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Review
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attack on prejudice was to be achieved by the study of both the sciences and Étienne de Condillac's philosophy, called "Ideology." When prejudice was defeated, the assumption was, the natural political system that would result would be democracy. Democracy, of course, was exactly what Napoleon and later French rulers were intent on preventing.

Neither project really came to fruition, for almost immediately upon assuming power Napoleon struck down the *écoles centrales* and substituted the *lycées.* The study of Latin was restored. Mathematics and mathematical physics, useful to military engineers, dominated the scientific curriculum at the expense of natural history and chemistry. More important, the military dimension of the sciences served as a damper on the enthusiasm of parents of secondary school students who became increasingly unwilling to prepare their sons for dying for the Empire. The result was the split that Balzac so graphically described in *Les illusions perdues,* where he detailed the success of the career of his belletristic character and the misery of the one who chose the path of science and invention. The one led to the Prefecture, the other to the poorhouse.

This basic tension continued through the century. Although Belhoste does not emphasize the conflict, he clearly indicates its appearance in the documents that illustrate the swing, back and forth, between the two ideals. The result is a detailed and fascinating account, surprising in what, at first glance, appears to be a dull collection of laws. The book provides a fascinating view of French culture and should be useful to anyone working on the history of that culture in the nineteenth century. It also will spare such searchers a great deal of effort and time spent waiting for the arrival of documents in the archives or of volumes in the new National Library.

L. Pearce Williams

Carl Friedrich Gauss. *Theoria combinationis observationum erroribus minimis obnoxiae.* Translated by **G. W. Stewart.** (Classics in Applied Mathematics, 11.) xii + 241 pp., bibl. Philadelphia: SIAM, 1995. $28.50 (paper).

There is a distinct bimodality in writings on the history of probability and statistics. Works that deal with philosophical and social aspects of the subject tend to be historiographically sophisticated, au courant representatives of intellectual and cultural history. Writings concerned with technical content, on the other hand, are often very whiggish, combining a reverence for the original documents with a resolutely modern approach to their analysis and interpretation.

The SIAM series "Classics in Applied Mathematics" consists of the republication of several mathematical textbooks, dating from 1960 to 1980, which have been allowed to go out of print. The appearance of the book under review in the series is therefore (ironically) something of an oddity. It presents the Latin text and English translation of a work Carl Friedrich Gauss wrote in 1823 on the method of least squares in statistics. It also contains the text and translation of some supplementary writings published by Gauss in 1826 and 1828. There is relatively little in the way of explanatory footnotes or historical commentary, and the translator's afterword is devoted to an informative if somewhat technical discussion for modern specialists of Gauss's and Pierre Simon Laplace's methods. According to the preface the book is aimed at an audience of statisticians, numerical analysts, and interested scientists.

The invention and development of the method of least squares provides a conceptually fascinating study in the early history of error analysis. The theory of errors consisted around 1800 of a collection of rules in astronomy and geodesy. (The discipline of mathematical statistics as such did not become established until the early twentieth century.) The method was first published by Adrien Marie Legendre in 1805 in a paper on the calculation of the orbits of comets. In 1808, in a major theoretical advance, Gauss presented a proof based on the assumption that the errors are distributed normally. The latter assumption was in turn deduced from the assumption that the arithmetic mean is the most likely value of a set of measurements.

Gauss's result stimulated Laplace to devise a new proof of least squares using a result later known as the central limit theorem, applied in this instance to measurements involving a large number of observations. Gauss's primary achievement in his 1823 treatise was to take elements of Laplace's analysis and produce yet another demonstration of the method, one valid for any number of observations. His proof was based on the postulate that among all linear combinations of the observations, the least-squares estimate has minimum variance. The treatise would provide an important source of ideas and techniques for later researchers in mathematical statistics.

German and French translations of the material published here already exist, and the original

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text is readily available in Gauss's *Werke.* The book will therefore be of somewhat limited value to historians of science. Gauss's 1823 treatise is nevertheless a genuine classic of applied science, and an Anglo-American readership will find an English translation very useful. The translator's essay, despite its generally whiggish outlook, should as well prove of considerable interest to historically inclined readers with a good background in modern mathematical statistics.

CRAIG FRASER

Arleen Marcia Tuchman. *Science, Medicine, and the State in Germany: The Case of Baden, 1815–1871.* xii + 200 pp., frontis., figs., tables, bibl., index. New York/Oxford: Oxford University Press, 1993. $39.95.

Explicitly allying herself with Peter Borscheid's 1976 study *Naturwissenschaft, Staat und Industrie in Baden, 1848–1917* (Klett), Arleen Tuchman offers what she calls a revisionist account of the institutionalization of experimental medicine at Heidelberg. In his well-received dissertation, Borscheid argued that Baden poured funds into chemical education immediately after the revolutions of 1848–1849, hoping thereby to alleviate through scientific research the social problems (such as persistent agricultural failure) to which some government officials attributed the political uprisings. Tuchman seeks to extend back into the *Vormärz* this link between perceived economic and social problems and state science policy. An "ideology of the practical," she argues (p. 8), prompted Baden's political liberals already in the 1830s to urge that "exact methods" be introduced into the teaching of natural science and medicine at the University of Heidelberg, so that its students would be better prepared to face the twin demands of a slowly industrializing economy and a newly established constitutional state.

Tuchman builds her case around the development of experimental physiology in Heidelberg's medical faculty. Drawing on a thorough analysis of ministerial, parliamentary, and university records and programmatic essays appearing in newspapers and medical periodicals, she offers a splendidly detailed institutional history of what might be called the science policy-making process in Baden. The book opens with the appointment in 1815 of Friedrich Tiedemann as professor for anatomy, physiology, comparative anatomy, and zoology; follows the subsequent appointments of Jacob Henle and Friedrich Arnold to teach physiology and other topics; and concludes with the call in 1858 of Hermann Helmholtz as "professor of physiology," for whom a large new physiological institute would be completed by 1863. For each of these appointments, and for decisions about pedagogical innovations such as practical exercises at the university or introducing *Realwissenschaften* into the schools, Tuchman seeks to identify the "interests" of various actors involved in making policy: government officials, parliamentary representatives, physicians, students, the medical faculty as a group, and individual professors. In nearly all of the decisions examined, both before and after 1848, liberal state officials played dominant roles in defending the medical and cultural utility of what they called the "exact methods" of experimental physiology. To their defenders such methods provided foundations for a "scientific," "rational," or "objective" medicine—that is, for a medicine that could heal more effectively than its competitors and hence should be privileged by state regulation, examinations, and university teaching.

Tuchman draws several important historiographical conclusions from her case study. Warning against the "Prussianization of German history" (p. 7), she argues that institutional developments in Prussia (where, for example, in contrast to Baden state, interest in university-based science sharply declined in the reactionary 1850s) should not be generalized to all German states. Criticizing the concept of an "institutional revolution," according to which German states after 1871 suddenly began an unprecedented expansion of university laboratories for the natural and medical sciences, she suggests that a continuity reaching back to the 1830s characterizes science policy for liberal states like Baden. And, finally, she claims that the ideology of material interests, which she and Borscheid found well developed in Baden long before 1871, refutes the widely known model of the "German university system" developed by the late sociologist Joseph Ben-David. According to Tuchman's interpretation, Ben-David described the decentralized system of German universities as a competitive marketplace dominated by aggressive professors who demanded new chairs, institutes, or laboratories as conditions for accepting academic appointments. To preserve the reputation of their universities (as measured by student enrollments, which were essential to the financial well-being of the faculty) and the ideal of *Wissenschaft* as a vehicle for neohumanist *Bildung,* German states had to capitulate to the professional requests. Hence, innovations such as disciplinary specialization and the rapid integration

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