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An Uneasy Courtship: Rhetoric and Reality in the Relations between Academic and Industrial Chemistry, 1770-1914 (**)

In his two-volume work *De l'industrie française*, published in 1819, the chemist J.A.C. Chaptal looked back on half a century in which, as he saw it, science had become established at the heart of industrial activity. In an account redolent with pride in the achievements of French industry, in particular during the First Empire, Chaptal painted a rosy picture of the contribution of science to manufacturing. It was a picture in which even the highly theoretical innovations of Lavoisier had their place. For Chaptal, Lavoisier's role in elevating chemistry to the status of a «positive science» had been as important for the chemical industry as it had been for chemical science.

Chaptal's account, in fact, suggests that the roots of industrial science lay somewhere in the half century between 1770 and 1820. And it is that implication of his work which provides the starting point for my own reflexions. I begin, inevitably, with an obvious *caveat*. In what sense can it be maintained that the chemistry of the later eighteenth century was responsible for the technical innovation of, say, chlorine bleaching, pioneered in the 1780s? At one level, it is hard to see what the theory of chemical affinities could have offered. But the point (however obvious) has to be made that the new departure could not have come about but for the chemical work of Berthollet and Scheele which had led, a few years earlier, to the isolation and identification of chlorine. Less obviously, but more importantly, we must recognize, as Barbara Whitney Keyser has done, that contemporary chemical science also played a part in encouraging a systematic approach to testing and what would otherwise have been a rather random procedure based on trial and error.

I shall say right away that I am convinced by the implications of Keyser's evidence. I believe that in judging the efficacy of science as a support for industrial

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practice, we have to focus not so much on the consequences stimulated by major theoretical breakthroughs as on subtler, more elusive aspects of the intellectual and experimental "package" that science, at various times, has had to offer. One reason why I favour this solution is that if we try to test the role of science by the touchstone of its theoretical contributions alone, it becomes hard to understand why there has been such a long tradition of belief in the efficacy of science as a stimulus to industry. The solution makes sense, therefore, not only of Chaptal's assertions but also of rhetoric of the kind that was used, routinely and often unreflectively, to justify science throughout the eighteenth and nineteenth centuries.

Of course, even the approach I advocate does not solve all the historiographical problems. We still have to face and interpret the many programmatic statements, in particular from chemists, asserting the utilitarian importance of theory and what we might loosely term "pure chemistry". In the early and mid-nineteenth century, Justus von Liebig in Germany, Jean-Baptiste Dumas in France and A.W. Hofmann in England were just three of Europe's leading chemists who argued for the utility of chemistry for industrial practice but who also insisted on the importance of the chemist's remaining firmly in the realm of pure research. Hofmann's prescription was typically unequivocal: it was that the chemist should seek "pure truth" and avoid becoming too closely involved in the routines of manufacturing.

The obvious question we have to ask, as historians, is whether this conception of the chemist's role commended itself to the industrialists whose interests Hofmann claimed to be serving from his academic laboratory at the Royal College of Chemistry in London. My clear impression is that it did not. At least in England, there were few signs of any serious recognition of the contribution that could be made by university-trained chemists before the mid-century, or even for some years after that. When Lyon Playfair, fresh from Edinburgh and Liebig's laboratory at Giessen, was appointed as works chemist at a calico-printing factory in Lancashire in 1840, he was in the vanguard of a process of integration that was to be made painfully slow not by a shortage of chemists but by the attitudes that prevailed among manufacturers and, even more conspicuously, the simply educated workmen who ruled the colour shops of the textile mills. As one self-educated but highly successful colour chemist, John Mercer, recalled, the majority of managers and colourmen in Britain displayed a mixture of jealousy and contempt for chemists who had been fashioned in the universities, in ignorance of the ways and practices of the shop floor.

In the light of this evidence, I feel that we should think again about the way in which the marriage betweeen science and industry came to be consummated in the chemical industry of the nineteenth century. At least in Britain, we have repeatedly been told, most notably by Martin Wiener, that one of the greatest weakness of the British economy was the tendency for the educated classes and the universities in which they were fashioned to disdain the alien world of manufacturing. While the ancient universities of Oxford and Cambridge may have been open to this charge (though even there, I can think of important individual exceptions), it does not have even a distant ring of truth when applied to the newer colleges that began to emerge in London and the provincial manufacturing towns from the mid-century. How can it be claimed that the Royal College of Chemistry (founded in

London in 1845) or Owens College (the future University of Manchester, founded in 1851) were hostile or even indifferent to the integration of scientific knowledge with industrial practice? It was one of their *raisons d'être*. My own, very different view is that if we want to understand the slowness of the engagement of academic science in the advance of industry, we are less likely to find the impediments in the failings of academe than in the suspicion and hostility that circulated among industrialists and their employees.

In using words like "suspicion" and "hostility", I do not wish to imply that industrial attitudes were bred simply of ignorance or blind animosity. There were good reasons for believing that the emphasis on precision and theory that characterized the training of an academic scientist had little place in the rough and ready world of manufacturing. Pursuing the example of chemistry, I doubt whether even the introduction of artificial dyestuffs, following W.H. Perkin's discovery of mauve in 1856, significantly increased the scope for the attitudes and skills that were routinely and uniquely inculcated in a university laboratory. It is significant that the leaders in the old tradition of natural dyes and dyeing — Camille Koechlin and J.A. Schlumberger in Mulhouse and Charles O'Neill in Manchester, for example — remained as leaders in the new age of the aniline dyes; their rather approximate methods and simple facilities continued to be perfectly adequate.

Of course, it would be absurd to suggest that nothing at all had changed. In the 1860s, a small number of chemists with skills in advanced analysis found a new role as expert witnesses in legal cases, of which the litigation surrounding the red aniline dye fuchsine in France was the outstanding example. But it was only in the 1880s and 1890s that chemical manufacturers began to open the way to chemists in numbers significant enough to justify and encourage expansion within the universities. A study of the Bayer company in Germany has shown how late even this important manufacturer of dyestuffs and pharmaceutical products significantly extended its laboratory facilities. In 1877, Bayer employed only seven chemists, four of them engaged in routine quality control and two on colour testing. By the mid-1880s, the number had risen to almost thirty, but it was only after 1891, when the company opened its first purpose-built research laboratory (i.e. a laboratory dedicated to the search for new dyes and other substances, as opposed to control and testing) that Bayer became an employer of chemists on a large scale. Between 1890 and the eve of the first world war, the size of Bayer's "army" of chemists increased five-fold from about fifty to over 260.

One conclusion to be drawn from this is that academic chemistry made its mark in industry at a rather late stage. Bayer was already established as a leader by the time it embarked on the phase of its heaviest investment in laboratories and the chemists who manned them. Chemistry, in other words, was a tool in the consolidation of an already strong position rather than in the creation of the position in the first place. Another conclusion that emerges from the study of Bayer, in particular that by George Meyer-Thurow, is that we should beware of supposing that the work of even the research laboratory was of a kind that regularly generated marketable new products. In the years just before the first world war, only two per cent of the new compounds that emerged from the research laboratory were ever exploited commercially. The main function of Bayer's dyestuffs research in this period was to identify new compounds, most of them in the huge family of the azo-dyes, which were then patented, not (in the great majority of cases) with a view to exploitation but rather to impede their exploitation by other companies. The laboratory, in fact, was an important strategic weapon in a policy of defensive patenting.

These comments on the integration of research in industry in the late nineteenth and early twentieth centuries are offered as yet another element in a much longer cautionary tale. My aim has not been to deny the importance of science for industrial success: as early as the eighteenth century, chemistry in particular plainly had a role, even if its theoretical contribution was slight. I have sought rather to point to the diversity of ways in which science could become involved in industry and to the circumstances which, at various times, have impeded the process. In that diversity and in those circumstances, there lies what I offer as my most important warning. It is that, in working towards an historical account of the relations between science and industry, we should firmly divest ourselves of our present perceptions of the ways in which chemical knowledge can and should advance utility. The modern conception of in-house chemical research as a fount of sophisticated new products or processes devised in a well-founded laboratory and destined, at least in principle, for commercial exploitation is a late-comer in the history of industrial science. But that is not to say that industrial science itself is a late-comer. For the reasons I have advanced, I would argue that its roots lie far back in the eighteenth century. Our task, as historians, is to unravel those roots. As we do so, we should not be surprised if they bear little resemblance to the fruit that we see around us, in virtually any advanced chemical company, today.

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