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Science, Philosophy, and Human Behavior in the Soviet Union.

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a propensity for deception, they are superbly organized, bureaucratically and ideologically, to carry it out.

However, two areas for further research are readily apparent. First, there is ample evidence that self-deception is an American characteristic and has more to do with U.S. policy blunders than with Soviet active measures. The book does not explore the linkage between latent misbeliefs and Soviet reinforcement in detail. Second, with the exception of one reference to fake SSBNs, there is no mention of the use of deception in Soviet naval operations. This is a grievous fault in a book from the Naval Postgraduate School.

Everyone who studies the formation of U.S. defense policy or American-Soviet relations should read this book. Unfortunately, at the publisher's price, I suspect that few will. A less expensive executive summary is definitely in order.

Graham, Loren. *Science, Philosophy, and Human Behavior in the Soviet Union*. New York: Columbia Univ. Press, 1987. 565pp. $45

This important book is a major revision and expansion of the author's earlier work, *Science and Philosophy in the Soviet Union* (New York, 1972). So thoroughly has Loren Graham recast and enlarged his earlier work that the result is virtually a new book.

The underlying structure of the present volume remains that of Graham's earlier work: description and analysis of the relationship between Soviet science and the philosophy of dialectical materialism. The period that interests him most follows the end of the Second World War, although he does not neglect earlier work by Soviet scientists. Against a background of the history of Soviet science and philosophy, Graham describes scientific research in the U.S.S.R. as well as philosophical controversies over various aspects of research in the fields of genetics, physiology, biology, cybernetics, chemistry, quantum mechanics, relativity physics, and cosmology.

Graham, a professor of Soviet studies at the Massachusetts Institute of Technology, enjoys complete command of the Russian language as well as a record of long periods of research residence in the Soviet Union. The trip described in his recent *NOVA* telecast "How Good is Soviet Science?" was his 15th visit to the Soviet Union. For the most part, Graham's visits have been welcomed by Soviet academicians, particularly those of the Academy of Science of the U.S.S.R.

Graham's earlier book carried his detailed examination of Soviet science and philosophy up to 1970. The present work takes the reader through mid-1985. Two new chapters on Soviet research and studies on

human behavior include descriptions of prominent Soviet figures in the "Nature or Nurture" debates, as well as various topics on the relationship of biology to human life—sociobiology, crime and social deviance, ethnic relations, and biomedical ethics.

Following a historical overview of the relationship between Soviet politics and science, Graham devotes a chapter to dialectical materialism, the official philosophy of the Soviet Union, which Graham claims to be not only an important intellectual achievement in itself, but a conceptual scheme that a number of front-rank Soviet scientists have found stimulating and helpful in their work. This high estimation of dialectical materialism (the term was first used not by Marx or Engels but by Plekhanov) will prove troublesome to many scholars.

Graham's respect for dialectical materialism does not influence him to ignore the long history of Soviet Government interference with scientific research. The Lysenko affair remains the best known to Westerners and, oddly, has the least to do with dialectical materialism. Graham illuminates a number of important but less familiar controversies in various fields of Soviet science in which one party or another has been accused of diverging from orthodox materialism. For example, he describes how, decades ago, resonance theory in chemistry and quantum mechanics in physics alerted guardians of Soviet scientific orthodoxy to wag warning fingers at Soviet scientists concerned with research in these disciplines.

The complementarity principle associated with Bohr's and Heisenberg's interpretation of quantum mechanics threatened to lead to "idealism," a philosophical position Lenin considered incorrect. The squabble over the alleged unorthodoxy of "Copenhagen physics" lasted nearly twelve years before it finally petered out; in 1960 the *Great Soviet Encyclopedia* gave its blessing to quantum mechanics. But as recently as 1981, Graham notes, Iurri Zhdanov, son of Andrey Zhdanov, Stalin's cultural hatchet man, declared that chemical reactions obey dialectical laws, an opinion not wholly seconded by Soviet chemists. The latter are willing to grant dialectical materialism an epistemological role in scientific research, but balk at being forced to acknowledge an ontological one. The epistemologists acknowledge the value of dialectical materialism as a cognitive method, but are reluctant to grant the more conservative ontologists' claim that dialectical materialism represents an actual description of Being or Reality. According to Graham, progressive figures in Soviet science today tend to favor the methodological, less metaphysical, understanding of the official philosophy.

The high value of Graham's book rests largely in its rich cargo of meticulously researched information about personalities and developments in 20th century Soviet science.

The book could have been written only by one closely familiar with the Russian language, with Soviet culture, and particularly with the manifold scientific theories—many quite recondite—here chosen as representative. Much of this data would have remained inaccessible to the West were it not for Graham's tireless pilgrimages to the Soviet Union and his patient searching in the Soviet and pre-Soviet courses which has yielded so much of the material he so lucidly presents.

This reviewer's reservations about the book concern the author's claim that dialectical materialism is an intellectual achievement comparable to the Aristotelian or Cartesian models of the physical universe. Certainly Graham has assembled an impressive array of acknowledgment citations by Soviet scientists who talk, apparently with some freedom, of their debt to this official philosophy and of courses that are still compulsory in every field of Soviet higher education. It is puzzling to a Westerner that this dated schematism, so closely related to late 19th and early 20th century process philosophies and emergent evolutionisms, should still escape demythologizing in the U.S.S.R., while it has been dismissed as arid scholasticism even by Communist intellectuals in other countries—for example, by Raymond Jean in France.

But perhaps unqualified, official approval of dialectical materialism in the Soviet Union is already easing off. Graham himself cites I. B. Zel'dovich and I. D. Novikov, two cosmologists who represent new trends in that scientific discipline and whose reputations have spread favorably to the West. This brilliant pair, says Graham, tend to avoid writing about Marxism or dialectical materialism in their scientific works. Indeed, Graham adds, they back away from philosophical and historical questions in general, "as if they know such issues can only cause trouble."

In *Science, Philosophy, and Human Behavior in the Soviet Union*, Graham does not deal directly with the question raised in his *NOVA* presentation, "How Good is Soviet Science?" In the telecast, he made it forcefully clear that so far as pure science is concerned, Soviet science today still lives in a quasi-spiritual tower, hermetically sealed off, save in exceptional instances, from application to technology. As a result, Graham says, Soviet technology, at least in the civilian sphere, lags 10 to 15 years behind that of the West, particularly trailing the United States and Japan. This is part of the gap Gorbachev is trying to close. In the military sector, the lag may not be as great. With their prestige, power to cut through bureaucratic restrictions, and consequent easier access to required high-quality material, the Soviet military may be in a better position to acquire first-class, high-tech equipment for their armed forces. Graham did not discuss this in his book, nor did he touch on it in his *NOVA* program save for his introductory statement that military scientific laboratories are off-limits to Western visitors.

In any case, for military and civilian readers alike, Graham's large book, with its panorama of Soviet scientific research and accomplishments, stands as required reading for all those who share interest in the science, philosophy, and culture of the great nation to the east, some of whose leaders at least today incline to the belief, hitherto unthinkable, that their national interests may coincide to some degree with our own.

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Gleick, James. *Chaos: Making a New Science*. New York: Viking, 1987. 352pp. $19.95

In the last twenty years mathematicians and scientists have come to recognize that much of what goes on in nature is not as random and noisy as previously thought, but contains beautifully and subtly intricate behavior which appears to be chaotic only at first look. James Gleick of the *New York Times* has written a remarkable and orderly book about this disorderly business. He has used his considerable talent to present the fundamental concepts and applications of chaos in ways which the nonmathematical reader will find exciting and stimulating.

There are concepts and techniques in this new field that may well have application to both the development of naval hardware and to an understanding of the complex processes of naval warfare. Indeed, the Navy has supported some considerable research into the mathematics of chaos.

Through the early 1970s, much of the observable variation in the world around us was assumed to be random noise of no significance for prediction. When Edward Lorenz began modeling the earth's atmosphere and weather on an early digital computer at MIT, he found that he got rather dramatic changes in the resulting climate forecasts from apparently insignificant changes in the initial conditions.

Lorenz' work, along with similar observations in other fields of natural science such as insect population growth, led to a serious challenge to traditional scientific intuition. That intuition had held that, over the long term, a steady state will evolve in nature. Chaos was not an acceptable answer. Not so in the things studied by Lorenz and the others. They began to find many situations where orderly disorder prevails over the long term. Plant and animal populations, while appearing to change slowly but constantly, might in fact be constantly and forever alternating between two or more short-term stable states. This sort of bifurcation was quite unrecognized until the tools of the mathematics of chaos became available.

As Gleick describes it, the mathematics of chaos is itself a wonderfully chaotic subject with many trails and threads leading to new and intriguing ideas. One that has received a good bit of popular attention is the study of fractals, those ornate, almost rococo, shapes