Conference Reports

From the Test-tube to the Autoanalyzer: The Development of Chemical Instrumentation in the Twentieth Century, Workshop of the Commission on the History of Modern Chemistry, Science Museum London, 11-13 August 2000.

Today we are almost surprised that mainstream philosophers of science ignored nearly every aspect of both scientific instruments and experiments until the early 1980s. So, what was that thing called 'science' that they were taking about? First of all, it was an intellectual construction, designed to provide reliable knowledge. Knowledge about what? Those who called themselves 'positivists' or 'empiricists' were concerned about knowledge of sense data provided through the 'naked eye'. They considered basic sensation the most unconditional and decontextualized form of cognition, and as such the most suitable kind for a logical basis or the touchstone of truth. The prize for truth was high, however. It was complete disconnection from all experimental sciences. The 'spectator view' of knowledge, as the pragmatist John Dewey ridiculed it, was a bizarre fiction of science by philosophers.

In the 1920s, the physicist (or physical chemist) Percy W. Bridgman suggested the most radical counter-approach, operationism, that considered experimental operations including instruments, instead of sense data, as the basis of scientific concept formation. Philosophers, who realized that this contextualization undermined the purity of their 'empirical' truth basis, sharply reacted. As Gustav Bergmann put it in the early 50s ('Sense and nonsense in operationism', 1954) in the most absurd manner, experimentation and instrumentation do not add anything fundamentally new – in principle, we could remain spectators and wait until each of the experimental set-ups of science incidentally emerge in nature on their own. By then, mainstream philosophers of 'science' had lost any connection even to experimental physics, as they never had any to chemistry – and what is worse, they did not even realize that.

Strangely enough, it was particle physics, its accelerators and cloud chambers, that became the first object of interest in instrumentation by philosophers of science such as Ian Hacking, Allan Franklin, and Peter Galison in the 1980s. Previous sociological approaches, the so-called laboratory studies of Bruno Latour, Steve Woolgar, and Karin Knorr-Cetina, might have provoked this interest, since they raised severe epistemological questions concerning all philosophies of science that ignore the social context of scientific practice. Philosophers, who were already before forced to give up the strict theory-experience distinction and thereby the 'naked eye' basis of truth, now sought new fundaments in experimental practice, to the effect that there was a boom of the so-called 'new experimentalism' in the late 80s and early 90s. At the same time, also many historians of science gave up their former focus on theories and ideas and started to produce a wealth of in-depth studies on instrumentation, frequently inspired or even co-authored by sociologists and philosophers of science of the new approaches.

From that period is the only corresponding book on chemistry worth mentioning (*The History and Preservation of Chemical Instrumentation*, ed. by J.T. Stock & M.V. Orna, Dordrecht 1986) which is basically a rough stocktaking of recent developments in instrument making and includes some aspects of instrument preservation in science museums. (There is one earlier book that is mainly on US history and less reliable: *A History of Analytical Chemistry*, ed. by H.A. Laitinen, G.W. Ewing, ACS 1977). Despite the two facts that chemical instrumentation goes back to at least as far as Arabic alchemy and influenced 20th century chemistry more than anything else, historians of chemistry have showed extremely little interest in that topic; nor did they feel any ambition to enter the parallel discussions in philosophy and sociology of science. Thus, it is not surprising that the German Chemical Society (GDCh), who annually awards the most prestigious international prize for the history of scientific instruments since 1993, the Paul Bunge Prize of the Hans Jenemann-Foundation, have never found a suitable candidate from the history of chemistry but, for instance, several from the history of astronomy.

Thanks to the recently founded Commission on the History of Modern Chemistry (*cf.* HYLE **5** (1999), 171-4) the odd situation might change in the future because their recent workshop was on "From the Test-tube to the Autoanalyzer: The Development of Chemical Instrumentation in the Twentieth Century", hold at the Science Museum London, 11-13 August 2000. The organizers – PETER MORRIS (Science Museum, London) assisted by CARSTEN REINHARDT (Germany), TONY TRAVIS (Israel), and LUIGI CERRUTI (Italy) – did an excellent job of broadening the focus beyond isolated stories about the invention and making of instruments. Emphasis was rather on the mutual impact between chemical instrumentation, on the one hand, and various aspects and fields of chemistry, neighboring disciplines, chemical industry, technology, politics, economy, and environmental issues, on the other. They also expected stimulation from philosophy, as they invited at least one commentator and two speakers from philosophy of chemistry.

The well-prepared workshop was divided up into four sections with each three pre-circulated papers and two distinguished commentators: "*Different Approaches to the History of Chemical Instrumentation*" (DAVIS BAIRD, USA; JOACHIM SCHUMMER, Germany; TERRY SHINN, France; and commentators ARNOLD THACKRAY, USA; JAMES BENNETT, UK); "*Structures, Spectra, and the Quest for Precision: The Chemical Sciences*" (CHARLOTTE BIGG, UK; CARSTEN REINHARDT, Germany; LEO SLATER, USA; and commentators CARL DJERASSI, USA; DAVID KNIGHT, UK); "*Detection and Control: The Environmental Sciences and the Chemical Industry*" (TONY TRAVIS, Israel; PETER MORRIS, UK; STUART BENNETT, UK; and commentators ERNST HOMBURG, Netherlands; WILLIAM H. BROCK, UK); "*Organisms, Automation, and Innovation: The Biomedical Sciences*" (NICHOLAS RASMUSSEN, Australia; DAVID BROCK, USA; LUIGI CERRUTI, Italy; and commentators CHRISTOPH MEINEL, Germany; PIERRE LASZLO, Belgium/ USA).

As it happened, the section 'Different Approaches' was not as different as the organizers might have expected, so that I will regroup the papers and start with TERRY SHINN's. His concept of 'research-technology instrumentation', originally developed in a historical case study on the ultra-centrifuge, combined both methodological and sociological categories to analyze the generation of new devices applicable in diverse fields. Its key features are 'genericity' (general purpose, open-ended design), 'interstitiality' (interdisciplinarity, involvement of various social institutions), and 'metrology' (standardization of units and procedures of measurement). Both CHARLOTTE BIGG and DAVIS BAIRD (more or less intentionally) provided excellent examples of how this concept can help understand the successful development of spectrometers in their case studies on the British company Adam Hilger, Ltd. and the US company Baird Associates, respectively. Furthermore, Stuart Bennett's study on the development of control instruments, with emphasis on their use in the chemical process industry, may be regarded a third example of applying Shinn's concept of research-technology devices.

As another coincidence, both LEO SLATER and JOACHIM SCHUMMER, though from completely different perspectives, suggested that the rapid development and ubiquitous use of spectroscopic methods changed, in view of chemists, the ontological status of molecular structures: from properties to entities. Slater ("Woodward and the Reification of Chemical Structures") referred to natural product chemistry and used biographical material particularly of Woodward. Schummer, in an effort to analyze the impact of spectroscopy on identity concepts in chemistry, referred to synthetic chemistry and applied content analysis of randomly selected paper of the past 100 years. Both came to different results, however, as concerns dating and evaluating the ontological change. The third paper on instrumentation in organic chemistry, was CARSTEN REINHARDT's astute analysis of the development of mass spectroscopy. Originally developed for gross analyses in the petroleum and synthetic rubber industry, mass spectroscopy became one of the most powerful methods of structure elucidation of organic products in the 1960s, and as such superseded the classical chemical methods. However, unlike other spectroscopic methods, this was achieved by applying a chemically oriented approach, *i.e.* by adopting the concepts of reaction mechanism of physical organic chemistry, as Reinhardt pointed out.

Two papers dealt with the impact of chemical instrumentation on environmental analysis. TONY TRAVIS reviewed the rapid instrumental improvements of quantitative spectroscopic analysis of synthetic organic compounds and trace metals since the 1930s, illustrated by the tremendous shift of detection limits from the ppm to the ppt range. As his main thesis, he argued that the driving force of improving instrumental techniques for environmental analysis and monitoring was the control of laboratory conditions and manufacturing processes within the chemical industry. In a sense complementary was PETER MORRIS' study of the development of the electron capture detector and its application in environmental analysis. On the one hand, he gave a biographic account of its inventor, James Lovelock, one of the most unconventional physical chemists who was incidentally also the inventor of the Gaya thesis. On the other hand, he placed the improvement of detection methods in the context of both the competition with bioassay methods and the medical as well as political question of threshold values. As chemical detection levels are now frequently below politically fixed threshold values, Morris concluded that chemists have done their job. Nonetheless, I think the issue seems to be worth further sociological investigation as to how chemical instrumentation has impact on the public awareness and assessment of environmental issues.

The final section, on chemical instrumentation in the biomedical sciences, consisted of three papers, each exploring disciplinary boundaries with different philosophical implications. DAVID C. BROCK analyzed the origin, development, and marketing of chemical autoanalyzers in the clinic, as a continuation of Foucault's social history of medicine. He argued that the clinic was the birthplace of the autoanalyzer and remained the center of its technological evolution until at least the 1970s. This in turn changed the clinical practice fundamentally, from classical pathology to biochemical 'chart analysis' in which blood values rather than human bodies are subject to therapy. In his study on chromatographic and electrophoretic techniques, LUIGI CERRUTI first showed how these methods were crucial to the development of biochemistry, particularly to protein biochemistry, since they allowed for the first time the isolation of many compounds to be followed by biochemical reasoning on the structure-function relationship. In his second part, he provided many examples of how this biochemical approach was mixed and combined with classical biological approaches, originating new hybrid disciplines such as molecular evolution. NICLAS RASMUSSEN's study on the bioassay as an biochemical instrument, while being full of historical details, essentially presented an interesting antireductionist argument that I would reformulate in the following manner. Insofar as biochemical properties are operationally defined by means of bioassays, and thus necessarily depend on concepts of biological functionality, they cannot be reduced to chemical properties alone as long as the concepts of biological functionality are not redefined in terms of chemical properties.

Overall, the workshop took place in a very stimulating atmosphere, supplemented by Peter Morris's circumspect care of all the participants' needs. Given the previous lack of interest in the topic, a great deal of work of gathering historical material was necessary and much is still to be done. The way in which the material was placed in topics of general interest, *i.e.* the mutual relation between instrumentation and various scientific and non-scientific fields, should be continued and further enlarged. Having been both a philosophical participant and 'observer', I may suggest that philosophy of technology and philosophy of chemistry should even be more considered as complementing and inspiring future historical research. As to the former, clarification and diversification of concepts such as 'instruments' or 'tools' in terms of purposes inside and outside of science might be helpful to systematize the material and to draw more precise conclusions. As to the latter, I am pleased to say that there is now a growing number of philosophers of chemistry who are interested in instrumentation and could further enrich the discussion.

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Wilhelm Ostwald at the Crossroads of Chemistry, Philosophy, and Media Culture, University of Leipzig, 2-4 November 2000.

When Ostwald received the Nobel Prize of chemistry for his work on catalysis in 1909, he had already retired 3 years ago, at the age of 53, from his chair of physical chemistry at the University of Leipzig. How did this most influential cofounder of the new physical chemistry spend his remaining 26 years at his private estate near Leipzig, after having educated some 100 later professors of physical chemistry worldwide; and why did he finished his successful university career at all?

Nicely located at the University of Leipzig, an international workshop organized by philosopher of chemistry Nikos Psarros and historian of chemistry Britta Görs, shed new light on widely unknown facets of a great chemist. To start with the final discussion, the number of papers (16) did not suffice to cover all his manifold activities. Besides Ostwald the physical, analytical, and technical chemists, the founder and editor of chemistry journals and book series, the tireless chemistry textbook writer and historian of chemistry, there was also Ostwald the quick-witted philosopher, the ardent reformer and leader of various international movements, the enthusiastic popularizer of science, as well as the painter and poet who tried to apply the aesthetic theories on which he had been working so hard during his final 20 years.

Did all these activities spring up from his chemistry? Not directly. It rather emerged from philosophical reflections on chemistry. Ostwald himself was quick in elaborating his views towards an abundant and complex philosophy of nature that incorporated even sociology, psychology, ethics, and aesthetics. Though he received harsh criticism from many of his scientific colleagues, his philosophy was throughout scientistic, an all-embracing scientific world view, largely based on three principles: an ex-