edges, "a strictly chronological account of the life and works of Giuseppe Peano."

Apart from tracing the year-by-year activity of one of Italy's foremost mathematicians, this biography describes Peano's major mathematical and philosophical interests and offers some especially vivid moments that help to reveal aspects of his personality. Of these, the more interesting episodes invariably concern the many rivalries and controversies that enlivened Peano's early career. Especially noteworthy were differences of opinion—or worse, open hostilities—with several of his colleagues in Italy and elsewhere, including his old professor Angelo Genocchi (who was so displeased by Peano's "edition" of his course of lectures on the calculus that he disavowed any connection with it), Corrado Segre (who was greatly offended when Peano pointed out that some of his theorems were incorrect or admitted exceptions, thus beginning the first of ongoing hostilities between Peano and his colleagues at the University of Turin), and Giuseppe Veronese (whose book *Fondamenti di geometria a più dimensioni* was described by Peano as full of "absurdities . . . errors, lack of precision and rigor"). In fact, Kennedy describes Peano's confrontation with Veronese as "strong enough to give rise to histrionics to match Veronese's mother's cousin, the actress Eleonora Duse!" Unfortunately, we are never told what the histrionics were, nor is much detail actually provided as to the substance of the differences between Peano and Veronese (with whom Georg Cantor, creator of transfinite set theory, also had a heated polemic over the issues of infinitesimals).

Nearly one-third of this book, especially the later portions devoted to Peano's life after the congresses for philosophers and mathematicians held in Paris in 1900 (chapters 15 through 25), concerns Peano's interests in the Interlingua movements dedicated to the creation and adoption of an international language. In fact, for a brief introduction to the ups and downs of the most influential of these movements, including Volapük, Idiom Neutral, Esperanto, Ido, Ro, and Peano's own favorite, *Latino sine flexione*, Kennedy's book serves as an informative guide.

Peano includes one photograph of Peano and three appendixes, which provide short biographical sketches of 14 of Peano's professors, including one who was canonized in 1971 (Francesco Faà di Bruno), a list of students making up the

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"School of Peano" that identifies those who were also Peano's assistants at the University of Turin, where he taught for his entire professional career, and a list of papers by other authors presented by Peano to the Academy of Sciences of Turin between 1892 (when he was elected to membership) and 1932. There is also a comprehensive list of the publications of Peano, which goes beyond the list of 231 items published in volume 1 of Ugo Cassina's edition of Peano's *Opere Scelte* by 45 entries, the majority of which are reviews and published letters to editors, replies to questions, and short biographies. The indexes are made the more useful by the inclusion of an index to the publications of Peano as mentioned or discussed in the course of the book.

Peano is a study many will find useful, not for its explication of Peano's mathematics or even of his philosophy, but largely for its success in painting the day-to-day life and changing influences and interests of one of the last century's great contributors to mathematical logic and international languages. Particularly interesting is the last chapter, "Summing up" (pp. 172–175), in which the author suggests that Peano lived too long, that his significant contributions to mathematics and logic were all made before 1900; consequently, he should be seen as a great figure of the last century, but not of this one. Further contributing to Peano's neglect, suggests Kennedy, were strong anti-Peano forces at the University of Turin, as well as Peano's preferences for immediate results, his editorial interests in the *Rivista* and *Formulario* projects, and the later almost exclusive devotion he gave to the cause of Interlingua. Ultimately, this book succeeds in providing the first comprehensive account of Peano's life available in any language, including Italian.

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Argumentation Examined

Galileo and the Art of Reasoning. Rhetorical Foundations of Logic and Scientific Method. MAURICE A. FINOCCHIARO. Reidel, Boston, 1980 (distributor, Kluwer Boston, Hingham, Mass.), xx, 482 pp. Cloth, $42; paper, $21. Boston Studies in the Philosophy of Science, vol. 61.

When Galileo published his *Dialogue on the Two Chief World Systems* in 1632, the debate on the heliocentric theory had been going on for almost a century. Copernicans and Anti-Copernicans could cite the same arguments, ostensibly based on direct observations and experiments, to demonstrate the validity of their diametrically opposed views. The crucial factor in the disagreement over how the empirical data should be interpreted was the a priori constructions of both parties. Far from being decisive, the variously interpreted experiments merely mirrored the entrenched positions of their proponents. This situation was changed when Galileo's telescopic discovery of the rugged surface of the moon made the already dubious division between moon and earth even less plausible, and the fact that Jupiter orbited with no fewer than four satellites provided a reply to those who asked how the earth could rush through space without losing its moon. But a mere looking-glass could not dispel a theory about the structure of the world, and the Aristotelians had to be shown that their world view was wrong! To achieve this Galileo had recourse to a fictitious dialogue between Salviati, a militant Copernican, Simplicio, an avowed defender of geocentrism, and Sagredo, an intelligent layman already half converted to the new astronomy. They are presented as having gathered at Sagredo's palace in Venice for four days to discuss the arguments for and against the motion of the earth. In the First Day, the Aristotelians' radical division between terrestrial and celestial phenomena is revealed as gratuitous. In the Second and Third Days, the arguments against the diurnal and annual revolu-

tions of the earth are shown to be inconclusive, and, in the Fourth Day, Galileo produced what he considered his decisive argument, the celebrated, and unfortunately mistaken, proof from the existence of the tides that the earth moves.

In the first part of his book Maurice A. Finocchiaro rightly insists on the importance of Galileo's rhetorical skill in the *Dialogue*. Never before had any critic of Aristotle been so gifted as a writer, so apt at convincing an opponent by the sheer brilliance of his presentation, and so masterful at laughing him off the stage when he refused to be persuaded. Galileo drew from the literary resources of his native Italian to convey insights and to stimulate reflection, but his style did not possess the bare factualness of the modern laboratory report or the unflinching rigor of a mathematical deduction. Words are more than vehicles of pure thought. They are sensible entities, they possess associations with images, memories, and feelings. Galileo knew how to use these associations to attract, hold, and absorb attention. He did not present his ideas in the nakedness of abstract thought but clothed them in the colors of feeling, intending not only to inform and to teach but to move and to entice to action. He wished to bring about nothing less than a reversal of the 1616 decision against Copernicanism, and the dialogue form seemed to him most conducive to this end. It is true that the written dialogue is deprived of the eloquence of facial expression and the emphasis of gestures, of the support of modulated tone and changing volume, but it retains the effectiveness of pauses, the suggestiveness of questions, and the significance of omissions. Galileo made the most of these techniques, and it is important to keep this in mind when assessing his arguments, for too often passages of the *Dialogue* have been paraded without sufficient regard for their highly rhetorical content.

Finocchiaro is a philosopher, however, and he is eager to disclose the logic inherent in Galileo's reasoning. For instance, Galileo's refutation of the Aristotelian assertion that the world is perfect because it has three dimensions is spelled out as follows (pp. 346–347):

(A1) The world is perfect because (A11) it has the three dimensions of length, width, and depth and (A13) these are all the dimensions that exist; and (A11) the world has three dimensions because (A111) three is a very special number (in that three is (A1111) the number of parts that everything has, namely beginning, middle, and end; (A1112) the number used in sacrifices to the Gods; and (A1113) the least number of things required before the word "all" can be applied to refer to them collectively).

The relevant proposition here is the three-dimensionality of the world, A11. Galileo is here accepting this proposition, but neither its alleged implication (A11, ∴ A1), nor its alleged justification (A1111, A1112, A1113, ∴ A111; ∴ A11). In short, Galileo is agreeing that the world is perfect and that it has all three dimensions, but denying that there is a connection between the two propositions such as to ground perfection on three-dimensionality.

This exercise may come as a pleasurable experience to some philosophers, but scientists and historians of science will be excused for finding that it actually robs Galileo's text of its rhetorical force without providing any demonstrative rigor. As Galileo himself says in a passage from the *Dialogue*, "The art of demonstration is learned by reading words which contain demonstrations. These are mathematical treatises, not books on logic." In the *Discourses on Two New Sciences*, Galileo's most important scientific contribution, this art is brilliantly illustrated. If Finocchiaro had wrestled with the proofs in this work, he would have found it more difficult to use Galileo as a scourge to castigate a wide range of philosophical positions and individual researchers in the second and third parts (over 300 pages) of his book. The great Galilean scholar Alexandre Koyré is faulted for "demonstrated inadequacies in erudition, logic (reasoning), methodology (historiography) and scholarship" (p. 205), Maurice Clavelin for "his practice of interpreting passages out of context" (p. 246), Stephen Toulmin for his tendency "to neglect the interdisciplinary nature of most creative reasoning" (p. 304), and Ernan McMullin for offering an argument "at best circular" (p. 22). The only person to escape unscathed seems to be Stillman Drake, on whom Finocchiaro leans heavily and uncritically for his interpretation of Galileo's notion of inertia and the proof from the tides. Readers with a taste for swashbuckling rhetoric rather than historical accuracy will take to this book.

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Views of a Watershed

Reminiscences of Los Alamos, 1943–1945. LAWRENCE BADASH, JOSEPH O. HIRSCHFELDER, and HERBERT P. BROIDA, Eds. Reidel, Boston, 1980 (distributor, Kluwer Boston, Hingham, Mass.). xxii, 190 pp. Cloth, $26.50; paper, $9.95. Studies in the History of Modern Science, vol. 5.

The birthplace of the atomic bomb looms larger in the legend of wartime science than the magnitude of its contribution would seem to warrant. As one contributor to this volume puts it, "Radar won the war, atomic energy shortened it." Yet the accomplishments at MIT's Radiation Laboratory, Chicago's Metallurgical Laboratory, Oak Ridge's separation plants, and the Hanford Engineering Works do not exert the hold that Los Alamos does upon the generation of American scientists who contributed to these efforts. The story of Los Alamos, after all, features a tragic hero, Robert Oppenheimer, a picturesque and isolated setting that is easily romanticized, and a spectacular climax that casts a long shadow over the future of humanity, even if Los Alamos did not "win" the war.

This collection of lectures, delivered at the University of California at Santa Barbara in 1975 by veterans of the wartime experience at Los Alamos, illuminates the reality behind the drama. They capture domestic nuances of Los Alamos life as well as more compelling tales of implosion research and development, effects studies, and preparations for the Trinity test. Although the entire range of wartime Los Alamos society is not represented, we hear from scientists, engineers, soldiers, and housewives. Their reflections upon problems ranging from bomb design to truancy, from the contradiction between security and scientific communication to the conflicts between army censors and wives who illustrated their letters with unauthorized doodles, capture the spirit of life in this army camp cum academic think tank.

Scientists who spent long days inside the technical area recall tensions arising there between academic and military rationality and between the scientific and technological demands of wartime research. In a humorous talk, Richard Feynmann recounts his struggle against the censorship and compartmentaliza-