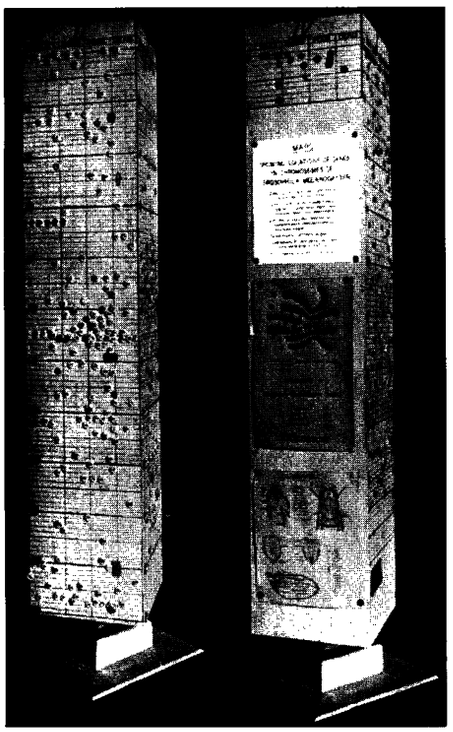
development and evolution did arise in the 1930s, but at considerable cost to both fly and fly people. George Beadle's work with Boris Ephrussi on the formation of *Drosophila* eye pigment led him to abandon the fly for the bread mold *Neurospora*. Theodosius Dobzhansky made a smaller shift in organism (to the wilder *Drosophila pseudoobscura*), but his novel work on the genetics of natural populations so disrupted the Caltech status hierarchy that he felt compelled to leave for Columbia. New species correlated with new species of scientific work.

It should be clear that Kohler presents an account that is Darwinian in many more senses than that with which I began. His grounding of his story in ecology, his emphasis on experimenters' construction of "contrivances," and his effort to blur the distinction between artificial and natural phenomena, as well as his plethora of "just-so stories," are all intellectual tools whose use Darwin pioneered. The image that results is both socially realistic and philosophically materialistic; yet there is grandeur in this view of science, in which the most wonderful forms of knowledge are shown to have come from relatively ordinary labor processes. It contrasts sharply with the "evolutionary epistemology" advanced by more explicitly philosophical analysts; their rootless analogies and complex abstractions owe more to Herbert Spencer's modes of thought than to Darwin's.



"Calvin Bridges's 'totem pole,' a four-sided working and valuation map showing locations of mutant genes and their relative usefulness for mapping." [From *Lords of the Fly*; T. H. Morgan, *Journal of Heredity* **30**, 356 (1939)]

"Fly culture in specially designed bottle with yeasty banana pulp and absorbent paper." [From *Lords of the Fly*; courtesy of American Philosophical Society, Stern Papers]

Because of his Darwinian deflationary strategy, Kohler demurs at providing any Big Answers at the end of his story. A reader interested in the implications of his account is left hanging. How, apart from details, would the study of material culture in fact "transform" traditional accounts of science? Was "production"—the drosophilists' highest value—peculiar to them, to American science, or to the 20th century? How did the experience of "experimental life"—a provocatively ambiguous phrase—affect modern scientists' identities? Since Kohler shows that *Drosophila* genetics was produced by a quite small group of people working with an extremely versatile organism, one can question whether his story is fully representative of experimental science, and whether, as he claims, it provides an "endlessly productive" model for future historical work.

Darwin, of course, confronted similar dissatisfactions due to his peculiar strategy. While contemporaries admired his efforts to unravel adaptive mechanisms, few emulated him. At the same time, they continued to dispute the Big Questions, and they did so with relatively little attention to the specifics of Darwin's thinking. Still, Darwin made evolution respectable and thereby transformed the intellectual landscape of his time. Kohler takes a considerable step toward doing the same for the study of experimental work. If he is successful, the result will be, in Darwin's phrasing, "truly wonderful."

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Fatal Disharmonies

The Ghost of the Executed Engineer. Technology and the Fall of the Soviet Union. LOREN R. GRAHAM. Harvard University Press, Cambridge, MA, 1993. xvi, 128 pp. + plates. $22.95 or £17.95.

Loren Graham has written a wonderful book about the relationship between technology and society. He has woven together an account of the life and work of a Russian engineer, Peter Palchinsky, and an analysis of the failures of Soviet engineering projects. The result is an elegant and concise essay on the dangers of engineering which ignores human values.

Peter Palchinsky was born in 1875. After graduating from the Mining Institute in St. Petersburg in 1900 he was appointed to a commission to investigate why coal production was falling in the Don Basin. His task was to study the living and working conditions of the miners. He spent two years gathering information, but his data exposed the bad conditions at the mines, and he was dismissed from the commission.

Palchinsky was exiled to Siberia during the 1905 Revolution but escaped in 1908 to western Europe, where he spent five years as a successful consultant. He wrote a detailed analysis of the ways in which the big European ports might be improved. His basic argument was that the workers' living conditions—housing, schools, public transportation, medical care, recreational facilities—were as important as cranes, wharves, and warehouses. Productivity and efficiency depended not only on technology but on the social system in which the technology was embedded.

Palchinsky returned to Russia in 1913 and set up an Institute of the Surface and Depths of the Earth. The Institute's motto, which is just as relevant today as it was then, was taken from an ancient Russian epic: "Our land is great and rich, but there is no order in it." Palchinsky supported the Provisional Government in 1917. He was arrested by the Bolsheviks when they seized the Winter Palace, which he was helping to defend. After his release he worked for the new government. Although he disliked the Bolshevik regime, he believed that he should serve his country.

Palchinsky supported the Bolshevik goal of making Russia a great industrial power, but his conception of industrialization differed from Stalin's. He believed that engineers had a central role to play in drawing up plans for economic development and providing objective advice; he stressed the importance of realistic policy goals; and he argued for attention to human needs in

carrying out the policy of industrialization. Stalin, on the other hand, favored unrealistic targets and brutal methods. Nor was Stalin willing to tolerate engineers' claims to autonomy. Palchinsky was arrested in April 1928 and shot in secret. He was accused of heading a conspiracy of engineers to overthrow the regime. A reign of terror against Soviet engineers followed.

Palchinsky's life underscores vividly the general argument that Graham makes about Soviet engineering projects. The Soviet leaders disregarded the principles that Palchinsky had advocated. Political and ideological imperatives overrode technical advice; vast projects were carried through without regard to human cost. Huge numbers of engineers were trained, but in very narrow specialisms, completely against the spirit of Palchinsky's conception of engineering.

Graham provides a series of brief case studies of Soviet large-scale technological projects—among them the White Sea Canal and Chernobyl. He ascribes the major technological failures of the Soviet period to the regime's rejection of Palchinsky's vision of a harmonious relationship between technology and society. The human costs imposed by the regime in its engineering projects contributed to its collapse.

This superb book distills in a vivid and moving way the results of Graham's many years of research on Soviet science and technology. It deserves to be read by all those interested in the relationship between technology and society.

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Vignettes: The Science of Humans

Ordinary people, mere social actors, average citizens, believe that they are free and that they can modify their desires, their motives and their rational strategies at will. The arrow of their beliefs now goes from the Subject/Society pole to the Nature pole. But fortunately, social scientists are standing guard, and they denounce, and debunk and ridicule this naive belief in the freedom of the human subject and society. This time they use the nature of things—that is the indisputable results of the sciences—to show how it determines, informs and moulds the soft and pliable wills of the poor humans. "Naturalization" is no longer a bad word but the shibboleth that allows the social scientists to ally themselves with the natural sciences. All the sciences (natural and social) are now mobilized to turn the humans into so many puppets manipulated by objective forces—which only the natural or social scientists happen to know.

—*Bruno Latour*, in *We Have Never Been Modern* (Harvard University Press)

I think it must be admitted that our society has become a little more humane in a number of large ways, and in a myriad of details, because of inquiries and teachings of the social sciences which work to systematize compassion, to make human concern less sentimental, more effective. We are a little more efficient at counseling and consolation, we are a bit more regardful of the claims of mutual respect, solace, support, and sympathy in companies, hospitals, schools, and courts of law, when we are told that this is a matter not only of religious or human commitment but simply of best practice, of appropriate technique, for which evidence can be adduced.

Charles W. Anderson, in *Prescribing the Life of the Mind: An Essay on the Purpose of the University, the Aims of Liberal Education, the Competence of Citizens, and the Cultivation of Practical Reason* (University of Wisconsin Press)

A Theory of Perception

Information, Sensation, and Perception. KENNETH H. NORWICH. Academic Press, San Diego, CA, 1993. xx, 326 pp., illus. $59.95 or £46.

The 18th-century philosopher George Berkeley argued that knowledge of the external world is acquired indirectly, on the basis of information provided by the senses, and is therefore necessarily uncertain. In *Information, Sensation, and Perception*, Kenneth Norwich skillfully translates Berkeley's phenomenology into a mathematical theory that considers the process of perception in terms of the nervous system's attempt to maximize the verisimilitude of the sensory picture that it receives.

The theory offers an explanation of the psychophysical transformations performed by the sensory neuron in response to an external stimulus. The empirical laws of psychophysics, such as those bearing the names of Weber, Fechner, and Stevens, are seen as alternative manifestations of the behavior of single neurons acting in parallel, which thereby provide redundant information to the brain about the nature of the stimulus.

The mathematics is that of information theory, but viewed through the lens of the physicist rather than that of the psychologist or computer scientist. It is assumed that the stimulus population being sampled by the receptor is approximated by a Gaussian distribution; hence the measures used to describe such distributions are developed for the continuous rather than the discrete case. This in no way hinders the model from generating explanations for the empirical channel capacities of sensory systems that have been tested by noting their response to discrete stimuli; nor does it deter the model from achieving the more lofty goal of providing a unified picture of human information processing and psychophysical laws. A single equation is used to derive estimates of empirical indices presumed to reflect perceptual sensitivity, such as the Weber fraction for stimulus discrimination, the exponent of the power function between perceived and actual intensity, and the inverse relationship between reaction time and stimulus intensity.

Perceptual accuracy, according to Norwich, depends on the ability of the senses to reduce the uncertainty in a variable input and thereby gain information about the precursor to the ensemble of events that constitute the stimulus distribution. This process is relative because the stimulus distribution is always evaluated against an ongoing internal noise or reference distribution of neural events—which leads to some interesting conjectures about the existence of undetectable stimuli produced by the sense organs themselves, though the underlying neurophysiology is not part of the theory. For the broader theoretical structure, as well, Norwich intends to furnish guidelines, not strictures, concerning possible physiological mechanisms.

Norwich's approach is markedly different from that of most theoretical psychologists working in the fields of perception and psychophysics. The departure is most striking in the treatment of perceived magnitude, which is thought by Norwich to depend on the variance of the stimulus