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Book Review

Davis Baird: *Thing Knowledge: A Philosophy of Scientific Instruments*, University of California Press: Berkeley–Los Angeles–London, 2004, xxi + 273 pp., ISBN: 0-520-23249-6

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Historians of technology have long disputed the notion that technology is simply applied science by providing numerous examples of technological developments that emerged autonomously and independently from scientific theories. On a surface level, this book simply extends the argument by pointing out the autonomy of instruments and their independence from theories within science. Yet, the case to be made is much more difficult, because Baird argues that scientific instruments are epistemologically on par with theories, that they constitute an independent and material form of knowledge that he calls "thing knowledge". Thus, he tries to overcome the old philosophical dogma, according to which knowledge is essentially mental or intellectual and never material, by adding a "materialist conception of knowledge" (p. 1). What makes the book particularly interesting for historians of science is that Baird uses a wealth of historical studies on scientific instruments to argue for his epistemological case.

Baird distinguishes between three kinds of "thing knowledge": First, there is "model knowledge" in the form of material models that, like theories, represent the world and allow exploring our understanding and manipulation of the world. Examples include Rowley's orreries in astronomy, Smeaton's model waterwheel in civil engineering, and Watson's cardboard models of DNA. Since these material models play roles epistemologically analogous to intellectual theories, he concludes that it is justified to take them as a form of knowledge.

Second, there is "working knowledge" in the form of instruments that create and stabilize scientific phenomena by controlling the behaviour of artefacts. Historical examples are Faraday's electromagnetic motor, Watt's steam engines and pulse glasses, Boyle's air pump, and, more recently, particle accelerators. By arguing that at least some of these instruments were historically developed independently from theory or in spite of misleading theory, Baird points out the cognitive autonomy of such instruments as an own form of knowledge.

Third, "encapsulated knowledge" integrates model knowledge and working knowledge, as well as theoretical knowledge, in the form of measurement instruments. His main historical examples are spectrometers for chemical analysis that have arguably brought about an instrumental revolution in chemistry (see also P. Morris (ed.): *From Classical to Modern Chemistry: The Instrumental Revolution*, Cambridge 2002). This allows Baird to develop a third, historiographic argument for thing knowledge. If we limit the history of science to theories only, we would fail to understand extremely important developments in science.

Baird illustrates the productivity of his "materialist account of epistemology" by discussing many further topics of which I pick only two that are particularly important for chemistry. First, his account sheds new light on the notion of objectivity. By encapsulating and black-boxing knowledge in instruments, a new form of "public objectivity" emerged that, in analytical chemistry, superseded the objectivity based on the personal expertise of chemists. Second, as materialized forms of knowledge, scientific instruments became commercial products and thus started a long-term trend of the "transformation of all knowledge into commodities".

Despite all these convincing arguments, I find Baird's epistemological main thesis, according to which scientific instruments *are* a material form of knowledge, still difficult to swallow. And so does he when he varies his wording, writing that instruments "constitute" (p. 1), "bear" (p. 15) or "express" (p. 131) knowledge. While I am still struggling with myself

about what the best formulation would be, I can strongly confirm that the book provokes philosophers into rethinking the notion of knowledge and, at the same time, opens up and explores new areas in the history of science.