a large number of young companies, such as Symyx (Santa Clara, USA) and Avantium (Amsterdam, The Netherlands), in combinatorial discovery and high throughput testing, and by innovative 'step out' changes in selected existing processes, such as Fischer–Tropsch, probably leading to 'shut down' technology – that is, new technology that is so good that the old can no longer compete.

If we are going to 'step out', then we should also address the relationship between society and industry.

Society and the chemical industry

There is a close interaction between society and industry, and four categories of interaction are recognised [3].

- *Synergy* – enthusiastic acceptance of technology by society. For example, most people are accepting of microelectronics as shown by mass ownership of TV, video, hi-fi, DVD player, home computer *etc*.
- *Deviation* – partial acceptance of the technology, but not without reaction and not without significant re-structuring. One example is the way mobile phone technology is developing. There is a body of opinion that does not accept that a radiator of microwaves should be placed so close to the head, and wants the technology changed.
- *Enforced penetration* – placement of the technology by a powerful agency, which is usually a Government Agency, but sometimes a global company. Society is forced to live with the technology – for instance, nuclear power in France.
- *Allergy* – complete rejection by society of the technology. A clear example is nuclear power in Sweden, and maybe GM foods in Europe will be completely rejected by society when the outcomes of the present trials are known.

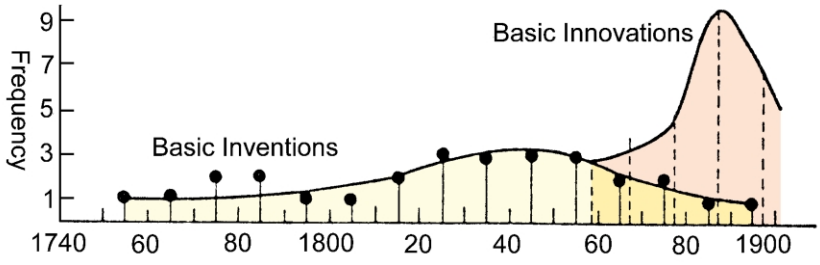

Fig. 4 Frequency of basic inventions in chemistry before 1900, and the take-up of innovation.

The chemical industry started off in the *Synergy* category, where people were very proud to live next to a chemical plant even though it was dirty, smelly and inefficient. In the 1970s and 1980s, as society became more aware of environmental issues, it was more difficult to persuade local communities to have a chemical plant built in their neighbourhood, which led to the industry moving to the *Deviation* category, and almost into the *Enforced Penetration* category. Fortunately the chemical industry has never quite got itself into the *Allergy* category, like the nuclear industry.

"....the next 10 years is going to be very exciting for industrial catalysis"

However, there is a paradox here. Over the same period the processes that were being developed were cleaner, more efficient, used less capital, and had lower fixed costs, but that does not seem to have been enough to satisfy society. Society changed faster than the recession-hit chemical industry could keep up with.

Many readers will be developing new chemistry, catalysts, or processes for the 21st Century but are we doing enough to move the chemical industry back to the *Synergy* category? Simply improving the efficiency and making the process cleaner is necessary, but not sufficient it seems. Are we engaging in the right dialogue with society? Should we not be doing 'societal research' to understand what society wants from us in the same way that companies undertake market research to understand what is required in a new product?

Conclusions

There are several indicators which point to the ending of the major upheaval in the chemical industry, providing the industry innovates its way out of the depression and engages in the right dialogue with society. If Kondratieff was right, the next 10 years is going to be very exciting for industrial catalysis.

References

1 F. M. Smith. *The Outlook for the Eighties.* Keynote address of the 8th National Symposium of the Oil and Colour Chemists Association, Durban, South Africa, 6–7 November 1980 (*J. Oil Col. Chem. Assoc.*, 1981, **64**, 144).

2 G. Mensch, *Stalemate in Technology: Innovations overcome the depression*, Ballinger Publishing Co. (Cambridge, USA), 1979.

3 R. van Wyck. *Management of Technology: new frameworks.* (*Technovation*, 1988, **7**, 341).

Colin Gent graduated with an MSc in Chemical Engineering from Birmingham University. The whole of his career was spent in various parts of ICI in UK and India, in R&D, process design, production and business planning. He retired in June 2000 from the R&D Director's job at Synetix - ICI's catalyst business that has just been sold to Johnson-Matthey. Since retirement he has been Technical Director of iAc (Institute of Applied Catalysis) and has acted as consultant to several companies in the chemicals sector.