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Review

Reviewed Work(s): How Experiments End. by Peter Galison

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local factors. At this local level, Fantasia's studies are well worth reading. They are an insightful look at how collective action is culturally constructed at the microsociological level. Yet Fantasia's study illustrates that to understand the American worker, we must focus more on the relationship between the micro and macro levels.

How Experiments End. By Peter Galison. Chicago: University of Chicago Press, 1987. Pp. xii + 330. \$37.50 (cloth); \$14.95 (paper).

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Every experimental result in frontier science is attended by doubt and uncertainty. Did I do it right? Is what I am looking at signal or noise? This result may be strong enough to counter Professor Smallfry's arguments, but what if Professor Toughguy sides with him? In more abstract terms, the Duhem-Quine thesis and the Experimenter's Regress show that theory is underdetermined by evidence. Peter Galison sets out to answer the question "Given these circumstances, how do experiments ever come to an end?" Interwoven is the theme of the increasing scale and cost of 20th-century physics, with its relative inflexibility of experimental design and its move to collaboration and teamwork. What difference has this made to the way experiments end?

To illustrate his arguments, Galison looks at three periods in modern physics, culminating with high-energy experiments with gigantic particle accelerators. In its combination of philosophical and historical sophistication and grasp of the technical detail of modern physics, *How Experiments End* can be compared only with Pickering's *Constructing Quarks*. Pickering held a doctorate in high-energy physics before turning to sociological history, whereas to complete this book Galison took a second degree in high-energy physics—a tribute not only to himself but also to the American educational system.

In its aims and its major argument the book is admirable. Galison sees the ending of experiments as the "building up of a persuasive argument about the world around us . . . in the absence of the logician's certainty" (p. 277). His primary targets are oversimplified philosophical models and whiggish histories: "Unravelling these factors is essentially a historical enterprise, one that follows no fixed set of rules" (p. 277). He ends the book with a lovely metaphor: "The sunset, refracted through the dust and droplets kicked up by all that has happened, recounts in compressed form the whole story of the day. The end of an experiment resembles this sunset, recapitulating in a human context the encounter of reason with the world" (p. 278). His secondary target is sociological "interest theory" and especially Pickering's version, which gives primacy to interests on the basis of investments in certain mathematical techniques.

The high point of the book, Galison's analysis of the consequences of different experimental traditions and styles in high-energy physics, provides a welcome counter to Pickering's theoretical chauvinism.

Galison extends his attack on Pickering to the whole genre of sociological relativism: "Nor can experimentation be parodied as if it were no more grounded in reason than negotiations over the price of a street fair antique" (p. 277). To counter relativism, he shows that experimentalists change their minds in the face of recalcitrant data. In this respect the book is very like Rudwick's *Great Devonian Controversy*. To maintain this stance, Galison has to square it with the underdetermination that sets up the original puzzle. He describes how most experimenters (an exception is Millikan) finally give up the defense of their preconceptions when "every reasonable test [leaves the effect] unaltered" (p. 259). He suggests that the persuasiveness of experimental evidence increases with its "directness" and "stability." Of course, Galison's observations on these points are correct, but they can be epistemologically decisive only if one is content not to ask questions such as "What is reasonable?" "Why do some people see one stopping point as reasonable while others do not?" "Is what counts as directness the same for everyone?" "How are people who refuse to accept that an event is stable excluded from participation in the ending of experiments?" Asking these questions of Galison's case studies would transform his question about how experiments end into the standard sociological debate about "closure" of scientific controversies, with its far less comforting epistemological conclusions. Gary Taubes's journalistic account of some of the same episodes, *Nobel Dreams*, makes an interesting companion volume.

In fact Galison's discussion of differing experimental traditions is a paradigmatic study of the problem of "closure" if one sets aside certain historiographic reservations. The people Galison interviewed all seem to be principal actors in the game—those who form our notions of what is reasonable. This makes the eventual conclusion seem to follow naturally from the evidence. Nowhere does one get the impression that he has forced himself to face up to the problem of the scientifically unpersuaded—the starting point of the principle of symmetric treatment of the right and the wrong that informs sociological studies of scientific knowledge. One would have liked to see some of Rudwick's diagrams in the book so that the problem of unbelievers was more salient. On the other hand, perhaps there just are no lasting recalcitrants in high-energy physics. That might be the most important consequence of the move to big teams; perhaps science is transforming itself into its textbook image.