A View of Scientific Thought

Genesis and Development of a Scientific Fact. LUDWIK FLECK. Translated from the German edition (Basel, 1935) by Fred Bradley and Thaddeus J. Trenn. Thaddeus J. Trenn and Robert K. Merton, Eds. University of Chicago Press, Chicago, 1979. xxviii, 204 pp., illus. $17.50.

In 1935 Ludwik Fleck, a Polish-Jewish serologist and microbiologist working at a bacteriological laboratory in Lvov, published a book called *Entstehung und Entwicklung einer wissenschaftlichen Tatsache*. Only 200 copies were sold, and of those just seven apparently found their way into American libraries. Eleven reviews had appeared by 1937, all in European journals, most written by medical practitioners or historians of medicine. One of the early readers of the book, however, was the philosopher of science Hans Reichenbach, who cited it in a footnote to his 1938 *Experience and Prediction*, where he gave a fundamentally misleading account of Fleck's epistemological orientation. Fleck himself never returned to the concerns of his book in any significant way. In the same year it appeared he was sacked from his laboratory post because of his religion. When Lvov came under German control, Fleck was offered Nazi hospitality at Auschwitz and Buchenwald, where he survived thanks to his utility in preparing antityphus vaccine (produced, he assured the Germans, only from the urine of Aryans). After the war Fleck worked for some years at the Institute for Microbiology at the University of Lublin before Polish authorities finally granted a long-standing request to emigrate to Israel. He died there in 1961.

Until quite recently neither the name of Ludwik Fleck nor the ideas contained in his book meant anything to historians and sociologists of science. In 1950 Thomas S. Kuhn, then a junior fellow at Harvard, chanced to see Reichenbach's footnote and located a copy of Fleck's book in the Harvard library. When Kuhn's *Structure of Scientific Revolutions* appeared in 1962, it contained a generous acknowledgment of *Entwicklung und Entstehung* as "an essay that anticipates many of my own ideas . . . I am indebted . . . in more ways than I can now reconstruct or evaluate." Since that time, owing to Kuhn's celebrity, scholarly curiosity about Fleck has been growing, even though few have been able to obtain the original or to plow their way through the sometimes difficult German prose style. Thaddeus Trenn and Robert Merton now make available an English translation so that Fleck's place in the sociology of scientific knowledge can be properly understood.

The core of Fleck's book is an interpretation of the relationship between the notion of syphilis as a disease entity and the development of the Wassermann test for its diagnosis. How, he asks, did the thing now understood by the term "syphilis" and the Wassermann reaction as a reliable indication of "syphilis" come to be *facts*? To many scientists, just as to many historians and philosophers of science, this is an odd, even perverse, question to pose. Facts are things that simply are the case; they are discovered through properly passive observation of natural reality. To such views Fleck replies that facts are invented, not discovered. Moreover, the appearance of scientific facts as discovered things is itself a social construction: a *made* thing. Thus, Fleck wants to account both for the processes by which something becomes a scientific fact and the illusion that no active social processes were involved in its making. He wants to explain how, as it were, the ship got into the bottle and also how, once in the bottle, it appears impossible that it was ever outside.

Fleck's way toward a sociological interpretation of the making of scientific facts lies through a repudiation of inductivist and individualistic pictures of the nature of science. Scientific thought has a holistic character. At the cognitive level this is manifested in the notion of the "thought style" (*Denkstil*) and at the social level through the entity that expresses and maintains it, the "thought collective" (*Denkkollektiv*). Building on the work of the anthropologists Durkheim and Lévy-Bruhl and of Viennese anti-*Wiener-Kreis* philosophers, Fleck asserts the essentially social nature of thought. Indeed, cognition "is the most socially-conditioned activity of man, and knowledge is the paramount social creation." All cognition and perception occur within a particular thought style, which Fleck characterizes as "a readiness for directed perception."

Like Durkheim's "collective representations," Fleck's "thought style" has a compelling force. The thought style constrains the ways in which it is possible to perceive reality. One is inducted into a thought style through an "initiation rite"; within it the shape of answers is preformed in the nature of permissible questions. In the medieval thought style syphilis was reckoned to be a "carnal scourge" resulting in pathological syphilitic blood; in the thought style of the early 20th century syphilis was the effect of a particular microorganism (*Spirochaeta pallida*) which attacks the body and against which the body produces specific immunological defenses. Perceiving syphilis in one or the other compulsory way is the result of the moral force exerted by a thought collective.

In his advocacy of a social epistemology for the study of science Fleck moved beyond Durkheim or even Mannheim, who applied their methods to the thought of "savages" or to nonscientific thought while holding "an excessive respect, bordering on pious reverence, for scientific facts." For Fleck, and for an increasing number of present-day sociologists of science, it is necessary to treat all thought symmetrically, whether it is currently evaluated as "false" or "true." There is no reason to think that a sociological account undermines the validity of science or its utility for specific purposes.

If scientific facts are socially constructed, why is it that they appear not to be? Fleck's answer to this question is grounded in an intriguing analysis of the effects of history and communication in the thought collective. In 1906 Wassermann and his colleagues published their first work on "A serodiagnostic reaction with syphilis." The reaction they described was far from precise, and the results fluctuated. However, they stated quite clearly that what they were searching for was syphilis antigen and a specific reaction between syphilis antigen and syphilis antibodies. Originally, extracts from syphilitic organs were used, but soon it was discovered that even extracts from normal organs could yield a positive reaction in the complement-fixation test system. The actual presence of *Spirochaeta pallida* was not, therefore, a diagnostic requisite. Years later Wassermann reflected upon what he had been doing in the chaotic early days of the work. He claimed that he had all along been looking for syphilis antibodies and not for a specific reaction between anti-

gen and antibodies. A meandering and diffuse scientific development had become, in reconstruction, a straight and goal-directed process, the result of clear individual intentions. This, Fleck suggests, is how memory works. The socially constructed character of a scientific fact had become submerged in a recollected account of clear individual goals. When the new thought style has developed, everything that preceded it is necessarily reprocessed in terms of the new Gestalt. This is how thought styles leave their imprint on scientists' sense of history.

Even more interesting is Fleck's account of the relationship between what he calls "journal science" and "vademecum science." Journal science, while a poor indication of actual scientific practice, nevertheless represents findings as provisional and dubitable. Journal science is the science of the esoteric core of participants; it makes a plea for the findings to become collectively accepted facts. As the findings are communicated to the exoteric periphery, and as the periphery then represents findings to a wider audience, the results become vivid, self-evident, and given. They are made into hard facts. Fleck is not offering merely an account of the "popularization" of science. He claims that "every communication . . . tends to make any item of knowledge more exoteric and popular." That is to say, the act of transmitting findings is what makes scientific facts acquire their apodictic character. The history of the Wassermann reaction exemplifies the process whereby journal science was made into vademecum science. The development of any scientific fact is an artifact of the social processes of communication.

In general terms, what Fleck was aiming for was a picture of the connection between "active" and "passive" elements in knowledge. The passive component of knowledge is what we call "existence" or "reality"; it seems independent of us and compels us to accept it. On the other hand, what Fleck calls the active components of knowledge rest upon particular dispositions, assumptions, and goals actively adopted by the thought collective. Fleck does not, however, use the distinction between active and passive to place limits on relativism. In his account, active and passive are "inevitably united." For example, if we actively adopt 16 as the atomic weight of oxygen, then it will "inevitably" (passively) follow that the atomic weight of hydrogen will be 1.008. Yet this passive feature will itself be a function of the assumptions and goals adopted by a particular thought collective and is, therefore, explicable in terms of cultural history. What appears passive and a function of "reality" in one set of circumstances may appear actively constructed in another. One cannot isolate purely passive features of knowledge. Hence, there is nowhere that cultural history (or, as we would now say, "sociology of knowledge") cannot go.

Fleck slyly suggests that scholars have a tendency to regard as hard and immutable those areas of culture with which they are unfamiliar. The philosophers of the Vienna Circle, trained in the natural sciences, maintained that ideal human thinking ("logic") was fixed and absolute whereas empirical facts were relative. Humanistically trained philosophers, contrarily, tend to treat human thought as relative and empirical facts as given. Might it not be possible, Fleck asks, to manage without the notion that anything is fixed?

Genesis and Development of a Scientific Fact is a flawed book; it is poorly organized and repetitious. Its empirical materials are a messy jumble, ranging from anecdotes of the author's own scientific experiences, through patchy extracts from histories of medicine, to snippets from the journal literature of early-20th-century serology. It is also a work of transparent brilliance: one of the most significant contributions toward a thoroughly sociological account of scientific knowledge.

For all that, it is difficult to know what role Fleck's book ought to play in the history and sociology of science. Certainly, it ought to be read and seriously discussed; there is no doubt that we still have much to learn from Fleck. There is no reason to regard him merely as a precursor of Kuhn, for all the striking resemblances noted by Kuhn and others. In many respects Fleck's relativism and his search for a social epistemology are more vigorous than Kuhn's. On the other hand, the style of research into the nature of scientific knowledge has, at last, caught up with Fleck. While relativism and advocacy of a sociology of scientific knowledge are by no means dominant positions, they are steadily gaining in academic significance. Moreover, empirical work predicated upon orientations similar to Fleck's is growing in quantity and persuasiveness.

Fleck's truest legacy may be his passionate conviction that we will never be in a position to understand scientific culture scientifically if we persist in an egocentric attitude toward it. Whatever is known has always seemed indubitable to the knower; equally, whatever is alien has seemed fanciful and arbitrary. If we do not find the courage to examine science sociologically and comparatively, we will remain like the 18th-century French philologist Fleck describes. "*Pain, sitos, bread, Brot, panis* were," the savant claimed, "arbitrary, different descriptions of the same thing. The difference between French and other languages . . . consisted in the fact that what is called bread in French really was bread."

STEVEN SHAPIN
Science Studies Unit,
University of Edinburgh,
Edinburgh EH8 9JT, Scotland

Oxygen Metabolism

Oxygen Free Radicals and Tissue Damage. Papers from a symposium, London, June 1978. Excerpta Medica, Amsterdam, 1979 (U.S. distributor, Elsevier, New York). viii, 382 pp., illus. $52.75. Ciba Foundation Symposium 65 (new series).

The product of the limit reduction of molecular oxygen is water, and therein lies the greatest advantage of using the oxygen molecule as the terminal electron acceptor in bioenergetic systems. Indeed, the electron transport systems of aerobic organisms are designed to produce water as the sole product of the reduction of O_2, thereby avoiding the large-scale formation of superoxide radical (O_2^-), hydrogen peroxide (H_2O_2), and hydroxyl radical ($OH^\cdot$). However, it is now clear that finite quantities of these reactive intermediates are produced in aerobic organisms by minor pathways of oxygen utilization, and the possibility of hazardous consequences arising from the generation of these species has to be considered. *Oxygen Free Radicals and Tissue Damage* is a collection of papers presented at a symposium on the subject. Starting off with Hill's paper on the chemistry of dioxygen and its reduction products, the book deals with the biological mechanisms by which reactive intermediates of oxygen reduction are produced, their possible roles in the generation of tissue damage, and the roles of certain enzymes as defensive mechanisms against oxygen toxicity.

Several of the papers discuss the possible mechanisms of cytotoxicity produced by oxygen radicals. The data of Bielski and Shiue on the reactivity of O_2^- with amino acids appear to preclude significant damage to proteins as a result of the formation of that radical. On the other hand Fridovich gives compelling evi-