From Workshop to Laboratory

Research and Innovation in Electric Industry 19-20th Centuries

Introductory Remarks

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The aim of the Mulhouse conference was to explore ways of enlarging our conception of the nature and sites of industrially related research in electricity. In proposing this focus, the organizers did not underestimate the importance of sophisticated, well equipped in-house laboratories as sources of success: from the time such laboratories emerged as common accoutrements of well founded companies in the early twentieth century, they have had an ever more central (and now well studied) role both in fundamental innovation and in pursuit of equally important if less eye-catching goals such as economy, safety, and efficiency in the day-to-day processes of industry. Hence there was certainly no intention that such laboratories and their academically trained staff should be ignored. Speakers were simply invited to range widely. In particular, they were asked to extend their brief to include forms of research and settings for such research that lay outside the walls of the conventional laboratory. Research, in other words, was to be conceived as being as much an affair of workshops and sites of production as it was of laboratories[1].

By the time we gathered in Mulhouse in December 2005, such goals were not new. We were already able to draw on a secondary literature that offered some answers and posed key questions. In 1991, for example, W. Bernard Carlson had advanced his conception of craft knowledge as a crucial element in the achievements of Elihu Thomson at General Electric in the late nineteenth century[2]. At GE, as Carlson

1 In this pairing of workshops and sites, I draw on the terminology and general thrust of Robert Fox and Anna Guagnini, *Laboratories, workshops, and sites. Concepts and practices of research in industrial Europe, 1800-1914*, Berkeley (CA), Office of the History of Science and Technology, University of California, 1999.

2 W. Bernard Carlson, *Innovation as a social process. Elihu Thomson and the rise of General Electric 1870-1900*, Cambridge, Cambridge University Press, 1991.

described it, Thomson's achievement, like that of many inventors, rested upon a mixture and constant interplay of craft knowledge and scientific knowledge. A few years later Wolfgang König developed his notion of 'industry-based-science'. In a book and classic article, he opened perspectives on forms of science that drew their problems, research strategies, and techniques from the industrial rather than the academic world, the world of doing rather than the world of knowing[3]. König's analysis, focussed on the German electrical industry in the late nineteenth and early twentieth centuries, encouraged us to analyse the interaction between science and industry as complex, multi-faceted, and reciprocal rather than as a straightforward passage of ideas and knowledge from the scientific laboratory to a quite separate world of industrial practice.

Long before Carlson and König wrote, of course, historians had become used to complexity. But engagements with complexity have often served to engender as many historiographical loose ends as they have helped to tie. The most pertinent of the loose ends for the Mulhouse conference was the very category of research. As the organizers felt, the shifting boundaries of what has constituted research since the industrial revolution of the eighteenth century call for fundamental re-examination in ways that transcend present-day conceptions of the activity. Think, for example, of the largely unsung pioneers who installed France's first hydroelectric power-stations in the Alps or the Pyrenees towards the end of the nineteenth century. It is hard to see the activity in which these pioneers were engaged as anything but research. A telling case was that of Aristide Bergès, outstanding among the French innovators of his day in hydroelectricity. The essence of Bergès's achievement in the valley of the Isère was his mastery of steadily greater falls of water over a period of three decades or more. His path to that achievement was distinguished by a capacity to respond, and to do so creatively, to a succession of technological challenges of the type that Thomas Parke Hughes has analysed as 'critical problems', the problems that guide and focus the efforts of inventive minds and generate innovation.

Two comments on the problems that early hydroelectricity faced are in order here. One is that the problems were usually mechanical, linked to the difficulty of manipulating water at ever-increasing pressures. Hence most of the problems required for their solution the practical skills of a mechanical engineer (which Bergès possessed in abundance)

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[3] Wolfgang König, *Technikwissenschaften. Die Entstehung der Elektrotechnik aus Industrie und Wissenschaft zwischen 1880 und 1914*, Chur, Fakultas, 1995 and "Science-based Industry or industry-based science? Electrical engineering in Germany before World War I", *Technology and culture*, No. 37, 1996, p. 70-101.

rather than an advanced background in physics, mathematics, or electrical engineering (the elements of which Bergès possessed, though without their being the main weapons in his intellectual armoury). The second comment is that, in the pioneering phases of hydroelectricity, laboratory-based research was of little value. What mattered were full-scale experiments, conducted on the installation itself. Such on-site investigations were informed first and foremost by practical know-how rather than theoretical knowledge. For the participants in the conference, however, they were not to be confused with simple rule-of-thumb tinkering and, to return to my initial point, certainly not to be excluded from the category of research.

The broad conception of research that the organizers of the conference had in view made it necessary to broach other, related questions. In particular, what were we to say about location? Any rethinking of the category of research inevitably entailed a parallel rethinking of the term 'laboratory'. It seemed to follow that the places where Bergès and other pioneers of hydroelectricity conducted their trials should be regarded as laboratories for the historian's purposes. It is easy, too easy, to see such places as having little to do with the scientifically sophisticated laboratories that have grown up over the last eighty years. The reality is that their history cannot be seen as separate from that of laboratory-based research. The two forms of research, in fact, are inextricably related and have to be studied accordingly.

One consideration here is that the well endowed laboratories of, say, the 1930s, with a focus on innovation and the quest for fundamentally new products or methods of production, emerged from far simpler facilities, often from installations whose primary purpose was the relatively routine work of quality-control and testing. The point emerges strongly from Muriel Le Roux's account of the evolving provision for research in the Pechiney company[4]. As Le Roux shows, important early work on aluminium was performed at Pechiney in the nineteenth century with none of the materially and intellectually advanced tools that would have been regarded as normal a few decades later. Le Roux's term of 'proto-recherche' to describe what was being done fits the bill perfectly, evoking the sense of change while retaining the activity as something we can and should properly define as research.

Another study that reinforces the point is Nicole Chézeau's *De la forge au laboratoire*[5]. A central theme of this book is the continuity

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4 Muriel Le Roux, *L'Entreprise et la recherche. Un siècle de recherche industrielle à Pechiney*, Paris, Éditions Rive droite, Institut pour l'histoire de l'industrie, 1998.

5 Nicole Chézeau, *De la forge au laboratoire. Naissance de la métallurgie physique (1860-1914)*, Rennes, Presses universitaires de Rennes, 2004.

between the advanced techniques and theories of twentieth-century metallurgy and their roots in the European and American workshops and production lines of iron and steel manufacturers in the nineteenth century. Chézeau resists the temptation to see this world of workshops and production as distinct from the one in which Henry Chatelier, Floris Osmond, and others refashioned metallurgy after 1900, introducing the now familiar battery of microscopes, bench-based chemical techniques, and phase diagrams. Instead, she demonstrates that the world of Le Chatelier and Osmond not only had roots in the less 'scientific' workshop tradition but also remained close to it. The emergence of metallurgy as a 'big' science emphatically did not entail the either the disappearance or the irrelevance of the practices of the workshop and the factory-floor. The boundaries between the two realms were shifting, and porous to a degree that makes the very notion of boundaries a potentially misleading one.

With such considerations in view, the Mulhouse conference set itself a fluid but clear agenda, and it pursued the agenda through studies of which the contributions to this volume and a recent special issue of *Annales historiques de l'électricité*[6] are the revised versions. As these introductory remarks have indicated, the emphasis was on the need to rethink some of the most fundamental categories we use, as historians, in our analysis of the relations between science, technology, and industry. That led in turn to an engagement with change and a recognition of the difficulty of retaining firm definitions when we try to apply these to different periods, locations, and industries. The historiographical challenge was formidable, and the participants in the conference were only too conscious of what remains to be done if we are to achieve the goal of a truly integrated account of the many faces of research in the field of electrical technology since the mid-nineteenth century. Case-studies in themselves cannot be the complete answer. But when such studies reflect ideals of inclusivenss and breadth of perspective of the kind that speakers set themselves in Mulhouse, they not only add to our stock of knowledge of a subject with immense potential for further enquiry; they also, and more importantly, suggest directions that future work might take. Those at least were the purposes of the conference, as they also are of this volume.

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6 "Recherche et innovation dans l'industrie électrique", published as *Annales historiques de l'électricté*, No. 5, 2007.