REPLACING NATURE
The arising of polymer science and synthetic fiber technology

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The flow of ideas between science and technology is not unidirectional: technology is often the cause of scientific speculation, which in turn might lead to theories to promote technological improvements as well as a wider range of applications for a technology.

This paper mainly analyzes the academic community which studied organic substances and the technological community, which tried to develop artificial fibers to replace natural fibers, and especially the blurring of the sharp borderline between academic research and technological development in the twenties and thirties.

Textile industry came into existence during the first industrial revolution. Cotton as natural fiber was taken from colonies. Silk as a high fashion textile was expensive and the supply was rather unstable. This condition triggered the early demand for artificial silk. In 1825, the discovery of “butylene” by Faraday and the following researches on the existence of two different substances with the same stoichiometric formula opened the door of “polymerism”. Gradually, various traditions in organic chemistry emerged. They tried to account for the nature of organic substances in different ways. In 19th century, scientists showed a great enthusiasm on characterizing starch, rubber and cellulose, in 1895, X-rays were discovered by Wilhelm Konrad Roentgen and in 1912 x-ray scattering technique was developed by which molecular structures could be studied.

The first commercial production of artificial silk took place in France by Louis de Chardonnet, though his process gradually outdated, it led various ways of dissolving cellulose and obtaining cellulose-derivatives which gave possibilities for technologists to find new ways to create cellulose based fibers in the later times. Generally, there were three processes: cuprammonium, viscose, and acetate. Based on these new methods, numerous companies emerged, like Vereinigte Glanzstoff Fabriken AG, Viscose Syndicate Ltd., Glanzstoff, Nederlandse Kunstzijdefabriek and so on.

After the name of “rayon” was introduced and accepted in 1924, it became big business worldwide between 1920 and 1930. Rayon producers in German, France, UK, Belgium, Italy and U.S.A all had big success. These companies generally institutionalized their research and development. What resulted in the thirties was a number of very large internationalized fiber manufacturers amongst which AKU, Courtaulds, Celanese and SNIA Viscosa were the most important, and fiber businesses that were part of large diversified corporations like Du Pont, IG Farben and Rhône Poulenc. These corporations were all supported by research and development institutes.

There was a furious debate between scientists on the existence of large molecules at the beginning of the 19th century. Hermann Staudinger, a professor of ETH in Zurich, demonstrated the existence of macromolecules which he characterized as polymers. However, his idea was strongly criticized by many scientists at that time, the 1953 Nobel Prize in Chemistry he received meant the final victory of the 'macromolecule'. Before Staudinger's publication on macromolecules, more resinous products had been developed which were later recognized as macromolecules. The most important of them were Bakelite and poly-vinyl-chloride (PVC). In 1930, PVC fibers were spun. These were the first commercially produced fully synthetic fibers. Staudinger's 'macromolecular revolution', which was completed by Carothers, reconciled the empirical-technological approach. The macromolecular revolution created a fruitful base for empirical research. It showed new ways to create technology.

At the end of 1926, Du Pont decided that it would start a fundamental research program and recruited academic scientists to do the researches. On February 28th, 1935, Carothers synthesized for the first

time polyamide 6.6. In July 1935, this polymer was chosen to be commercialized. At the end of 1938, after some major patents were granted on the new fiber, Du Pont launched it as 'Nylon'. It was an overwhelming success on the market. At the end of the twenties, Paul Schlack, a scientist of IG Farben, produced a fiber by polymerizing caprolactam. It was introduced as Perlon but was often called Nylon 6 and was entirely used for the German war effort. During the war and shortly afterwards, other new synthetic fibers were developed. Calico Printers Ltd. invented a high melting polyester fiber. Acrylic fibers were developed in the United States and Germany. Other polyamides were used to spin fibers. The main aim of these innovations was to develop synthetic fibers with special properties to replace natural fibers or rayon in specific applications. The rise of synthetic fiber technology was extremely harmful for the market position of some natural fibers, especially silk. Artificial fibers gradually were no cheaper alternative for natural fibers, but were seen as replacements of higher performance.

The change in the relationship between academic science and industrial technology did not only take place on the cognitive level. As a separate academic discipline, polymer science got its own journals, conferences etc. Scientists working in university and in industry interacted increasingly. Numerous academics maintained close relationships to industry and much industrial scientists published (normally some years after patent application) scientific papers.

The social changes in this field caused by the creation of fundamental research groups by fiber companies certainly were a very important factor to account for the change in the orientation of scientists which were trained in the tradition of 'Wissenschaft'. This erased the sharp borderline between industrial technology and academic science. Scientists bridged the gap between academics and industrial technologists. In order to get insight in the factors that determine the course of development, it therefore seems to be important to study the social structures in which polymer scientists/technologists operate, than to divide their work by some standard in 'pure science', 'applied science' and 'technology'.