

to dominate the magnetic recording market. Begun's book repeatedly details the troubled development of magnetic recording in terms of mechanical rather than electronic failings. Getting the tape or wire to move at the correct speed was a major obstacle to the successful innovation and diffusion of this particular invention.

By 1950 another, more successful, magnetic sound recorder had emerged, based on AEG's Magnetophone, a polyvinyl chloride tape recorder developed in Germany after Begun's departure and "liberated" by Allied troops in 1945. A refurbished version of this machine was used by John T. Mullen to record Bing Crosby's radio show in the 1947–1948 season and, shortly thereafter, became the basis for Ampex's highly successful recorder.

JOHN BELTON

Timothy Moy. *War Machines: Transforming Technologies in the U.S. Military, 1920–1940.* (Military History Series, 71.) xiv + 218 pp., illus., bibl., index. College Station: Texas A&M University Press, 2001. \$39.95.

War Machines: Transforming Technologies in the U.S. Military, 1920–1940, is not as broad as its title might suggest. Timothy Moy does indeed propose a broad thesis, that institutional culture plays a large, though seldom acknowledged, role in technological innovation. But he addresses only two very particular case studies of military innovation between the world wars. The longer reviews the Army Air Force's development of the technology for precision bombing; the shorter examines the U.S. Marine Corps's development of the technology for amphibious assault. What primarily shaped these innovations were, in Moy's view, the particular cultures of the air force and marines and their internal politics rather than the more commonly cited technical or industrial imperatives.

The book is divided into two parts, each of four chapters, plus an introduction (Ch. 1) and a conclusion (Ch. 10). As we might expect of a study derived from a Berkeley history of science dissertation, *War Machines* rests on a reasonably solid research base. The two stories are told separately, however, and differ significantly in both structure and documentation. Part 1, "Precision Bombing," alternates chapters on doctrine and technology. Chapters 2 and 4 follow the air force adoption of strategic bombing as a mission to win independence from the army. Judging by the endnotes, both chapters rest chiefly on secondary sources and are less analytical than assertive. Chapters 3 and 5 trace the air force effort to find

the bombsights and bombers that its self-chosen mission required. These chapters offer a more extensively documented and persuasive narrative than those on doctrine, although the two are not very well integrated. Part 2, "Amphibious Landing," in contrast, integrates doctrine, training, and technology in a single narrative. It begins with the marines adopting advanced base defense and amphibious warfare to define missions that would sustain institutional independence, then follows the interaction of doctrinal evolution, training exercises, and technological development. These chapters are based (again judging from the endnotes) much more heavily on archival research than those in Part 1.

Moy is a fine writer, but he sometimes lapses into phrasemaking at the expense of explanation. Referring to the air force as a "high-tech" organization, for instance, he claims that "the airmen's institutional self-image as futuristic and gallant knights of the sky shaped the vision of strategic bombing they articulated and embraced. Daylight bombing grew out of this high-tech culture" (p. 172). How bombing squares with a "knights of the sky" self-image he never explains. Nor does he ever fully address the specifics of one of his major categories, high-tech versus low-tech innovation. This becomes all the more troublesome when he extends the distinction by characterizing the air force as high tech, the marines as low tech. Quite apart from the anachronistic usage, this contrast tends to become more label than analysis.

However well chosen Moy's cases, two seems a slender base to sustain his thesis. One feature of his argument that I find particularly problematic is the almost complete absence of internal opposition. Neither airmen nor marines spoke with one voice about the choice of a single mission to define their service. Moy mentions the advocates of pursuit aviation only in passing, for instance, and is completely silent about any dissidence among marines. This places him in the company of a long line of historians and social scientists who have studied controversies over military innovation exclusively from the viewpoint of those perceived to be on the winning side. In his conclusion Moy does briefly discuss the alternatives each service might have chosen; but however well done, it is too little and too late.

BARTON C. HACKER

■ Recent (1950–)

Allan A. Needell. *Science, Cold War, and the American State: Lloyd V. Berkner and the Bal-*

ance of Professional Ideals. (Studies in the History of Science, Technology, and Medicine, 10.) xii + 404 pp., illus., bibl., index. Amsterdam: Harwood Academic Publishers, 2000. \$60, £40 (cloth); \$28, £19 (paper).

Lloyd Berkner (1905–1967), radio engineer and ionospheric physicist, was among a small circle of power brokers who helped bring American science and the American state closer together during World War II and the early years of the Cold War. In this exemplary biographical study, Allan Needell, a historian at the Smithsonian Institution's National Air and Space Museum, gives a well-documented account of Berkner's life and career and a nuanced examination of how American scientists and engineers defined and balanced the interests of their professions and of the national security state during those crucial years.

A product of the Midwest prairie, Berkner was an accomplished radio operator before entering the University of Minnesota to study electrical engineering and to train as a Naval Reserve aviator. The Bureau of Standards hired Berkner as a radio engineer in 1928, just in time for him to participate in Richard Byrd's highly publicized Antarctic expedition. The adventure helped form what Needell calls Berkner's "technocratic vision" that justified science both as a heroic exploration of the unknown and as a prime mover of technology and human progress. Berkner energetically pursued this vision of science, first at the Bureau of Standards and then at the Carnegie Institution of Washington (CIW), where he directed internationally respected research on ionospheric physics.

World War II honed Berkner's skills in instrument building and organization. On active duty he served as the naval liaison at the MIT Rad Lab to produce radars and helped install them on naval aircraft. He also came into close contact with Vannevar Bush, I. I. Rabi, Jerome Wiesner, and other influential scientists who shared his enthusiasm for collaboration with the military. A rising star at the end of World War II, Berkner worked to build a science-state partnership for the ensuing Cold War, which he saw as a continuation of the struggle between democracy and dictatorship.

Berkner helped bring scientific expertise to bear on American defense and foreign policy in the 1940s and 1950s as executive secretary of the military's Joint Research and Development Board and as a consultant to the State Department and the CIA. He drafted the famous "Berkner report" on science and American foreign pol-

icy, directed Project Troy on the overseas operations of the Voice of America, and participated in the heated debate over continental defense against a possible Soviet nuclear attack. Berkner's election to the National Academy of Sciences in 1948, despite the lack of an advanced degree, undoubtedly aided his agenda, as did his assuming in 1951 the presidency of the Associated Universities, Inc. (a consortium that ran the Brookhaven National Laboratory).

In the 1950s, Berkner helped initiate the International Geophysical Year (IGY), which led to the launching of the Soviet *Sputnik* in 1957. Did Berkner propose the satellite component of the IGY as a cover for U.S. satellite intelligence programs? Needell finds no smoking gun but presents strong circumstantial evidence that intelligence was indeed a factor in Berkner's thinking. The connection apparently posed no moral challenge for Berkner, who maintained an abiding faith in the harmonious goals of American science and state—what he called the "unity of democracy." Not everyone shared Berkner's faith, however. The geophysicist Merle Tuve, Berkner's boss at Carnegie, for example, feared government control of science and fought against Berkner both at the CIW and in national science policy. In the end, Needell sees Berkner as a kind of broker who brought American scientists together with the state through both strategies of insulation (he often hid national security considerations from them) and overt integration of interests and action.

Based on rich archival sources, *Science, Cold War, and the American State* is a superb social and political study of American science and technology rendered through Lloyd Berkner's life and times. Needell writes with clarity and achieves a nice balance between narrative and contextual analysis, which makes the book suitable for teaching courses. For scholars, the study raises fascinating questions for further research. One wonders, for example, to what extent Needell's intriguing hypothesis—that Berkner's activism derived from his nonacademic background—can be applied to other scientist-statesmen. Above all, the book's focus on the ease with which Berkner moved between the worlds of science, government, and national security points to the need to reformulate the well-known debate between the historians Paul Forman and Daniel Kevles over who was using whom in the U.S. science-state relationship during the Cold War. Neither the science nor state community was monolithic, and further comparative studies of mediators on the scene such as

Berkner should help deepen our understanding of the dynamics of that partnership.

ZUOYUE WANG

David Leverington. *New Cosmic Horizons: Space Astronomy from the V2 to the Hubble Space Telescope.* xii + 507 pp., frontis., illus., figs., tables, app., bibl., index. Cambridge/New York: Cambridge University Press, 2001. \$85 (cloth); \$29.95 (paper).

New Cosmic Horizons was written by a project manager, originally trained as a physicist, who worked in the European space world and in business for about twenty-five years and then returned to academia to complete his Ph.D. It is a well-written, comprehensive compilation of major scientific results in space astronomy obtained during the latter half of the twentieth century. As the book jacket explains, “it explores the triumphs of space experiments and spacecraft designs and the amazing astronomical results that they have produced.” It is particularly useful because it does not just concentrate on American contributions in this area, as important as they have been, but tries to redress the transatlantic balance by including scientific work in the Soviet Union and Europe, notably the European Space Agency. The blurb claims that David Leverington relates the changes in space astronomy programs in these various countries to their “changing political imperatives.” This is done very sketchily, however, and merely by way of a backdrop to his main objective.

Practicing astronomers, be they amateur or professional, and historians of science who could use a survey of the major milestones in space astronomy will find this a useful guide. It is seriously marred as a reference work, however, by the total absence of any reference to primary or secondary material in the text. There is a bibliography of what Leverington calls “general sources used in the preparation of this book” (p. 476), which includes standard histories of space and of space science. None of these books, nor any scientific papers, are cited in the body of the argument. Everything that is said, or claimed, has to be taken on the authority of the author, an extraordinary approach that can only undermine and discredit what was otherwise a laudable objective.

JOHN KRIGE

Constantin Roman. *Continental Drift: Colliding Continents, Converging Cultures.* Foreword by **John F. Dewey.** xvi + 211 pp., illus., index.

Bristol/Philadelphia: Institute of Physics Publishing, 2000. \$40, £26.

This is an interesting and charming book—even if not strictly an essay in the history of science. The dissident author studied earth sciences in Romania during the beastly Ceaușescu regime but managed to get out by attending a conference in Newcastle (U.K.) and never returning until after the end of Eastern European communism. Yet he remained a Romanian patriot and is presently a professor *honoris causa* in Bucharest, while residing with his family in salubrious Glyndebourne.

Constantin Roman must, by his account, surely be one of the world’s most upwardly mobile earth scientists. Starting in England with only £5 in his pocket, by ability, persistence, and charm, and using Newcastle as a stepping-stone, he became acquainted with the right people (especially the late Keith Runcorn) and obtained a scholarship to Peterhouse, Cambridge, to do a Ph.D. on the tectonics of the Caucasus and across into Central Asia, using seismic data to identify plate boundaries and movements. On this basis, and studying areas of compression and tension, he proposed the existence of two non-rigid “buffer plates”—Sinkiang and Tibet—between the Indian and Eurasian plates. This was an iconoclastic suggestion in the early 1970s. Later, after getting his doctorate under Edward Bullard, Roman became an oil industry consultant and, I infer, made good money.

Primarily, the book is about the madneses of dictatorships and bureaucracies—and also the lovely life of a research student at Cambridge. When it came to Kafkaesque bureaucracy, the British authorities could be quite as obdurate as their Romanian counterparts: you can’t have a work permit (and then residence) unless you have a job; you can’t have a job unless you have a work permit. The difference, though, was that Roman could enlist support via his influential Cambridge contacts, and eventually he broke the logjam by getting an acquaintance at the *Telegraph* to offer him a kind of pseudo-job (as a research assistant, on matters Romanian, to his contact there). He was tenacious, resourceful, and bright, and seemingly charming to boot. It worked!

Roman displayed similar qualities as a researcher. When he was well into his Ph.D. work, Bullard drew his attention to a paper emanating from Peter Molnar and his group at MIT that dealt with the same topic and arrived independently at essentially the same theory. The American paper had been refereed and accepted and