Book Reviews

The Nuclear Infrastructure

Nuclear Battlefields. Global Links in the Arms Race. WILLIAM M. ARKIN and RICHARD W. FIELDHOUSE. Ballinger (Harper and Row), Cambridge, MA, 1985. xx, 329 pp., illus. $28; paper, $14.95. An Institute for Policy Studies Book.

Last August the Australian Defense Ministry issued a press statement that Australia would be assisting the United States in checking the performance of the U.S. Navy's GEOSAT satellite. Data from the GEOSAT program would, it was explained, "significantly improve the forecasting of weather and sonar conditions in the areas surrounding Australia where Royal Australian Navy units routinely operate." There was no hint in the press release that the primary mission of the GEOSAT program was to collect gravitational data about the earth to help increase the accuracy of submarine-launched ballistic missiles. Nor was it revealed that GEOSAT was funded from the Trident missile program.

Ministerial response to parliamentary questions revealed ignorance about the links between GEOSAT and U.S. war-fighting policies—policies to which the Australian Labor government of Prime Minister Robert Hawke is officially opposed. This ignorance—on the part of both the government and the public—about GEOSAT's role is a perfect illustration of the central thesis of a meticulously researched new study by William Arkin and Richard Fieldhouse of what they call the global nuclear infrastructure.

Nuclear Battlefields provides the most comprehensive review to date of the infrastructure that supports and sustains the nuclear strategies and armories of the five recognized nuclear weapons powers. It describes the arsenals themselves, their storage and production complexes, and the strategies that would determine the use of the weapons should deterrence fail.

Fully half of the study is taken up with highly detailed appendixes that list all the known locations of the nuclear infrastructure installations of the five powers in question. These range from nuclear-weapon combat units to relatively obscure scientific installations that provide support—direct or indirect—for the nuclear forces.

The existence of an infrastructure that binds non-nuclear states into the nuclear war-fighting strategies of both superpowers has implications that are often far-reaching but are rarely understood. Australia, for example, hosts data processing ground stations for vitally important intelligence and early warning satellites—America's eyes and ears in space.

Some of the functions of these satellites, for example, arms control verification, are unambiguously stabilizing, Others, Arkin and Fieldhouse argue, are an integral part of a U.S. war-fighting policy that is quite as destabilizing as that of the Soviet Union. For example, the Defense Support Program early warning satellite that peers down at the U.S.S.R. from geostationary altitude carries nuclear detonation sensors (NUDETS) in addition to its missile launch sensors. In a nuclear war, NUDETS will tell the Pentagon exactly where U.S. warheads are exploding over the U.S.S.R.—essential information for retargeting follow-up strikes.

Australia thus finds itself locked into collaboration with nuclear war-fighting policies that the Hawke government officially rejects. Critics argue that the presence of these "bases," which play so indispensable a role in U.S. nuclear war-fighting plans, is totally at odds with the spirit of the South Pacific Nuclear Free Zone Treaty that Australia promoted with enthusiasm. Arkin and Fieldhouse agree and fault the various proposals for a nuclear-free zone for ignoring the question of the nuclear infrastructure.

Nuclear Battlefields demonstrates that the nuclear infrastructure is both more pervasive and more important than is generally realized. Meteorological, geodetic, oceanographic, and astronomical research plays a critical role in enhancing the war-fighting capabilities of both superpowers. For example, access to accurate geodetic data such as those collected by GEOSAT is necessary for precision nuclear targeting since gravity effects can account for up to 25% of the "accuracy error" of a missile.

The strategically vital functions served by some elements in the infrastructure make them priority nuclear targets for the other side. Enemy satellites facilities may be more important targets than enemy nuclear weapons systems. Countries that have no nuclear weapons stationed on their soil may still be targets in a nuclear war.

The work of such researchers as Arkin and Fieldhouse, Desmond Ball, and Jeffrey Richelson and of such investigative journalists as James Bamford, Dan Ford, and Duncan Campbell has greatly increased public knowledge about the nuclear infrastructure. The growing public awareness, along with widespread unease about the directions of superpower nuclear strategy, has stimulated growth of the so-called "nuclear allergy," a global phenomenon to which Arkin and Fieldhouse devote their last and most speculative chapter.

"Nuclear allergy"—aversion to collaboration with superpower nuclear policies—is mostly a Western phenomenon, but it is not exclusively so. In 1981 Romania refused to accept the deployment of new Soviet missiles on its soil, and Bulgaria, like eight of the 16 NATO nations, refuses the basing of nuclear weapons on its soil in peacetime. The best-known symptoms of the allergy, however, are decidedly Western—New Zealand's ban on nuclear ships, Greece's opposition to U.S. bases on Greek soil, the European peace movement's campaign against the deployment of intermediate-range nuclear forces, and so forth.

Arkin and Fieldhouse see the emergence of the nuclear allergy as fundamentally healthy; the Reagan Administration sees it as a major cause for concern—peace movements can undermine Western defenses, not those of the U.S.S.R.

Interestingly, there were no comparable manifestations of nuclear allergy in the mid-1970's—a period when, rightly or wrongly, most people in the West believed that genuine progress was being made in arms control and disarmament. Few people believe that to be the case today. The best antidote to nuclear allergy would seem to be a serious commitment to detente and genuine attempts to achieve disarmament.

Like other studies with which Arkin has been associated, *Nuclear Battlefields* is meticulously researched and highly informative. It is likely to be referred to repeatedly.

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Fractals

On Growth and Form. Fractal and Non-Fractal Patterns in Physics. H. EUGENE STANLEY and NICOLE OSTROWSKY, Eds. Nijhoff, Dordrecht, 1986 (U.S. distributor, Kluwer, Hingham, MA). x, 308 pp., illus. $44.50; paper, $14.95. NATO Advanced Science Institutes Series E, vol. 100. From an institute, Corsica, June 1985.

Fractals are self-similar objects, objects that look the same under different magnifications. Fractals are ramified; the mass M of a fractal within a cube (or square or segment) of linear size L grows as a power $M \sim L^D$ with a non-integer fractal dimensionality D (smaller than the usual $M \sim L^d$ in uniform systems, where $d = 3$, 2, or 1 is the Euclidean dimensionality). Since $D < d$, the density decays to zero as $L \to \infty$. Fractals were considered an abstract mathematical oddity until Benoit Mandelbrot showed

that fractal models imitate many natural phenomena (clouds, clusters of stars, coastlines, and the like). Now they are the subject of a growing new interdisciplinary field. This book is the proceedings of one of the many meetings devoted to the subject in the last few years. It contains 33 papers, 11 accounts of lectures delivered at the meeting and 22 summaries of seminars.

Fractal concepts have been very useful in describing the physics of dilute fractal networks. Different physical properties are determined by different sub-groups of the bonds on such networks, and therefore one needs many fractal dimensionalities (in addition to D) to describe them. The "zoo" of necessary dimensionalities is reviewed in the book by Stanley, and some aspects of percolation theory are described by Stauffer. However, the main purpose of the book is to discuss growth and aggregation processes: in addition to studying the physical properties of an object given its geometrical characterization, the book aims to understand how such geometry is determined by the physical laws that generated the growth of the object.

Although there has been some progress toward a unified picture (all the phenomena listed below are somehow related to Laplace's equation), the field is at a phenomenological stage in which experimental and numerical results are collected and attempts are made to classify them. Such phenomena as flow in porous media, in which fractal "viscous fingers" are sometimes exhibited, dielectric breakdown, colloidal aggregation, dendritic growth, and electrodeposition have been found in diverse experiments to exhibit very similar fractal shapes for some range of length scales. Similar shapes have been produced by computer experiments, using the Diffusion Limited Aggregation (DLA) model of Witten and Sander. In that model, a seed is placed at the origin. A particle is then released at the boundary and performs a random walk until it touches the seed, where it stops. A new particle is then released, and so on. The resulting cluster is a fractal, with $D \simeq 1.7$ at $d = 2$ and $D \simeq 2.5$ at $d = 3$. The book contains many variants of these computer experiments and discusses possible relations between this simple stochastic growth model and the various experiments.

Stanley and Ostrowsky have succeeded in putting together an up-to-date collection of papers by leading researchers. As in any collection of papers, some subjects (such as the DLA model) are discussed repeatedly and others (such as turbulence, chaos, cellular automata and glasses) are not sufficiently discussed. The papers are not all at the same level: some are introductory, to be understood with no background, and some (rather few!) are more technical.

The book is an excellent source of information about ongoing research. Those who want a full unifying understanding of growth patterns will have to wait several more years until the field fully matures. However, for those who want to enter this active, interesting field, the book is a good place to start.

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Transplanted Neurons

Neural Transplantation and Regeneration. GOPAL D. DAS and ROBERT B. WALLACE, Eds. Springer-Verlag, New York, 1986. xiv, 330 pp., illus. $105. Proceedings in Life Sciences. Based on a symposium, Boston, fall 1983.

The chapters in this proceedings volume are based on the work of ten laboratories. Although the chapters are not grouped according to content, they address three main issues. These are the effects of injury and transplantation of neural tissue on nonneuronal cells of the host nervous system, the restoration by neuronal transplants of functions lost in brain-damaged animals, and the influence of transplants on the regenerative response of the host brain.

Bignami, Chi, and Dahl and Smith and Ebner address the responses of astrocytes to injury and transplantation and the possible role these cells have in regeneration and in patterns of axonal growth from transplants. Bignami and co-workers also describe their research on the fibrinolytic system and postulate the role of this system in unsuccessful regeneration in the mature central nervous system. Plasminogen activator appears to play a role in normal embryonic development and regeneration in peripheral nerves but is not activated in injured CNS neuropile. These papers are interesting and enlightening. Rosenstein and Brightman discuss their studies in which peripheral nervous system ganglia are transplanted to the fourth ventricle, which leaves the underlying brain undamaged. Such transplants may provide a means of circumventing the blood-brain barrier, thereby allowing for the introduction of systemically administered substances into the CNS without injury to the brain. Such transplants also exert a neurotropic effect on the underlying brain to cause rearrangement of the neural circuitry. Rosenstein and Brightman's results may lead to therapeutic techniques in the future.

It is now well established that transplants can be used to replace damaged or diseased parts of the central nervous system and restore function. Gage and Björklund and co-workers describe their elegant studies of the use of transplants in models of neurodegenerative diseases. They were able to use intracerebral grafts to reduce age-related functional deficits as well as to replace damaged circuits in animal models of Parkinson's and Huntington's diseases.

Several chapters examine the ability of transplants to permit or promote regeneration of the host nervous system. Berry, Rees, and Sievers, for example, describe the ability of sciatic nerve grafts to support regeneration of mature ganglion cell axons. Grafts of peripheral nerve have proven very effective in demonstrating that mature CNS, long thought incapable of regenerative responses after injury, does have the intrinsic ability to regenerate injured axons.

The long lag between the symposium and the publication of this book makes the work described in the book somewhat out of date. A number of books have recently been published on these topics, and the volume generally duplicates what has been reviewed elsewhere in more detail. The chapters are uneven in quality, and a number of important areas of research are not covered. A general introduction to the main issues examined in the book and a summary of the directions of current research would have greatly improved the book.

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Books Received

Actual Minds, Possible Worlds. Jerome Bruner. Harvard University Press, Cambridge, MA, 1986. xiv, 201 pp. $15.

Adsorption Phenomena. Robert D. Harter, Ed. Van Nostrand Reinhold, New York, 1986. xx, 379 pp. $42.50. Van Nostrand Reinhold Soil Science Series.

Advances in Enzyme Regulation. Vol. 24. George Weber, Ed. Pergamon, New York, 1985. xvi, 506 pp., illus. $160. From a conference, Titisee, West Germany, May 1985.

Advances in Organometallic Chemistry. O. A. Reutov, Ed. Mir, Moscow, 1985 (U.S. distributor, Imported Publications, Chicago). 264 pp., illus. $9.95. Advances in Science and Technology in the USSR: Chemistry Series. Translated from the Russian edition (Moscow, 1984).

Advances in Penicillium and Aspergillus Systematics. Robert A. Samson and John I. Pitt, Eds. Plenum, New York, 1985. x, 483 pp., illus. $85. NATO Advanced Science Institutes Series A, vol. 102. From a workshop, Amsterdam, May 1985.

Animal Thought. Stephen Walker. Routledge and Kegan Paul, Boston, 1985. xiv, 437 pp. Paper, $15.95. Reprint, 1983 ed.

(Continued on page 894)