her parents that intrigues her the most: Bateson's abstract intellectualizing, his pessimism about the possibility of change in human affairs, his defiance of social convention, set next to Mead's eagerness for ever more data, her confidence that she could effect change for the better, her care to observe social conventions at least outwardly. Mead had Catherine take dancing lessons and write proper replies to formal invitations and taught her how to wear gloves. The richness of a culture, she believed, was in its details. Bateson taught his daughter natural history and logic. Mead taught her to accept and respect cultural differences and to see the patterns in each.

There is much more in this splendid book. *With a Daughter's Eye* is a perceptive double portrait of Gregory Bateson and Margaret Mead, an invaluable addition to the record, and above all a profoundly human document in which, as the author intended, personal experience illumines larger issues and "knowledge and art and caring are all intertwined."

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An Argument for Moderation

The Culture of Technology. ARNOLD PACEY. MIT Press, Cambridge, Mass., 1983. viii, 210 pp., illus. $17.50.

In this book Arnold Pacey says little that has not already been said by others, and he provides a somewhat limited perspective on most of the topics he addresses. Nevertheless, the book is quite worthwhile for almost anyone with an interest in technology policy and the social impacts of technology.

In the jacket blurb Elting Morison notes that Pacey "takes his charge from Francis Bacon," and Pacey himself makes reference to Bacon in several key passages in the book. But if Pacey is to be associated with a major historical figure, Aristotle or Thomas Jefferson would be at least as good a choice. In a very readable style, Pacey takes a peripatetic approach to a range of important problems and arrives at conclusions that closely approximate those which Aristotle's man of wisdom would reach in aiming for the Golden Mean between the extreme positions. Pacey indicates that he himself, though trained as a physicist, follows a lifestyle that tends toward the low-tech rather than the high-tech end of the spectrum and is a "near-vegetarian" environmentalist. But he closes the book by asserting that if human needs are to be met in "a civilized, humane way, we require a continuous, active dialogue, not the one right answer offered by either of the opposite points of view. . . . Openness, democracy and diversity are what will save us, not some environmentalist blueprint, nor any technocratic plan" (pp. 177–178). He sees this emphasis on open-ended, participatory, dialectical exploration of the unknown future as modeled on Jefferson's "controlling principle" (p. 123).

In moving toward this conclusion, Pacey intentionally uses a method that involves "shifts of scene between past and present—between agriculture and automation . . . [and] abrupt changes in geographical subject, from Britain to ancient Greece and then to Africa, and from industrial North America to rural South Asia" (p. 34). He has adopted this "distractingly kaleidoscopic" unconventional style to try to avoid what he feels are the "traps of linear interpretation" into which he fell in his previous book, *The Maze of Ingenuity* (1976). However harsh his assessment of his previous work might be, the new style works well in this book. Instead of marshalling a set of arguments to defend his thesis, Pacey has collected a number of personal anecdotes and second-hand accounts of specific situations that vividly illustrate and effectively support his basic theses.

Pacey focuses on the process of technological activity rather than on specific products, and he identifies a need for changes at two levels. He describes and demonstrates the virtues of a new type of engineer who is oriented more toward maintenance (and nurturing) than development (and creation of novelty) and who can take a broad interdisciplinary systems approach to problems. But he does not claim that engineers with this type of approach will be able to solve problems any better than the more narrowly oriented experts they would replace. The essential virtue of this new kind of engineer is the ability to work alongside lay people in addressing problems. And this is tied directly to the second level of change—the policy-making level, at which he shows how and why increased democratic participation is more desirable than control restricted to a small technocratic elite.

The knowledgeable reader might be tempted to criticize this book for saying nothing new. But the strongest criticism that can be made fairly is that Pacey does not seem to be aware—or at least he does not explicitly acknowledge—that the general thesis he propounds (that is, that the critical issue is increasing democratic control over technology) and many of the specific subpoints he makes (for example, concerning the difference between male and female attitudes toward technology) have been examined in considerable detail by American writers such as Paul Goodman, Carol Gilligan, Lynn White, Jr., Frances Moore Lappe, Wendell Berry, Buckminster Fuller, Thomas Szasz, Langdon Winner, and many others. But such a criticism, though valid on purely scholarly grounds, would mean that the most significant point about this book had been missed. This most impressive point may not even have been intended by the author: it is simply that the case for increasing democratic control over technology can be made forcefully without appeal to the work of these and other well-known (to some, notorious) American thinkers. It is a thesis that is equally defensible from the perspective of Western Europe, South Asia, China, or any other contemporary culture.

In sum, Pacey succeeds in presenting and supporting his radically moderate thesis so effectively that it is almost impossible to reject it. The more likely reaction of persons who find it threatening (persons at either extreme) is to try to dismiss it as nothing new. But if rational beings can agree on anything, it is that novelty is not a criterion for truth.

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A Field of Astronomy

Glimpsing an Invisible Universe. The Emergence of X-Ray Astronomy. RICHARD F. HIRSH. Cambridge University Press, New York, 1983. viii, 186 pp., illus. $39.50.

Hirsh has taken a new yet fairly limited and clearly defined specialty in science and examined its early growth to maturity in this brief and interesting work. The book benefits from its concentration upon the United States during the 1960's and 1970's—during this period the majority of x-ray astronomy research was performed by or sponsored by U.S. organizations. Hirsh touches upon the forerunners of x-ray astronomy (for example, ionospheric physics and solar ultraviolet and x-ray studies) that provided the instruments, methods, and community structure for its emergence.

The first non-solar x-ray observations were obtained from a rocket in 1962, and in the next half-dozen years about 30

celestial x-ray sources were identified, especially by Naval Research Laboratory (NRL) workers. Hirsh sees the decade of the 1970's as the next stage of development, from the satellite Uhuru in 1970 until satellite Einstein in 1978. Utilization of these platforms allowed a major expansion both of equipment and of observing time. The evolution of x-ray astronomy is examined along several axes: political, sociometric, and intellectual. X-ray astronomy received its first instrumental boost from post-World War II rocket development and its second boost from post-Sputnik developments. The growth of government laboratories (such as NRL and, especially, NASA) is presented in the climate of civil and military national objectives. Hirsh shows the complexity and pluralism of support for modern American science: civil, military, industrial, and university groups competed, collaborated, and contributed to the growth of x-ray astronomy.

Like ionospheric physics and radio astronomy, x-ray astronomy began as a subject heavy in instrumentation. Equipment, methods, and data searched for a theoretical community. The work was done not by astronomers but mainly by physicists familiar with balloon and rocket experiments, Geiger counters, and electronics. Early theoretical models (synchrotron radiation, the neutron star) for energy generation and conversion provided only limited success in application to x-ray astronomy until the evolving subject itself became of greater conceptual interest to other fields such as galactic astronomy, nuclear physics, and cosmology. Hirsh highlights a competition between Herbert Friedman at NRL and Riccardo Giacconi at American Science and Engineering (an MIT spin-off company). Very much as in earlier radio astronomy, there was also competition in x-ray astronomy between the sky-survey approach and the single-star approach.

Portions of this book will be heavy going for those not literate in physics, but the treatment of theory chasing data chasing theory is nicely done. An unsolved problem for historians is how best to tell the intellectual history of a highly technical field while treating the social and political aspects and still give at least cameo roles to individuals. Several persons are subjects of mini-biographies, especially Friedman and Giacconi, but Hirsh could profitably have given us more. Even hilarity has ties to intellectuality. For example, although this isn't mentioned in the book, a few years ago near NASA's Goddard lab there was a "Riccardo Giacconi Look-Alike" costume party. Although Hirsh treats the topic, this reviewer wished for a more extensive discussion of the relationships between scientific development and military needs and contributions. Military-scientific operations (for example, the Argus tests in 1958 or the Vela Hotel satellites in the 1960's and 1970's) have often made scientific contributions, but their design and implementation have not usually been maximized for cooperation with or contribution to science. One suspects there is more than meets the eye with respect to the ensemble of U.S. military and civilian work in satellite and ground-based x-ray astronomy.

This volume is generally well written, proofread, and printed and is a welcome contribution to the history of modern science.

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Quaternary Geology

Glacial Lake Agassiz. JAMES T. TELLER and LEE CLAYTON, Eds. Geological Association of Canada, Toronto, 1983. vi, 451 pp., illus. C$34; to members, C$28. Geological Association of Canada Special Paper 26. From a symposium, Winnipeg, May 1982.

This book uses glacial Lake Agassiz as the focus for a synthesis of the Late Quaternary history of a large segment of central North America. Agassiz was the largest of the North American glacial lakes and occupied as much as 950,000 square kilometers of the area that is now Manitoba, Northern Ontario, Saskatchewan, North Dakota, and Minnesota during the melting of the last ice sheet, 12,000 to 8,000 years ago. The papers in the book describe Quaternary geology and deal with such matters as vegetation colonization, Holocene climate, dispersal of lower vertebrates, and archeological development.

One group of papers covers regional aspects of Quaternary geology and paleoecology. Some of these papers, such as ones on the stratigraphy and history of the southern part of the Lake Agassiz region by M. M. Fenton, S. R. Moran, J. T. Teller, and L. Clayton, Lake Agassiz in Saskatchewan by B. T. Schreiner, and the paleoecology of the southern part of the Lake Agassiz basin by A. C. Ashworth and A. M. Cvancara, are largely syntheses of data already available. Others, such as ones on the development of northern Lake Agassiz and its relation to Keewatin and Hudsonian ice regimes by L. A. Dredge and Lake Agassiz and the late glacial history of northern Manitoba by R. W. Klassen, present data and interpretations not previously published. Other groups of papers take up specific problems or present Quaternary histories of limited areas—for example, there are papers on the Sheyenne River and its effects on Lake Agassiz by J. A. Brophy and J. P. Bluemle, the Lake Agassiz-Lake Superior connection by J. T. Teller and L. H. Thorleifson, the origin of reticulate and oblicular patterns on the floor of Lake Agassiz by J. D. Mollard, and the postglacial dispersal of lower vertebrates in the Lake Agassiz region by K. W. Stewart and C. C. Lindsay.

Although considerable research has been devoted to Lake Agassiz and general agreement has been reached concerning the events that occurred during its formation and drainage, agreement has not been reached on the age of all events. The paper by Fenton *et al.* is an excellent summary that correlates glacial and lacustrine stratigraphic units within the southern part of the lake basin and provides an integrated history—complete with paleogeographic maps—of Lake Agassiz. The chronology in the paper is based on radiocarbon dates for wood; the authors reject dates for other types of organic material because of the danger of errors due to contamination. The history they outline has the lake forming on the north side of the Red River–Minnesota River drainage divide as the Late Wisconsinan glaciers retreated. Two and possibly three readvances of the ice occurred before ice retreat opened spillways in Ontario that permitted drainage of Lake Agassiz into Lake Superior and abandonment of the Minnesota River spillway. Readvance of the ice caused the lake to rise to its former outlet before retreat again opened the outlet to Lake Superior. According to these authors this sequence of events occurred between 11,700 and 9,500 years ago. Disappearance of the lake took place about 8,000 years ago when ice retreat permitted drainage directly into Hudson Bay.

In another paper, Klassen disagrees with the rejection of all radiocarbon dates other than those for wood and uses dates for all types of organic material to develop a longer history that has Lake Agassiz coming into existence more than 13,000 years ago.

In 1985 W. Upham established the geological significance of glacial Lake Agassiz in his United States Geological Survey Monograph 25, *The Glacial Lake*