Issues for Soviet Technology

Politics and Technology in the Soviet Union. BRUCE PARROTT. MIT Press, Cambridge, Mass., 1983. xii, 428 pp. $45.

The comparative level and dynamism of technology in the U.S.S.R. and the West and the costs and benefits of technology transfer between them are crucial issues today for both U.S. and Soviet policy-makers. In the U.S.S.R. major preoccupations of the leadership include how to stimulate technical progress as an ingredient in growth, how much to depend on the West for technology, how to organize domestic R & D, and how to allocate this effort between military and civilian programs. In the U.S. an acrimonious debate continues over how large the flow of Western technology to the U.S.S.R. is, the relative importance of different channels, how much Soviet military power and civilian economic performance benefit from it, and what we should do to regulate it.

Bruce Parrott does not deal explicitly in his excellent book with the current situation, except for a few remarks at the end, but he offers a very enlightening perspective on many of the points at issue today by tracing Soviet policies and debates on R & D and technology transfer over the whole period of Soviet industrialization. The book explores three intertwined themes. The central issue of technology strategy for the Soviets is where to position themselves along the spectrum between autarky and openness with respect to science and technology, that is, to what extent to remedy their technological backwardness by obtaining advanced technology from the advanced capitalist countries, as opposed to relying on their own R & D efforts. In the Soviet setting, that question can be answered only in the context of an ideological position regarding economic, technological, and military competition with the West, since such a position is necessary to define the balance between need and danger in interaction with the imperialist enemy. In another direction, the answer to the big strategic question has strong implications for institutional arrangements, policies, and resource allocations to and within R & D. Thus the main issue is inevitably accompanied by two corollary debates—a political-ideological argument regarding the comparative strength of the forces of imperialism and socialism, and a political-bureaucratic struggle over power. In tracking these themes Parrott organizes his discussion around the relative influence of what he calls "traditionalist" and "nontraditionalist" stances. In the traditional view the West is implacably hostile but demonstrably losing the competition with socialism, whereas the nontraditionalist view appreciates the reality of a capitalist world still economically and technologically vital and less hostile as a potential partner and less dangerous than orthodox Marxian views might suggest.

This book is an excellent advertisement for the utility of looking at what might seem to be primarily contemporary concerns against the background of the historical record. Its method is careful reading of the statements of politicans at the apex of the power pyramid, officials of the state hierarchy, spokesmen for various other elites who have a stake in the issues, and, increasingly in recent years, the policy think tanks. Parrott finds a great deal of material—these issues have been intensely discussed at various times in a variety of contexts. His approach turns out to be not only neat as a framework but also a productive way to organize a review of six decades of policy and debate, revealing some long-term trends and some persistent systemic regularities. As an economist I am sometimes impatient with the guessing involved in deducing substantive differences among the debaters in Soviet-style discourse, but I have ended up chastened by seeing how revealing careful sifting of this political debate can be in interpreting what happens. Only a few of the interesting things that emerge can be mentioned here.

First, there has been an interesting evolution in the Soviet leadership's view as to how they should relate to the rest of the world in matters of science and technology. In the beginning, they were acutely aware of their backwardness but confident of the superiority of their system and its ability to outperform the capitalist world in terms of technological progress and economic growth. This led to heavy borrowing and an R & D system heavily distorted by that fact, paradoxically linked to campaigns to overcome a sense of inferiority by denigrating Western technology and isolating Soviet science and technology from the rest of the world. As the latter tendency came to dominate, the system's ability to realize its technological potential was badly crippled and the resulting structure perpetuated backwardness and dependence. It has been a painful revolution since Stalin's death to bring the system closer to the world mainstream of technology. As progress has been made in catching up, the early complacency about the superiority of the Soviet system for technological progress has been shattered. Evident in the Brezhnev period, this feeling is more acute today than ever, I believe.

A recurrent theme, more evident in the record than I would have suspected, is Soviet doubts about the ability of the system to keep up with the West in military technology. Over the years they have suffered many nasty surprises in this respect, and this still powerful latent perception is set off anew by each advance in Western military technology. These fears are today compounded by a suspicion that it is impossible to sustain a competitive military technology unless the system can be made to do a better job of technological progress across the board, and it is interesting to find that that preoccupation, too, has a long history.

Third, Parrott's survey demonstrates the bureaucratic free-for-all that ensues on any effort to change science and technology policies in search of improved performance on technological progress. There are many interests in conflict. Neglected ministries see in technology transfer a means to improve their performance and prestige; researchers want more freedom from bureaucratic and political interference, but also protection from competition (including foreign technology); managerial officials chafe at constraints but are not at all eager to take on the responsibility of innovating themselves; ministries can think of numerous reasons why it is inexpedient to devolve this function to the enterprise level; the KGB sees threats to security in any expansion of scientific interchange and gains something from having the military depend on it for clandestine acquisition of foreign technology. Everyone weighs in with some parochial interest that

makes it very difficult to implement a coherent reform.

The U.S.S.R. is undoubtedly going through an intense acute phase of this long-standing debate again today, but without all the arguments out in the open. In interpreting what clues we do get, I find the kind of retrospective Parrott has provided is extremely helpful.

ROBERT CAMPBELL
Department of Economics, Indiana University, Bloomington 47405

Differences of Scale

Powers of Ten. A Book about the Relative Size of Things in the Universe and the Effect of Adding Another Zero. PHILIP AND PHYLIS MORRISON and the OFFICE OF CHARLES AND RAY EAMES. Scientific American Library (Freeman), New York, 1983. xii, 150 pp., illus., + index. $29.95.

This book is a celebration of the creative friendship of two couples, Charles and Ray Eames and Philip and Phylis Morrison. It is also a memorial to the one member of this extraordinary quartet who is no longer among us, the architect Charles Eames. It is written in a tone of reverence—for Eames, for his vision, and above all for the sense of wonder that drives us to transcend the limits imposed by our senses.

It is a rendering in book form of a ten-minute film produced in 1977 by the Eames team with Philip Morrison providing the narration. The film presented 42 still photographs descending in scale by a factor of 10 at each step from the cosmic range of 10^{25} meters to a subnuclear 10^{-16}. At the center of each image, the next image in the sequence was highlighted by a thin border and defined in slightly greater detail, inviting the eye to make the next leap.

In order to take full advantage of the superior resolution of high-quality color printing, the images have been rephotographed from their original sources. On the page facing each are smaller illustrations and text, offering far more information than could be conveyed in the ten seconds alloted to each order of magnitude in the original sound track. A film designed to whet the appetite has become a book to satisfy it. The reader's attention is drawn to details that might otherwise be overlooked, and to ideas and facts that illuminate what is seen.

For the benefit of those not yet satiated, 50 additional pages of text explain the technologies behind the images, the history of the discoveries and inventions that made them possible, and the scientific and aesthetic visions that governed this enterprise. Devotees of Philip Morrison's book reviews in *Scientific American* will recognize his lucid and lyrical style in these passages.

For the insatiably curious the text is extensively referenced, and there is a bibliography. The book is also provided with a fairly comprehensive index. A short section introduces the uninitiated to the wonders of exponential notation.

The authors are careful to remind the reader that only 15 of the 42 images, those spanning the range from 10^{8} meters to 10^{-6}, are based on anything that can be rightfully called a photograph. Images of larger orders of magnitude depict the cosmos from vantage points that cameras have never reached. Those of smaller ones depict a world in which the very notion of vision, on which so much of our consciousness is based, breaks down. Any rendering of a DNA molecule, of the electron "cloud" in an atom, or of the dance of quarks and gluons at the final step is necessarily symbolic. Passive observation of objects that are unaffected by our presence, and that change slowly enough for the eye to follow, has no place in the study of the microworld.

Where true images are possible, however, they have been selected with great care. The splendid blue-and-white orb of our planet as seen from the moon grows closer until we view North America centered on the Chicago lakefront. There we spy on a couple sunning themselves on a blanket. We enter the surface of the skin, meeting a leukocyte and finally its nucleus as seen in a scanning electron micrograph. Then follows the symbolic plunge through molecules to the heart of a nucleon. The photographs have been enhanced to improve contrast and definition without making them seem artificial.

This book may be read for pleasure and profit by anyone from a teenager to a working research scientist. The former will gain a sense of the vast scope of present-day science and of some questions it can answer and others that remain tantalizingly unanswered. The latter may find a vivid depiction of how his or her work fits into this grander vista. The book is sufficiently handsome to serve as the kind of coffee-table ornament that seems to be required to keep the book business alive in an age of more clamorous visual media.

ROBERT H. MARCH
Department of Physics, University of Wisconsin, Madison 53706

Cosmology

Astrophysical Cosmology. Proceedings of a study week, The Vatican, Sept. 1981. H. A. BRÜCK, G. V. COYNE, and M. S. LONGAIR, Eds. Pontifical Academy of Sciences, Vatican City, 1982 (distributor, Specola Vaticana, Vatican City). xxxviii, 600 pp., illus. Paper. $43; to libraries and institutions, $58. Pontificiae Academiae Scientiarvm Scripta Varia, 48.

During the past few years there has been an enormous growth in the interaction between cosmology and fundamental physics, and elementary particle physics is now addressing such important cosmological issues as nucleosynthesis, the origin of galaxies, the excess of particles over antiparticles in the universe, the extreme isotropy of the universe, and the closeness of the universe to being gravitationally bound. Conversely, new theories of particle physics are being constrained by astrophysical and cosmological considerations.

This proceedings volume consists of papers on the large-scale structure of the universe, the origin and evolution of galaxies and active galactic nuclei, primordial nucleosynthesis, and particle physics in the very early universe. Roughly half the papers are reviews. The remainder present the results of original research, usually with broad introductory surveys of the field. A useful transcript of the questions and answers following each paper is also included.

An introductory paper by Rees and a summary paper by Longair are helpful in putting the other papers into a unifying context. In all, there is remarkable agreement among the authors about a variety of issues. A paper by Oort on the large-scale structure of the universe demonstrates the clumpiness of the universe, with filamentary superclusters of galaxies separated by large voids. Additional evidence concerning the large-scale structure and its dynamical implications is presented in a paper by Davis. Besides discussing the evolution of galaxies, papers by Faber and by Gunn discuss the evidence that only 10 percent of the mass in galaxies and clusters of galaxies is visible and that the ratio of visible to total mass may be constant on galactic scales and larger. Papers by Silk and by Peebles discuss constraints on models of galaxy formation and the possibility that the dark matter that dominates the mass of galaxies may consist of neutrinos having nonzero mass. The contribution of active galaxies to the x-ray background and the evidence that quasars were either formed or first began