it. This dichotomy is readily explained in terms of the benefits-capture hypotheses articulated by von Hippel.

Even so, there is a puzzling gap in von Hippel's analysis. His references include two publications by Jacob Schmookler, but nowhere in the text are Schmookler's contributions discussed. Schmookler is best known for having emphasized the importance of demand as a stimulus to invention. But in his *Invention and Economic Growth* (1966), he synthesized "demand-pull" and "science-push" theories, arguing that demand may have its impact anywhere along the vertical chain from material and component suppliers through system assemblers to end users and that the locus of invention therefore depends upon where relevant science-based skills are best brought to bear. Von Hippel improves upon Schmookler's schema by showing that the ability to tap the profit potential of a demand pull may be stronger at one point in the vertical chain than at another. But he fails to recognize Schmookler's symmetric assertion that the skills needed to tap the relevant science base may also be more heavily concentrated at one point than at another. The innovation locus in scientific instruments seems as explicable by the preponderance of relevant scientific knowledge among instrument users as by the greater ability of users to capture the benefits generated by their improvements. Also, when skills are concentrated at one locus in the chain and the appropriability of benefits at another—a condition poorly illustrated by von Hippel's relatively pure cases—there is need for a more general, quantitative theory. One hopes that further work by von Hippel will fill the gap.

F. M. SCHERER
Department of Economics, Swarthmore College, Swarthmore, PA 19081

The Beginnings of SDI

Lost in Space. The Domestic Politics of the Strategic Defense Initiative. GERALD M. STEINBERG, Ed. Lexington (Heath), Lexington, MA, 1988. x, 170 pp., $29.

The Reagan Strategic Defense Initiative (SDI) may have as many historians as it now has proponents and critics. The drama of its announcement in President Reagan's speech of 23 March 1983 and its shock effect on the bureaucracy and Congress guarantee that it will be a fruitful subject for study for many years to come. Certainly the topics covered in this study produced by the University of California's Institute on Global Conflict and Cooperation are crucial to any thoughtful political history and analysis of SDI. Unfortunately, the point at which this book was completed—1987—was too early to provide adequate perspective on most of the topics it covers. Nevertheless, the focus of the study is a useful one: the domestic politics of a highly controversial military research program.

The first two chapters, by Gerald Steinberg and G. Allen Greb, respectively, set forth what is common knowledge—that President Reagan's 23 March 1983 speech was not a carefully prepared and well-thought-out initiative. It was a rhetorical flourish, whose incubation was a carefully guarded secret. Nor, in all probability, was its enormous political impact foreseen by those who planned it. The boldness of the move and the surprise, excitement, and consternation it caused deserve a far richer contextual treatment than Steinberg's introductory chapter provides. Hedrick Smith, for example, in *The Power Game* gives a vivid and superb description of the "tiny power cocoon" in which the SDI concept was developed. And these events have been further dramatized in the Public Broadcasting Service series of January 1989 that grew out of that book.

The timing of the announcement and the unswerving commitment of President Reagan are keys to the enormous power of the "Star Wars" concept. Though antiballistic missile defense has had its advocates since the 1960s, the idea that nuclear weapons could be rendered "impotent and obsolete" was revolutionary and simply vaporized technical and bureaucratic obstacles that might have moderated or delayed the launch of the SDI program. The promise of eliminating the threat of nuclear weapons fed into the underlying fears that had generated grass-roots support for the Freeze movement. It also dealt with some of the moral issues that led to the May 1983 letter of the American Council of Catholic Bishops condemning mutually assured destruction as a policy.

It took several years of rigorous technical work and debate, as well as observation of what such a richly funded research program could actually accomplish, for technical skepticism to begin to have a wide audience. The American Physical Society report (which was published too late for this book) played a major role in legitimizing the technical doubts.

The SDI program has been altered substantially, even though $15 billion has been spent, and funding levels attained $4 billion in fiscal year 1989. This was less than requested but extremely high in comparison to other R&D programs, or even new weapons development programs. *Lost in Space* fails to develop the distinction between the political forces that supported the initial "space shield" concept and the continuing though eroding support for a far more modest set of defense concepts. SDI has gone through a major evolution from replacing deterrence to enhancing it, from full population defense to limited defense of silos and command and control or limited population defense against an accidental or aberrant launch.

Greb implies that the decline in the science advisory function may account for the lack of careful technical assessment of SDI early on. His historical description is interesting and accurate, as the collection of essays compiled by William Golden in *Science Advice* attests. But it is not at all clear that it would have made much difference in the case of the 23 March 1983 announcement whether or not President Reagan had a science advisory team on whom he relied for important technical judgments. In one sense he had a powerful science adviser, Edward Teller. An adviser in the Teller mold would have been likely to support President Reagan's enthusiasm, not dampen it. The critical political fact remains that the concept was kept from the knowledge of even many of the President's closest advisers on military matters, such as the Secretary of Defense.

In an era of widespread leaks and effective investigatory journalism, the ability of a small group in the Reagan White House to operate in absolute secrecy is a political phenomenon worth attention and analysis, particularly in view of the fact that a "tiny power cocoon" operated again in "Iran-Contra" with a somewhat different cast of characters.

The public fear and weariness of the balance of terror and willingness to accept a highly costly program that seemed to promise a shift in strategy away from mutual deterrence to defense are hardly explored in *Lost in Space*. Yet the contradiction and duality in public opinion have remained strong for many years, as polling data indicate. Americans harbor a serious fear of nuclear war. They support arms control, even while continuing to view the Soviets skeptically. But they also support a strong defense. SDI promised it all. The question that must be explored is whether this support will evaporate once population defense is deferred indefinitely and large resources are given for ballistic missile defense that may make strategic arms control non-negotiable.

The chapter by Pratt, Pike, and Lindley, "SDI contracting: Building a constituency," describes the very conscious strategy adopted by the Strategic Defense Initiative Organization of generating national support by

spreading contract funds widely. The analysis that indicates how SDIO went about seeing that the "iron triangle" would come into play is very useful, in part because it gives sufficient detail to enable the reader to form a judgment about the thesis proffered. It also offers a basis on which to observe future events to see whether the constituency that has been built is powerful enough to withstand the budgetary pressures that the Bush administration faces.

The story of the critical role of Congress in the evolution of SDI remains to be written. Alan Sweedler provides some early facts about budgetary review and hearings but does not discuss at all an issue that has had a major impact on the direction of SDI: the fact that the Senate considered the Reagan administration's reinterpretation of the ABM Treaty to be an attack upon its constitutional treaty power. There is no doubt that the four Nunn Reports on ABM Treaty interpretation and the Biden-Byrd Resolution on the INF ratification process affected the way Congress regarded SDI. They contributed to the rising concern that the SDI testing program, if not restrained, would sooner or later come into conflict with the ABM Treaty—thus undermining the arms control process. The various congressional amendments that have kept the testing program within the traditional interpretation may not have affected the pace of work but have certainly highlighted, if not caused in part, the growing deglamorization of SDI.

This book whets the appetite for a thoroughgoing political analysis of SDI but cannot begin to satisfy it.

ANTONIA CHAYES
Endispute,
1820 Jefferson Place, NW,
Washington, DC 20036

Some Other Books of Interest

Inorganic Mass Spectrometry. F. ADAMS, R. GIJBELS, and R. VAN GRIEKEN, Eds. Wiley-Interscience, New York, 1988. xii, 404 pp., illus. $65. Chemical Analysis, vol. 95.

"The scientific literature and conferences prove that mass spectrometry is most widely employed in the field of organic analysis, but this was not always the case," write the editors of this volume. Describing some difficulties that have limited its use with inorganic relative to organic materials, the editors note that recent developments have "implied a remedy, at least partially, to these limitations." Hence, "this book is published at a moment when there is, again, a sense of real excitement at the forefront of inorganic mass spectrometry." In it 12 mostly European authors (half from the University of Antwerp) report on the state of the art. In a brief opening chapter I. Cornides provides a historical introduction to the subject, tracing it from J. J. Thomson's investigations of "positive" electricity through the development of commercial instrumentation in the 1940s to the present era. The main text of the book consists of six chapters on the principles and applications of particular mass-spectroscopic techniques: spark source (Ramendik *et al.*), glow discharge (Harrison), secondary ion (Lodding), laser microprobe (Verbueken *et al.*), inductively coupled plasma source (Gray), and isotope dilution (Heumann). In a final chapter Gijbels and Adams discuss "recent trends and future prospects," noting the existence of "a profound interaction between those who design and build new mass spectrometric instrumentation and those who use it, which tends to push the field quickly forwards."—**K.L.**

Ultrasound. Its Chemical, Physical, and Biological Effects. KENNETH S. SUSLICK, Ed. VCH, New York, 1988. xiv, 336 pp., illus. $65.

The preface of this volume opens by tracing the discovery of cavitation, one of the mechanisms by which ultrasound affects liquid media, to difficulties experienced by the British destroyer H.M.S. *Daring* in 1894 and goes on to observe that "in spite of the impact that ultrasound has had on modern science and technology . . . there has been almost a complete lack of review materials on the underlying principles from which such effects originate." Noting both the diversity of uses for ultrasound and continuity in the underlying physical phenomena, the editor hopes with this volume to produce a "cross-fertilization [that will] be fruitful to each of the areas of specialization represented" in it. The opening chapter is a 64-page exposition by A. A. Atchley and L. A. Crum of acoustic cavitation and bubble dynamics, beginning with a basic definition of cavitation ("the formation and the subsequent dynamic life of bubbles in liquids") and including a historical perspective. James A. Rooney then discusses other nonlinear acoustic phenomena—streaming, emulsification and aggregate dispersal, atomization and droplet formation, radiation force, bubble oscillations. There follow chapters on industrial applications of ultrasound by A. Shoh, on homogeneous and heterogeneous sonochemistry by Suslick and P. Boudjouk, respectively, and on sonoluminescence by R. E. Verrall and C. M. Sehgal. The volume concludes with two chapters on biological effects, L. A. Frizzel on in vitro and non-human systems including plants and G. ter Haar on clinical applications. Each chapter has its own reference list, and there is an index for the volume as a whole.—**K.L.**

Books Received

Conservation Farming on Steep Lands. W. C. Moldenhauer and N. W. Hudson, Eds. Soil and Water Conservation Society, Ankeny, IA, 1988. xiv, 296 pp., illus. $25. From a workshop, San Juan, Puerto Rico, March 1987.

Consider a Spherical Cow. A Course in Environmental Problem Solving. John Harte. University Science Books, Mill Valley, CA, 1988. xvi, 283 pp., illus. Paper, $18.

Coordinates in Geodesy. Siegfried Heitz. Springer-Verlag, New York, 1988. xii, 255 pp. Paper, $39.50. Translated and revised from the German edition (Bonn, 1985).

Coordination of Observation Projects in Astronomy. C. Jaschek and C. Sterken, Eds. Cambridge University Press, New York, 1988. xii, 270 pp., illus. $49.50. From a conference, Strasbourg, France, Nov. 1987.

Crisis Stability and Nuclear War. Kurt Gottfried and Bruce G. Blair, Eds. Oxford University Press, New York, 1988. xii, 354 pp. $29.95; paper, $10.95.

Critical Levels in the Development of Natural Systems. Alexey V. Zhirmunsky and Victor I. Kuzmin. Springer-Verlag, New York, 1988. x, 170 pp., illus. $69.50. Revision of *Critical Levels in the Developmental Processes of Biological Systems*.

Critical Observations Versus Physical Models for Close Binary Systems. Kam-Ching Leung, Ed. Gordon and Breach, New York, 1988. xvi, 472 pp., illus. $95. From a colloquium, Beijing, China, Nov. 1985.

Crystallographic Statistics in Chemical Physics. An Approach to Statistical Evaluation of Internuclear Distances in Transition Element Compounds. F. Valach, J. Ondráček, and M. Melník. Springer-Verlag, New York, 1988. x, 185 pp., illus. $99.50. Inorganic Chemical Concepts, vol. 12.

CSL '87. E. Börger, H. Kleine Büning, and M. M. Richter, Eds. Springer-Verlag, New York, 1988. vi, 346 pp., illus. Paper, $25.70. Lecture Notes in Computer Science, vol. 329. From a workshop, Karlsruhe, F.R.G., Oct. 1987.

Emanuel Swedenborg. A Continuing Vision. Robin Larsen *et al.*, Eds. Swedenborg Foundation, New York, 1988. xvi, 558 pp., illus. $75.

The Encyclopedic Dictionary of Science. Bernard Dixon *et al.* Facts on File, New York, 1988. 256 pp., illus. $29.95.

The Human Brain. Paul Glees. Cambridge University Press, New York, 1988. vii, 204 pp., illus. $59.50. Revision of *Das menschliche Gehirn* (Stuttgart, 1968).

Human-Computer Interaction. Psychonomic Aspects. Gerrit C. van der Veer and Gijsbertus Mulder. Springer-Verlag, New York, 1988. xiv, 458 pp., illus. $79. Based on a conference, Amsterdam, The Netherlands, Dec. 1985.

Increasing Small Ruminant Productivity in Semi-Arid Areas. E. F. Thomson and F. S. Thomason, Eds. Kluwer, Norwell, MA. 1988. x, 296 pp., illus. Current Topics in Veterinary Medicine and Animal Science, vol. 47. From a workshop, Aleppo, Syria, Nov.-Dec. 1987.

Inhalation Toxicology. The Design and Interpretation of Inhalation Studies and Their Use in Risk Assessment. U. Mohr *et al.*, Eds. Springer-Verlag, New York, 1988. xiv, 318 pp., illus. $98. International Life Sciences Institute Monograph Series.

International Classification in Psychiatry. Unity and Diversity. Juan E. Mezzich and Micahel von Cranach, Eds. Cambridge University Press, New York, 1988. xxii, 390 pp. $59.50. From a conference, Montreal, Quebec, June 1985.

Interpreting Spectra of Organic Molecules. Thomas N. Sorrell. University Science Books, Mill Valley, CA, 1988. xii, 175 pp., illus. Paper, $18. A Series of Books in Organic Chemistry.

Neuroimmunoendocrinology. J. Edwin Blalock and Kenneth L. Bost, Eds. Karger, Basel, 1988. x, 165 pp., illus. $92.75. Progress in Allergy, vol. 43.

New Ideas in Astronomy. F. Bertola, J. W. Sulentic, and B. F. Madore, Eds. Cambridge University Press, New York, 1988. x, 349 pp., illus. $54.50. From a conference, Venice, Italy, May 1987.

(Continued on page 1501)