phasizes the potential destructive power of biological weapons and argues that defending populations and troops from such weapons will require scientific research, some involving human subjects. With this in mind, he sketches out a model for ethical military research. He describes the practices and policies of an elite research group at the Fort Detrick, Maryland, laboratory where biological weapons and infectious diseases are studied with the help of a corps of volunteers serving three-year tours as research subjects. "Of all the amazing things I learned in writing this book," Moreno writes, "nothing surprised me more than that dozens of soldiers of both genders are still used as normal volunteers in biological experiments."

In an evocative unpublished essay, the historian of science Larry Owens explores the development of wound ballistics, the "branch of terminal ballistics having to do with the phenomena that occur when a missile strikes and penetrates the body" (*5*). At a Princeton laboratory funded by the Office of Scientific Research and Development during World War II, cats and dogs were anesthetized and shot with scaled-down bullets. The shootings were recorded, photographed, and used to construct a "standardized wound event" characterized by a retardation equation. This equation, Owens proposes, represents "civilizing reason," not a failure of modernization but a characteristic expression of it, and a manifestation of the "infliction of harm in good conscience" (*6*).

Many of the human-subjects research projects carried out in the United States during the Cold War involved, in Owens's terms, the infliction of harm in good conscience. Such projects often provided information that could facilitate both healing and further injury. E. Newton Harvey's 1948 essay (*5*) made it chillingly clear: Wound ballistics research could suggest ways to increase the destructive power of projectiles. Knowledge of the body can facilitate both healing and injury. To turn our attention to this, and to try to understand why and how it came to be, seems to me a worthwhile enterprise.

In the wake of the 17 September 1999 death of 18-year-old Jesse Gelsinger in an experimental gene therapy trial at the University of Pennsylvania's Institute for Human Gene Therapy, questions about the integrity of the research process have a particularly sharp edge. It is critically important to understand the ideas and practices that have shaped experimentation with human subjects. Moreno is certainly correct in proposing that such research is here to stay, and his book is a contribution to the public debate.

References and Notes

1. See E. Scarry, *The Body in Pain: The Making and Unmaking of the World* (Oxford Univ. Press, Oxford, 1985), especially pp. 27–59, but also her discussion pp. 60–81 of the relation between the injuring of war and the injuring of torture. Recent works exploring research with human subjects include S. H. Harris, *Factories of Death: Japanese Biological Warfare 1932–45 and the American Cover-Up* (Routledge, New York, 1994); A. M. Hornblum, *Acres of Skin: Human Experiments at Holmesburg Prison* (Routledge, New York, 1998); and S. Lederer, *Subjected to Science: Human Experimentation in America Before the Second World War* (Johns Hopkins Univ. Press, Baltimore, 1995).
2. Robert Proctor, in *Deviant Bodies*, J. Terry and J. Urla, Eds. (Indiana Univ. Press, Bloomington, IN, 1995), pp. 170–196.
3. *Buck* v. *Bell*, 274 U.S. 200 (1927).
4. Advisory Committee on Human Radiation Experiments, *The Human Radiation Experiments* (Oxford Univ. Press, Oxford, 1996).
5. E. Newton Harvey, "Studies on Wound Ballistics," in *Advances in Military Medicine Made By American Investigators...*, E. C. Andrus *et al.*, Eds. (Little, Brown, Boston,1948), pp. 191–205.
6. L. Owens, "The Infliction of Harm in Good Conscience: A Cold War Fable," essay presented at the Massachusetts Institute of Technology, Cambridge, MA, 9 December 1998.

BOOKS: TECHNOLOGY

Tales of Cooling

David Goodstein

In the summer of 1620, a hustler named Cornelis Drebbel offered to amaze the English royal court by producing a roomful of winterlike cold. King James I took up the challenge and chose Westminster Abbey on a particularly warm day. We know Drebbel succeeded to the satisfaction of the king because the feat is mentioned in passing by Francis Bacon, philosopher of science and sometimes lord chancellor to James I. With this episode, Tom Shachtman begins the tale he calls *Absolute Zero and the Conquest of Cold.*

Absolute Zero and the Conquest of Cold
by Tom Shachtman
Houghton Mifflin, Boston, 1999. 271 pp. $25. ISBN 0-395-93888-0.

Shachtman, the author of some 25 books (although none of the others are about science), has pulled off a trick almost as neat as Drebbel's. He's written a page-turner about the history of cold. There are really two stories here, the commercial history and the scientific history. Shachtman wisely tells them both, side by side, in roughly chronological order. The result, unfortunately, is flawed because he failed to get someone better versed in science than he to read through the entire manuscript.

The scientific story is the one promised by the title. It involves the mastery of thermodynamics, the liquefaction of gases (culminating in the race to liquefy hydrogen and helium), the discoveries of superconductivity and superfluidity, and more, right up to the recent advances in laser cooling of trapped atoms. The commercial history involves the worldwide trade in stored natural ice in the 18th and 19th centuries, the development of artificial refrigeration and air conditioning, and the effects of artificial cooling on nutrition (including the story of Clarence Birdseye and his quick-frozen fish) and on where people can live in reasonable comfort.

All of this is genuinely fun to read. Shachtman is an enthusiast about the adventure of conquering the frontiers of cold, and he knows how to tell a story. The problem is, the author frequently gets in over his head when he tries to explain matters scientific. Let me give you just one example:

"It had long been known that a magnet's force could be amplified by means of electric current coursing through wire wrapped around it. When it became possible to make wires that were superconducting, and wrap them around magnets, the resulting current raised the power of the magnets even more."

It must have occurred to Shachtman that this gem seemed to contradict something that he wrote elsewhere because he decided to add a footnote:

"While the application of a magnetic field to a superconducting material could make that material lose its superconductivity, when an insulated superconductor was wrapped around a magnet, amplifying the magnet's power, the superconductor was not affected adversely by the magnet."

Unfortunately for Shachtman, superconducting magnets do not have iron cores, and they are not immune to the magnetic fields they produce. It wouldn't have taken the author much to get someone to explain to him what superconducting magnets are all about, but he didn't bother—not in this instance and not in countless others scattered through the book.

That's a real pity, because Shachtman has seen the history of low temperatures through fresh eyes and written what could have been a fine book. Moreover, although there are many similar errors, they would all have been easy to fix. Had General Motors put out a product like this, the company would issue a general recall for repairs. Houghton Mifflin ought to do the same for this book.

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