The empiricism is made striking by two speculative papers translated from a French collection of 1985. (Everything else in the book was published as an issue of *Human Studies* in 1988.) The theses expounded by Bruno Latour are paradoxical but welcome because they are theses. The success and power of science and technology are to be understood on political lines. A new idea, technique, machine, knowledge, theory—any enterprising part of "technoscience"—has to overcome competitors. It does so by forming allies. The most powerful way of building a controlling network is by overwhelming opponents with materials. You don't do this by hitting rivals with a diesel engine or an electron or a distant island or a floppy disk. You do it with paper and the like. The technoscientists think they convince by argument, by demonstrations, by prototypes. But what they exchange is inscriptions. Whether these are words or spreadsheets, photographs, tables, graphs, or maps, they have two essential properties: They are easily transported, sorted, and retrieved, and they are endlessly reproducible without change. They are "immutable mobiles."

Latour brings two tired subjects to life in a trice. Why did what we call science emerge in the Renaissance and never look back? What did the invention of printing do for the West? Answer: the two events are identical. Science is the manufacture of transportable reproducible inscriptions. The forms of representation are unimportant; all that matters are movable retrievable "documents" that can activate the largest network of users, allies. The editors of the volume say that the two translated papers "exemplify a distinctive approach . . . that creatively synthesizes semiotic, post-structuralist, and social-constructivist initiatives." Phooey; they exemplify imagination, daring, finely drawn argument, and far-reaching speculation.

The second of these essays, by the late Françoise Bastide, is a striking analysis of the diagrams and photographs in a contested paper in *Nature*. Originally stating an important discovery about the crystallization of a transfer RNA, it was later accused of error or worse. Bastide uses this story to exemplify Latour's theses and to examine what must be done to undermine this power of a coherent set of inscriptions and representations. She argues that it is unimportant whether the "immutable mobiles" are text or tables or figures or whatnot. They must compactly convey unassailable information. The sharp definition of Bastide's essay shows how much it helps to have a background theory (in this case, about the purpose of inscriptions), no matter how at odds that theory might be with the better judgment of readers of *Science*.

Edward R. Tufte's *The Visual Display of Quantitative Information* has already been praised to the skies. You'll see why on looking into *Envisioning Information*. Latour noticed how important it is that inscriptions are flat; it makes them so easy to transport and to file. Tufte illustrates "escaping flatland"—deploying the page to represent innumerable dimensions and facets. From Latour's philosophical perspective that's making the world flat. The two authors admire the same objects, the compact and immediately accessible display of complexity. (There are wonderful Japanese examples in Tufte's book, by the way, not just of "science" but of train timetables, which of course have to be flat enough to go in a purse or up on a placard.) Tufte also reminds us of the virtue of theory and slogans over mere empirical observation. He tells us why some visual things work and others are disasters, inimitably illustrating Josef Albers's doctrine about space, "1 + 1 makes 3."

There's a happy tension between the two completely different books under review. Many of the graphics taken from scientific texts and reproduced in Lynch and Woolgar are plain awful. They didn't help anyone envision information. So they must have had another purpose. *Exercise*: go through the present issue of *Science* first with Tufte in hand, to see how the information in the charts and pictures could be better presented (include the ads). Next go through it to ask whether the point of the representations is to convey information at all, or rather to convince us that this is solid stuff, not to be challenged, not challengeable.

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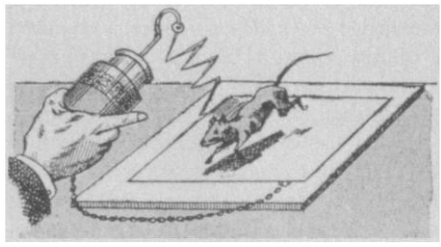
Ventures in Popularization

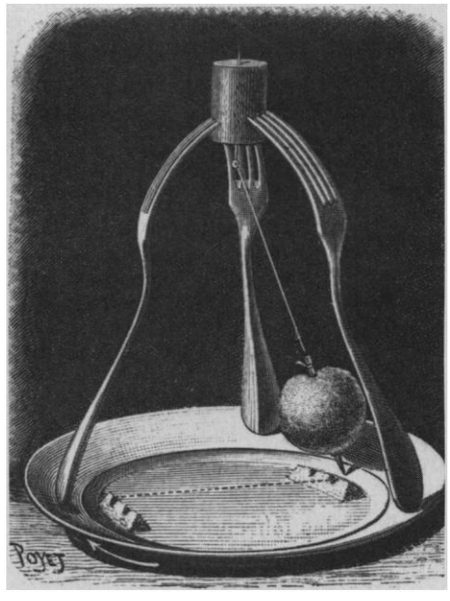
La Science pour tous. Sur la Vulgarisation Scientifique en France de 1850 à 1914. BRUNO BÉGUET, Ed. Bibliothèque du Conservatoire National des Arts et Métiers, Paris, 1990. 168 pp., illus. Paper, F230.

This beautifully illustrated collection of essays by scholars and staff members associated with the Conservatoire National des Arts et Métiers in Paris focuses on traditions of *vulgarisation* or popularization of science and technology in France before the First World War. Appendixes, annotated lists, and notes (including brief biographical paragraphs on 33 science writers) provide a wealth of information about science journalists, popular science books and periodicals, publishing houses, images and spectacles, lectures, and exhibitions that have been important vehicles for the diffusion of science and technology in France.



"Le rat condamné à mort," a *récréation électrique* proposed by H. Graffigny, according to whom "le condamné est parti *ad patres* sans douleur." [Reproduced in *La Science pour tous* from Graffigny's *100 expériences électriques* (Paris, 1896)]

The authors argue that a new phase of science popularization, different from the Enlightenment tradition, began around 1850, at the time of the popular success of the first Universal Exposition in London in 1851. Increased efforts were put into diffusing science to a broader public. The aims were to advance scientific progress, to increase national strength and prosperity, and to further social harmony through common goals and common understanding. In France, these aims were pressed in the 1860s and 1870s by republican scientists, educators, and administrators (like Paul Bert) who were concerned to counter Catholic



The Foucault pendulum as represented in Tom Tit, *La Science amusante* (second series, 1891). [From *La Science pour tous*]

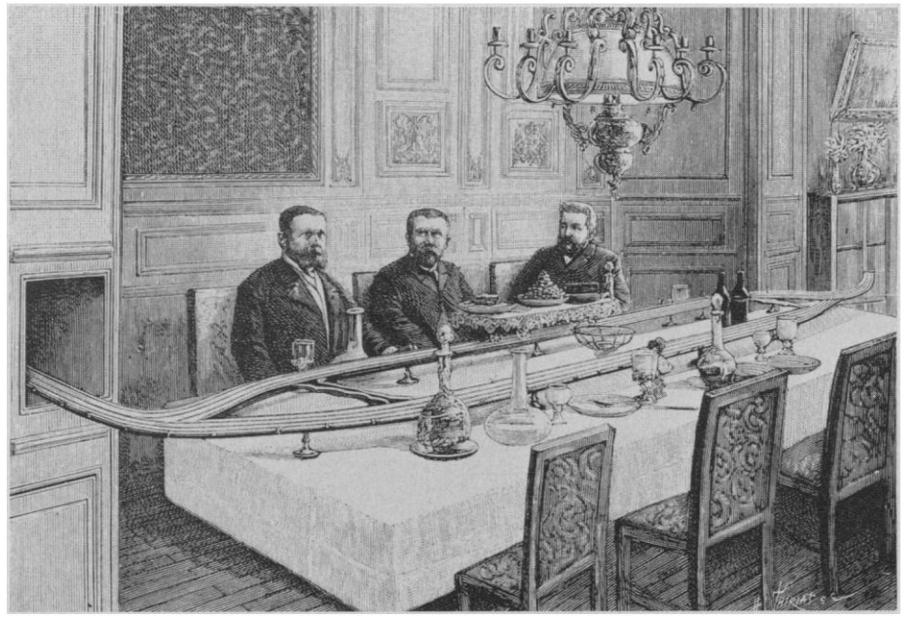
inroads in education and to prevent German ascendance over French culture. The authors do not say so explicitly, but science popularization also served the commercial interests of writers, illustrators, publishers, and booksellers in an explosive period of growth in the printing and publishing industry.

The title of the volume is the title of one of the 19th-century popular science periodicals, *La Science pour tous*, founded in 1856. Typical of scientific writers and entrepreneurs for such periodicals was Edouard Charton, a former Saint-Simonien, who founded two popular science reviews, then became director of the science and technology collection *Bibliothèque des merveilles* and the periodical *Le Tour du monde* for the Hachette publishing house. When a member of the National Assembly in 1848, Charton argued that only citizens who can read and write should have the right to vote. His aim, he said, was to destroy the ignorance that is at the origin of inequality, disorder, and evil in the world. Science was the key.

Among popular science writers, some of the most important were the Jesuit François Moigno, who founded the Catholic-oriented periodical *Cosmos* in 1852; Louis Figuier, science columnist for *La Presse*, who founded *L'Année scientifique et industrielle* in 1856; Gaston Tissandier, the founder of *La Nature* (the predecessor of *La Recherche*) in 1873 and author of numerous *Récréations scientifiques* for the young and general reader; and Camille Flammarion, author of *L'Astronomie populaire*, which sold 100,000 copies between 1880 and 1900. Camille Flammarion was the older brother of Ernest Flammarion, who established the Librairie Flammarion in the late 1870s.

Among publishing houses, early leaders in scientific popularization were Hachette and Hetzel, the latter the publisher of books like Flammarion's early *Histoire du ciel* (1872) as well as of "scientific novels" by Jules Verne and children's scientific books by Jean Macé. Some publishers specialized in "haute vulgarisation," rather than in science for the masses, and prices ranged from 30 francs for a volume like Amédée Guillemin's handsome *Le Ciel* to 10 centimes for one of the 363 issues of Figuier's *Merveilles de l'industrie*. Prestigious collections included Reinwald's *Bibliothèque des sciences contemporaines* (which published books by Darwin, Vogt, and Haeckel) and Germer-Baillière/Alcan's *Bibliothèque scientifique internationale* (which published volumes written by leading French and foreign scientists chosen by a committee of scientists).

How influential and well read were these books and periodicals? Subscriptions to *La Nature* increased from 2000 in 1873 to 15,000 in 1885. *La Science et la vie*, established in 1913 in a small format, with short articles, lots of photographs, and a full-color cover, sold 100,000 subscription copies in its first year. Who was reading these works? In 1862, lecture courses at the Conservatoire des Arts et Métiers, aimed at workers, foremen, young people, engineers, and the interested public, were said to attract 1500 to 1800 auditors each evening and a total of 180,000 "present" during the year. France was a country of roughly 40 million people at the end of the century. In 1889, the Paris Exposition Universelle attracted 32 million entrants in six months, many of them there to see Edison's phonograph, spectacular displays of electric lighting, and the "panorama du pétrole." The intended public for *vulgarisation* in science and technology was drawn from these people. This volume of essays provides an excellent introduction to the means, if not the achievement, of "la science pour tous."



"Vue d'ensemble du petit chemin de fer électrique du table de M. Gaston Menier." [Reproduced in *La Science pour tous* from *La Nature*, 1880]

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A Modern Necessity

Electrifying America. Social Meanings of a New Technology, 1880–1940. DAVID E. NYE. MIT Press, Cambridge, MA, 1991. xvi, 479 pp., illus. $29.95.

Man-made electricity permeates our lives. It illuminates our way, powers our machines, carries our messages. It is a necessity of modern life. Historian David E. Nye's *Electrifying America* describes how Americans first encountered, experienced, and employed electrification between 1880 and 1940. Nye's story is wide-ranging, as is the realm of electricity.

Books on technology usually fall into two camps: heavily researched monographs on how developers created and diffused a new system, or speculative essays, even polemics, on what the human meaning of it all is. *Electrifying America* is a rarer and valuable effort. It is a heavily researched study of the human meanings, an examination of how Americans came to live with a major new technology.

Others have old the technical and the business histories of electrification. Nye's focus instead is on "the human experience of making electricity part of city, factory, home, and farm" (p. xi). Using the particular case of Muncie, Indiana—"Middletown" of sociological fame—as a frequent grounding, Nye explores several large topics,