Book Reviews

On Exactitude

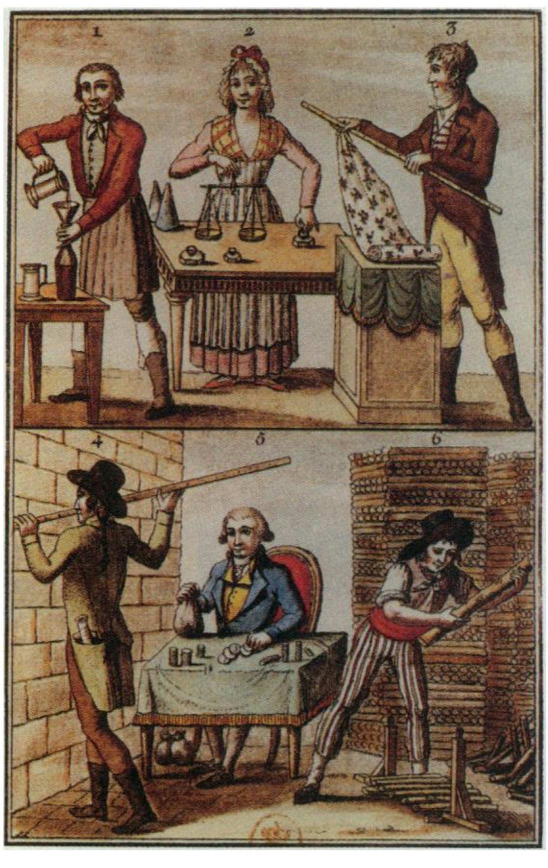
The Values of Precision. M. NORTON WISE, Ed. Princeton University Press, Princeton, NJ, 1995. viii, 372 pp., illus. $49.50 or £35. Princeton Workshop in the History of Science.

Standardization and precision measurement have often been taken for granted by historians of science. Norton Wise should therefore be applauded for having put together this excellent collection of essays that places the topic right where it belongs, at the center of historical attention. The authors present us with an array of good case studies bearing on the emergence of precision as a cultural value and of exact measurement as a key technology from the 18th to the early 20th century. Two aspects of the history of precision, as it is told here, are particularly striking. First, technical reliability depends on the organization of *people*. In this respect the development of the modern laboratory is comparable to that of industries or armies, where human behavior is similarly disciplined in order to ensure the efficient use of technology. Second, the values of precision are not only technical or economic but also moral. In the 19th century, the ideal of scientific precision was embedded in Western culture. Precision, accuracy, or exactitude—connoting disinterestedness and reliability—came to be regarded as particularly characteristic of members of the professional classes.

Several authors in the present volume point out that precision is the result not only of individual technological prowess but of networks of scientists who rely on an infrastructure of workshops and bureaucracies. One example is given in George Sweetnam's essay on Henry Rowland and his famous diffraction gratings. From the 1880s to the 1940s the gratings produced at the workshop of the Johns Hopkins physics department were coveted by the spectroscopists of the world. As Sweetnam shows, the precision of Rowland's gratings depended on the successful integration of science with engineering, and with expansionist American manufacturing in a broader sense. Unlike successful industrial production, however, the manufacture of gratings produced no financial gain. The profit was of a different nature: Rowland was supported by the university because his gratings established its scientific reputation at a time when scientific reputation was a scarce resource in America. Hence the emergence of this precision technology depended not only on the skills of Rowland and his engineer but on the ambition of American industry and universities to establish a strong position in the international markets of goods and knowledge.

A more intimate relationship between laboratory and workshop emerged also in the Old World at about this time. Simon Schaffer discusses physics at Cambridge during the Maxwell era, when a close collaboration between the Cavendish Laboratory and the Cambridge Scientific Instruments Company was established. "Close" should here be taken literally. The determination of a standard unit of resistance, which was an important part of Maxwell's interconnected theoretical and experimental agendas, demanded collaboration in a sense that was not easy to achieve unless workshop and laboratory were actually situated near one another. To communicate the standard, to ensure its acceptance in the scientific community, was no easy matter either. Once that had been achieved, however, increased precision was the reward. But then, writes Schaffer, "Precision is the result, rather than the cause, of consensus among scientific practitioners."

If a standard is to come into general use it must be reproducible. Kathryn Olesko shows, in an essay on German metrology, that the reproduction of standards led to the spread of practices such as error analysis and values such as "the ever-present concern for honesty." The idea here, as in several other essays in the book, is that the adoption of certain techniques cannot be successfully accomplished unless intellectual and material contexts associated with those techniques are also reproduced. In other words, as precision measurement spreads, science becomes in general more homogenous; the adoption of standards reflects the adoption of laboratory cultures.



"This 1800 illustration of the 'uses of the new measures' shows [French] workers performing traditional tasks as a way of introducing the new names for measures of capacity, weight, length, area, currency, and volume." [From Ken Alder's paper in *The Values of Precision*; Hennin Collection, Bibliothèque Nationale]

The moral importance of precision is perhaps illustrated most interestingly in Graeme Gooday's splendid paper on the introduction of so-called direct-reading voltmeters and ammeters from the mid-1880s and onward. By the early 1890s, students needed only a few minutes to produce results that seasoned researchers used to labor over for hours. Interestingly this was not generally welcomed among physics teachers. They thought that only the drudgery of tedious measurement would lead the student to an authentic encounter with nature and that this was necessary for molding an immaculate scientific character. If results were served on a silver tray, students would loose the sense of what actually constitutes proper science. Similar apprehensions also surface in Andrew Warwick's fascinating overview of the history of 19th-century number crunching—the development of tables and calculating machines. Here, the fear was expressed that mechanical aids to calculation would in time erode the mathematical skills of scientists. These worries reflect an important aspect of the social history of precision: during the second half of the 19th century the ability to produce knowledge with the aid of exquisite precision techniques came to be regarded as a hallmark of physics and other sciences as well. Indeed, this ability, this *reliability*, was

Vignettes: Sportstech

Such sports as mountaineering, sailing, skiing, scuba diving as well as traditional bat-and-ball games have all been subject to technological improvement. Whether these advances have added to the pleasure derived from such activities may be doubted and it is also doubtful if they have had any beneficial effects outside the individual sports in question. Sports technology does not seem to be a strategic technology.

—*Donald Cardwell*, in *The Norton History of Technology* (Norton)

Let me . . . make this modest proposal: an artificial indoor ski area in downtown Los Angeles. What would it look like? You may have seen in a sporting goods store the moving carpets that are mounted like large tilted conveyor belts and allow a skier to ski down the incline so that the skis sliding down and the carpet moving up roughly balance and, to a stationary observer, the skier stays in place. In addition to boots, skis, and poles, the skier is given a pair of goggles (skiers are used to these) where the lens is replaced by two microtelevision screens. The rest of the story tells itself. We play on those screens moving scenes of ski slopes that are coordinated with the varying speed and pitch of the conveyor belt carpet. Everything else is a matter of technological refinement: blowers to simulate the rushing of the wind, a harness to suspend the wayward or crashing skier, and more. And let me briefly extol the virtues of the new kind of skiing, the reduction of gasoline consumption and automobile pollution, the infinite variety of conditions and terrains, the instant, continuous, and wide availability of skiiing, and the supreme safety of the sport.

—*Albert Borgmann*, in *Reinventing Nature? Responses to Postmodern Deconstruction* (Michael E. Soulé and Gary Lease, Eds.; Island Press)

closely identified with the moral character that entitled scientists to that professional autonomy which has allowed systems of peer review to flourish in most walks of scientific life. In the 19th century the ammeter or the calculating machine could be seen to pose a threat against this still budding self-sufficiency, because these devices seemed to dislocate mastery over nature and control over the values of precision from the scientist to the manufacturer of instruments.

Why, then, has precision had such a strong impact on Western culture? At the end of the book, Wise addresses this interesting question, and he rightly points to a general tendency to pursue *unity*, apparent also for example in the centralization of nation states and international commerce. Wise sees scientific conventions, such as standards, as both "agents of unity and products of agreement." This is in fact how scientists at the turn of the century liked to view the matter: international commerce and international science would create unity between nations and ensure peace. But history has corrected that optimistic view. Several essays in this book do in fact emphasize that unity and agreement on standards often emerge only after acrimonious disputes. Therefore, when unity has been achieved someone has lost out; the smooth surface of standardized science also hides the ragged edges of discontent.

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Reprints of Books Previously Reviewed

The Hubble Wars. Astrophysics Meets Astropolitics in the Two-Billion-Dollar Struggle over the Hubble Space Telescope. Eric J. Chaisson. HarperPerennial, New York, 1995. Paper, $15 or $C21. *Reviewed* **265**, 1743 (1994).

A Natural History of Shells. Geerat J. Vermeij. Princeton University Press, Princeton, NJ, 1995. Paper, $14.95 or £12.95. *Reviewed* **264**, 295 (1994).

The Quantum Theory of Motion. Peter R. Holland. Cambridge University Press, New York, 1995. Paper, $39.95 or £24.95. *Reviewed* **263**, 254 (1994).

The RNA World. Raymond F. Gesteland and John F. Atkins, Eds. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NY, 1995. Paper, $45. *Reviewed* **264**, 1479 (1994).

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Books Received

Alcohol and Hormones. Ronald R. Watson, Ed. Humana, Totowa, NJ, 1995. xii, 339 pp., illus. $89.50. Drug and Alcohol Abuse Reviews, vol. 6.

American Women Afield. Writings by Pioneering Women Naturalists. Marcia Myers Bonta, Ed. Texas A & M University Press, College Station, 1995. xviii, 248 pp., illus. $35; paper, $15.95. Louise Lindsey Merrick Natural Environment Series no. 20.

Biologic. Designing with Nature to Protect the Environment. David Wann. 2nd ed. Johnson Books, Boulder, CO, 1994. xviii, 285 pp., illus. Paper, $14.95.

The Biology of the Southern Ocean. George A. Knox. Cambridge University Press, New York, 1995. xiv, 444 pp., illus. $130. Studies in Polar Research.

Biomembranes. Vol. 3, Signal Transduction Across Membranes. Meir Shinitzky, Ed. Balaban, Brooklyn, NY, and VCH, New York, 1995. viii, 325 pp., illus. $135.

The Black-Tailed Prarie Dog. Social Life of a Burrowing Mammal. John L. Hoogland. University of Chicago Press, Chicago, 1995. xiv, 557 pp., illus. $90 or £71.95; paper, $34.95 or 27.95. Wildlife Behavior and Ecology.

Brainmakers. How Scientists are Moving Beyond Computers to Create a Rival to the Human Brain. David Freedman. Touchstone (Simon and Schuster), New York, 1995. 215 pp. Paper, $12 or $C16.

Chemical Processing of Ceramics. Burtrand I. Lee and Edward J. A. Pope, Eds. Dekker, New York, 1994. xii, 554 pp., illus. $165. Materials Engineering, vol. 8.

Coastal Evolution. Late Quaternary Shoreline Morphodynamics. R. W. G. Carter and C. D. Woodroffe, Eds. Cambridge University Press, New York, 1995. xxii, 517 pp., illus. $79.95. A contribution to IGCP Project 274: Coastal Evolution in the Quaternary.

Coercion and Punishment in Long-Term Perspectives. Joan McCord, Ed. Cambridge University Press, New York, 1995. xiv, 392 pp., illus. $59.95.

The Collapse of Chaos. Discovering Simplicity in a Complex World. Jack Cohen and Ian Stewart. Penguin, New York, 1995. x, 495 pp., illus. Paper, $13.95 or £8.99 or $C17.99. Reprint, 1994 edition.

The Collected Papers of Albert Einstein. Vol. 5, The Swiss Years. Correspondence, 1902-1914. English translation by Ann Beck. Princeton University Press, Princeton, NJ, 1995. xxii, 384 pp., illus. $85; paper, $29.95 or £19.50.

Colobine Monkeys. Their Ecology, Behavior and Evolution. A. Glyn Davies and John F. Oates, Eds. Cambridge University Press, New York, 1995. xiv, 415 pp., illus. $79.95.

Colour. Art and Science. Trevor Lamb and Janine Bourriau, Eds. Cambridge University Press, New York, 1995. viii, 227 pp., illus. $59.95; paper, $24.95. Darwin College Lectures.

Combustion Efficiency and Air Quality. István Hargittai and Tamás Vidóczy, Eds. Plenum, New York, 1995. xiv, 289 pp., illus. $85.

A Common Fate. Endangered Salmon and the People of the Pacific Northwest. Joseph Cone. Holt, New York, 1995. xii, 340 pp. $25.

The Dictionary of Ecology and Environmental Science. Henry W. Art., Ed. Holt, New York, 1995. viii, 632 pp., illus. Paper, $19.95 or $C27.95.

Dictionary of Gene Technology. Günter Kahl. VCH, New York, 1995. xii, 552 pp., illus. $90.

The Dilemma of the Fetus. Fetal Research, Medical Progress, and Moral Politics. Steven Maynard-Moody. St. Martin's, New York, 1995. xviii, 235 pp., illus. $23.95 or $C33.50.

The Dingo in Australia and Asia. Lawrence K. Corbett. Cornell University Press, Ithaca, NY, 1995. viii, 200 pp., illus. Paper, $25.

Doctorate Recipients from United States Universities. Summary Report 1993. Delores H. Thurgood and Julie E. Clarke. National Academy Press, Washington, DC, 1995. viii, 101 pp., illus. Paper.

Eldoret. An African Poetics of Technology. Richard M. Swiderski. University of Arizona Press, Tucson, 1995. xvi, 229 pp., illus. $35. Culture and Technology.

Electrochemical Process Engineering. A Guide to the Design of Electrolytic Plant. F. Goodridge and K. Scott. Plenum, New York, 1995. xiv, 312 pp., illus. $59.50.

Electronic Processes in Catalysis. A Quantum Chemical Approach to Catalysis. Satohiro Yoshida, Shigeyoshi Sakaki, and Hisayoshi Kobayashi. Kodansha,