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Two Tribes

Image & Logic: A Material Culture of Microphysics
Peter Galison
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This is an important and coherent book. Indeed, it is the second of a planned trilogy of books, seeking not merely coherence but an intellectual programme to explain the nature of modern physics and beyond. It was preceded by *How Experiments End* (1987), which used the history of physics to explain the creation of knowledge. In it, the author implied a hierarchy of theory, experiment and applications. This present book "reverses that perspective", says Galison, placing scientific instruments, not theories, centre-stage. Machines are not merely convenient tools, he argues: they draw together disparate scientific cultures, seed the nuclei of new working practices and even determine how their users visualise the world.

The book devotes over eight hundred pages to seven closely related historical studies and careful generalisations from the world of "microphysics" – a wide category that for Galison denotes studies ranging from raindrops to fundamental particles. A brief review cannot do it justice.

At the heart of the book is the author's mistrust of dichotomies. Understandable neither as a struggle between theory and experiment, nor merely as intellectual rule-making versus social interests, physics is "a complicated patchwork of highly structured pieces" [p. xx]. Nor is this collection of instrument makers, experimenters, theorists and their associated social resources immutable. The nature of experiments and the experimenter have changed dramatically over the century. There are, however, enduring contrasts to be located on the patchwork, and one of the most evident is the fundamentally different approaches of the "image" and "logic" instrument-making traditions in microphysics.

Galison begins with C. T. R. Wilson's turn-of-the-century research into cloud phenomena, and his invention of the "cloud chamber" to create artificial clouds. With it he was able to observe the formation of fogs (visual entities) and, later, the actual tracks of what came to be recognised as charged particles (hitherto theoretical entities). Wilson's photographic analyses brought image-based observation – previously the domain of meteorologists and geologists – to physicists, who

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elaborated its methods by collecting and classifying track patterns into "atlases" for photographic interpreters. The cloud chamber, and its ability to render the physical world in pictorial form, bridged the "morphological" and "analytical" traditions of these two scientific cultures. The "image tradition" was carried on by bubble chambers, closely analogous to the early cloud chambers, and by the use of nuclear emulsions (essentially refined forms of photographic film) which could record the tracks of particles directly.

Galison illustrates the "logic tradition" by the use of electronic counters (such as the Geiger-Müller counter) coupled to electronic logic circuits. By counting "events" such as the simultaneous transit of two charged particles, these more blinkered, myopic devices – detecting only what they were set to look for – could amass large quantities of data to be analysed statistically In return they could detect rarer occurrences and more subtle effects. While visual imagery allowed a single image to serve as evidence, by the 1960s automated methods of image interpretation were sought to deal with the vast numbers of photographs produced by the bubble-chamber research programmes. Logic was partly a way of doing real-time statistics and much more rapid analysis.

All these devices were embedded in the material culture of their times. Nuclear emulsions borrowed the technology of medical x-ray films. Counting experiments were promoted by the influx of war-surplus and novel electronic equipment. Bubble chambers relied not only on post-war technology, but on the methods of teamwork then in vogue in military and industrial laboratories. The genealogy of Monte Carlo simulations can be traced to early electronic computers and nuclear weapons research.

The growing experimental complexity of all these instruments created an almost impenetrable wall between the two traditions. Experimenters could no longer cross over from one methodology to the other, or even fully understand each other. Hence Galison's anthropological concept of a 'trading zone' between scientific cultures and sub-cultures. Those scientific workers at the boundaries between the image and logic sub-cultures, or between theory and experiment, military and civilian science, had to develop local languages to translate between them. The author sees the use of local languages – pidgins and creoles –as being common for technical exchanges between varieties of physicist and engineer. This fertile analogy works very well for what Galison to some extent disparages but acknowledges to be a seductive and ubiquitous idea in science studies: the notion of science as "island empires, each under the rule of its own system of validation" [p. 12].

What interest does this book have for public policy? Perhaps the major relevance concerns the context of funding and intellectual sponsorship. The author shows how the two methodologies of image-based and logic-based experimentation each dominated microphysics at various times, and how funding institutions mirrored physicists' own weighting of their relative merits and discovering power. He also details the consequences of big science through the ill-fated Superconducting Supercollider (SSC) project.

Galison succeeds admirably in his goal of explaining how "these machines, these gases, chemicals and electronics, came to make facts about the most theoretically articulated quadrant of nature" by exploring "the site where engine grease meets up with experimental results and theoretical constructions" [p. xvii]. We must remember, though, that this *tour de force* focuses on perhaps the most prestigious and esoteric part of modern science – a behind the scenes look at high church practices, as it were, rather than into the chapel were most of the faithful worship. Nevertheless, by unravelling the particular paraphernalia, resources and methods of this elite, Galison suggests just how effective this approach can be for understanding other branches of science and technology.

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