HYLE--International Journal for Philosophy of Chemistry, Vol. 12, No.1 (2006), pp. 157-159.
http://www.hyle.org

HYLE Book Review

The End of Silent Rites

Philip Ball: *Elegant Solutions: Ten Beautiful Experiments in Chemistry*, The Royal Society of Chemistry, Cambridge, UK, 2005, vii+212 pp. [ISBN 0-85404-674-7]

by *Joachim Schummer**

In 2002 the American Chemical Society (ACS) asked its members to submit proposals for the "ten most beautiful experiments in chemistry" (*C&EN*, Nov. 18, 2002, p. 5) and then proudly published the result of the vote in its *Chemical and Engineering News* magazine (*C&EN*, Aug. 25, 2003, pp. 27-30). Democratic as the procedure is, it avoids asking critical questions: What is an experiment? What is beauty? What is chemistry? In fact, you need not be able to give an answer to these questions in order to vote. We could even imagine none of the voters being able to answer any of the questions in explicit terms. And yet, the members of the society might correctly consider the result valid, not only with regard to the top ten list but also regarding its implicit definitions of what 'experiment', 'beauty', and 'chemistry' means. The result thus reflects the tacit knowledge and the unquestioned feelings of the majority, as they have previously been trained to respond to such unusual questions, and helps newcomers to acculturate easily. However, such implicit consensus definitions and assessments are neither binding for non-members, nor suitable for explicit debates. Prompted by the questions of what a beautiful experiment in chemistry is, you might repeat the top ten list you have learnt by heart, but otherwise remain silent.

Now imagine that 'beautiful' is just another term for 'important' and that 'experiments' means whatever chemists are doing in their labs. How can you educate young chemists to become researchers doing important chemistry if you avoid discussing what 'important' means? They can gather the meaning of 'importance' from the role models of the top ten list, you might respond. The list includes, of course, the most famous heroes from the history of chemistry and captures their most important breakthrough experiments. By copying or transferring to current research issues the heroic deeds of the past, young scholars can accomplish excellence. Now, if the key to doing important chemistry is learning from the history of chemistry, why did the ACS encourage doing history of chemistry in the clumsiest manner one can imagine – by collecting and ranking decontextualized historical 'facts' and anecdotes from the memory of its members who used to have no training in the history of chemistry? Because the scholarly historiography of chemistry does not matter here, you might respond. What matters is only what today's chemists consider to be important chemistry of the past, be that invented anecdotes or not. The reference to the past only serves as a means to communicate about the values of today – in lack of an explicit discourse about values such as importance. In other words, the democratic ranking is a rite of the tribe of the chemists.

Why and how then did such an accomplished science writer as Philip Ball create his own list of "ten beautiful experiments in chemistry"? On the one hand, the project was commissioned by the British Royal Society of Chemistry, in response to the ACS ranking, of course. On the other, Ball has in fact been seriously searching for the role of aesthetics in chemistry before, though not in the design of experiments. Thus, the book was from the outset a compromise, but one that helped him counterbalance and, I am sure, redirect the chemists' interest in beauty. In almost any regard, he puts emphasis on the opposite of the ACS approach, even if his list of experiments, at first glance, greatly overlaps with that of the ACS. Thus, the book starts out with conceptual clarifications. It questions the concept of experiment as theory testing, which has led generations of philosophers of science to such absurdities as 'astronomical experiments', and emphasizes the explorative, manipulative, and technological character of chemical experiments. Unlike the ACS, it rejects the idea that a beautiful experiment must be significant or important in retrospect and rules out any serendipity findings of whatever later importance. Instead of providing a ranking, Ball's ten experiments are each meant to illustrate one aspect of beauty. And throughout the section called 'Asking Questions of Nature', it elaborates on the difficult historical distinction between chemistry and physics.

Most important, however, Ball does not present a 'list' of ten experiments, that simple-minded readers could learn by heart, but ten chapters, each exploring an episode in the history of chemistry, from van Helmont's 17th-century experimental approach to the latest achievements in synthetic chemistry. A remedy against the isolated historical 'facts' collected by the ACS, Ball heavily contextualizes 'his experiments' by providing scientific, philosophical, social, and biographical background information, sometimes to the extent that 'the experiment' almost vanishes within the narrative. Moreover, he does away with plenty of anecdotes and myth that the chemistry community and its hagiographers have uncritically spun around their history, from the Wöhler myth to the romancing of numerous chemical heroes. And what is more, he discusses why chemists of all scientists have such a particular need for historical myths and romances (pp. 119-123).

The book is not free of small errors or misleading interpretations, such when Bacon's choice of his book title *Novum Organum* is said to be a metaphor for applied science (p. 2) rather than an allusion to Aristotle's *Organon*; when Lavoisier is made the single author of the New System of Nomenclature (p. 31); or when Pasteur's rejection of spontaneous generation is interpreted as an anti-vitalist move (p. 115). All that is forgivable, however, in the face of the wealth of historical details and in-depth interpretations that are usually based on the latest history of science scholarship. What makes this book particular strong is that it is readily accessible by a general readership with all its historical intricacy and scientific details included. Indeed, Ball is even able to explain in simple words the Woodward-Hoffmann rules, which he needs to make plausible an aesthetic feature of chemical synthesis.

Since each of the ten chapters highlights one feature of the beauty of chemical experiments, they seem to be conceived as individually sufficient conditions rather than as altogether necessary conditions of beauty. This suggests that Ball has ten different concepts or aspects of beauty in mind, which are, in the order of the chapters,

- exact quantification (van Helmont),
- attention to details (Cavendish),
- patience in the conduct of the experiment (Marie Curie),
- elegance in the design of the experiment (Ernest Rutherford),
- miniaturization and acceleration of the experiment (various nuclear chemistry groups),
- conceptual simplicity (Louis Pasteur),
- imagination that transcends common views (Stanley Miller),
- simple-minded, straightforward reasoning (Neil Bartlett),
- economy, avoidance of deviations (Robert B. Woodward), and
- conceptually straightforward design (Leo Paquette).

Although I have pushed Ball's own terms a little bit, it seems obvious that all the ten features are first of all virtues of the experimenter (Ball's main examples are listed above in brackets) rather than attributes of

specific experiments in which these virtues have been materialized. Two important consequences follow from that distinction.

First, the shift from specific historical experiments to experimental virtues allows a more general analysis. Virtues, *i.e.* attitudes and capacities of people, can be more readily transferred from context to context; here, from the specific historical contexts to current research issues. (This is why, in ethics, moral virtues have been preferred over moral values, norms, and consequences by many philosophers since Aristotle.) Thus, provided Ball's experimental virtues are generally accepted, his analysis of beauty provides a much better educational approach than the rite of the ACS.

Second, 'beautiful' is a normative concept that belongs to the realm of aesthetics, besides 'true' (epistemological), 'right' (moral), and 'important' for something else (instrumental). As far as I can see, Ball's concepts of beauty are clearly distinguished from epistemological and moral concepts. Moreover, the focus on virtues allows decontextualizing the experiments and thus abstracts from their historical (*i.e.* instrumental) importance, *i.e.* the experimental virtues of each of the examples are valuable regardless of the historical importance of the specific experiments in retrospect. Hence, Ball 's experimental virtues are clearly distinguished from the three other normative concepts. They comprehend a forth normative realm of what scientists appreciate and value in their experimental practice and which they call, in lack of a better term, 'beautiful'. The book provides no less than the first analysis of that realm regarding chemistry.

Finally, Ball clearly distinguishes his notion of scientific beauty from artistic beauty – if beauty still plays a role in the fine arts. In addition, he rejects the dull notion that a molecule would be beautiful by way of its symmetry (pp. 195-6). While his experimental virtues are scientific rather than artistic virtues, he is confident that in the hands of an artist they could turn into the skills to create true art.

I am sure many chemists will read the book only to learn about what the ten most beautiful experiments in chemistry are, or how they could polish their public image by one or the other association with art. I am also sure that readers, both chemists and nonchemists, will greatly benefit from learning more about the history of chemistry and about what matters in chemical experiments. However, the intellectual strength of the book is that it provokes you to think about how aesthetic values are related to experimental virtues, so that it might end a period of silent rites.

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