Innovation, Dual use, and Security: Managing the Risks of Emerging Biological and Chemical Technologies.

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Source: BioScience, 63(5) : 403

Published By: American Institute of Biological Sciences

URL: https://doi.org/10.1525/bio.2013.63.5.14

How to Abate Fear of the Plausible

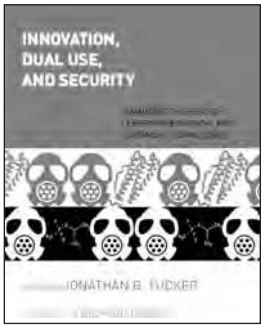
Innovation, Dual Use, and Security: Managing the Risks of Emerging Biological and Chemical Technologies. Jonathan B. Tucker, ed. MIT Press, 2012. 356 pp., illus. $27.00 (ISBN 9780262516969 paper).

Innovation is a force both to admire and to fear. Our fear usually applies indirectly: to social change, to economic disruption, and so on. Innovation in arms technology generates fear directly. Indeed, innovation in armament is intended to create fear in others and, as long as the innovation is unmatched by that of our adversaries, to lessen fear in ourselves. Innovation that might be used in armament generates fear in relation to demonstrated danger. Thus is fear of the unknown increased by fear of the plausible. In no other field of scientific endeavor has the plausible been expanding as rapidly as in biology.

The actual or potential application of beneficial technologies to malicious purposes bedevils biosecurity theory and muddles biosecurity practice. Most any substance, technique, or facility might be used either legitimately or maliciously. The consequences of malicious use are frightening, and the potential for harm and calamity are far out of proportion to the governmental and intergovernmental resources committed to stopping them. That's the worry, anyway.

Problems of dual use are not peculiar to biosecurity. Nuclear security, for example, has dual-use problems, too, but those are centered on uranium-enrichment technologies, which have conceptually changed little in decades. Biosecurity's dual-use problems are more varied, and their variety has been growing exponentially. Moreover, although many people might choose to ban uranium enrichment totally, far fewer—if any—would choose to forgo biological research. Yet, no one wants to open another anthrax letter, either.

Biosecurity's dual-use problems, even taken together, may not be insoluble. What if dual-use dilemmas were addressed systematically by subfield experts, all using a single analytical scheme? This is the question Jonathan Tucker, who died in July 2011, must have asked himself when planning *Innovation, Dual Use, and Security: Managing the Risks of Emerging Biological and Chemical Technologies.* Tucker wrote the introduction, a review of the relevant literature, a decision-framework exposition, and an essay on combinatorial chemistry and high-throughput screening (HTS), and he cowrote the conclusion. The review and the essay are especially effective. Also quite welcome is the summary of current dual-use governance measures by Lori P. Knowles, a research associate at the Health Law Institute of the University of Alberta. Making up the balance are contributions by 20 additional authors, many of whom are venerable biosecurity thinkers.



Most of the book is devoted to case studies, although these entries would more fairly be described as topic discussions. Fourteen of the case studies are contemporary; two are historical. On the contemporary case studies, Tucker imposed a structure: an overview of the technology, the history of the technology, the utility of the technology, the potential for misuse, the accessibility, the ease of misuse, the magnitude and imminence of risk, the awareness of dual-use potential, the characteristics of the technology relevant to governance, the susceptibility to governance, the relevance of existing governance measures, and the proposed governance measures. This structure served well to discipline the contributors, although technological similarities were accentuated by structural similarities in these subsections, which made case-to-case repetition more noticeable than might have been hoped.

Many ease-of-misuse entries focus on a distinction between *explicit* and *tacit* knowledge, the former being cookbook knowledge applied by workers succeeding in unskilled positions, the latter being the artful intuitive touch of laboratory veterans and innovative investigators. Explicit knowledge, then, would be widespread but insufficient for sophisticated misuse. Tacit knowledge would make sophisticated misuse more feasible, but tacit knowledge has remained concentrated in major centers and has been developing elsewhere only slowly. Tucker acknowledged that the biosecurity importance of this explicit–tacit distinction was debatable—or, at least, debated.

Under the category "characteristics of the technology relevant to governance" are five sections: embodiment, maturity, convergence, rate of advance, and international diffusion. The first of these, embodiment, is hard to define, but its provenance seems to be computational—a software–hardware metaphor. All the contemporary technologies discussed in the book are based either on intangible information (knowledge) or on the tangible "hardware." Honoring this distinction was evidently a bit of a strain; writing the chapter "Synthetic biology with standard parts," Alexander Kelle, a lecturer in politics and international relations at the

doi:10.1525/bio.2013.63.5.14

University of Bath, objected respectfully that DNA itself encodes information but is also tangible.

The case studies are informative and generally well crafted. The innovations they discuss are clearly distinguishable, but many are also clearly complementary, making the discussions of the potential for misuse and the susceptibility to governance quite similar in multiple chapters. The contributors' modal judgment would suggest that these innovations could indeed be used maliciously. A terrorist group, however ambitious, would find the presented innovations far beyond its abilities without a cooperating or sponsoring state or corporation; more familiar devices would have to do, and—sad to say—they do plenty. An advanced state, or an otherwise backward state determined to advance in biological or chemical weaponry, might succeed over time.

Of the innovations reviewed in the book, several are exceptionally intriguing and worrisome. Combinatorial chemistry with HTS (chapter 5) ordinarily discards products excessively toxic to humans; laboratory warriors would save these very products for further development. Synthetic biology using standard parts (chapter 9), once called *BioBricks*, may allow the fabrication of useful or dreadful organisms, but useless or simply dead organisms would be its more typical creations. Immunological modulation of intended victims through gene insertions into pathogen genomes (chapter 12) has been an all-too-real prospect since late in the last century, and an analysis of this hazard still presents no critical control point more promising than professional honor—a decidedly nontechnical and extraregulatory global asset. Chemical microprocess devices (chapter 16), which channel fine streams of reagents into tiny precatalyzed reaction chambers and then convey products to the next reaction points or to terminal collection, are becoming standard in chemical industries, including pharmaceuticals and plastics. Large-scale production requires large numbers of these microprocess devices; small-scale production requires small numbers. A specific chemical, such as one used in chemical munitions, could be produced in useful quantities in a very small space and would not present to remote sensors any signature suggesting a chemical weapons plant or even a *chemical* plant.

Malice certainly is no prerequisite for reckless endangerment or even for misadventure. However, biosafety risks are not much discussed in the book. Environmental damage, intended or unintended, is likewise barely mentioned. In a lucid discussion of RNA interference, Matthew Metz notes that "a wide variety of invertebrates, fungi, and plants employ RNA interference as a mechanism for innate cellular immunity against viruses" (p. 210) but leaves these nonhuman life forms to their own devices as the discussion turns to "ethnic weapons" (p. 214), whose development would require a genocidal purpose in a consistently committed and scientifically adept sovereign government willing to waste a lot of money. Mark Wheelis, formerly a lecturer in biology at the University of California, Davis, is a contributor eminently qualified to assess microbial risks to agriculture, but here he has written a chapter about the use and misuse of LSD by the US Army and the Central Intelligence Agency (chapter 20). Jonathan D. Moreno, a professor of medical ethics and the history and sociology of science at the University of Pennsylvania, might have analyzed the motivations for misuse and professionalism's role as a misuse preventive, but he has written instead about transcranial magnetic stimulation (chapter 15), a purportedly therapeutic innovation that in clinical testing, barely—if ever—beats placebo and that owes its Food and Drug Administration approval more to advocacy than to evidence.

Innovation, Dual Use, and Security was brought to completion under extraordinary circumstances. Quibbles aside, it is stuffed with fascinating information interpreted by people who know their chosen subjects. It is well written, well edited, and even well copy edited. I have seen no better book on this subject.

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ENVIRONMENTAL PHILOSOPHY: A FRESH PERSPECTIVE

Environmental Philosophy: From Theory to Practice. Sahotra Sarkar. Wiley-Blackwell, 2012. 224 pp., illus. $34.95 (ISBN 9780470671825 paper).

My opinion of the academic field in which I work is that it was accidentally named *environmental ethics* rather than *environmental philosophy*. I came to this field from the philosophy of science and epistemology, rather than from an ethics background, but I have never had a problem maintaining a dialogue with environmental ethicists, because most of them engage with empirical science—especially ecology. I have never found a shortage of issues and principles to discuss and argue with them. The difference in labels has never seemed intellectually important to me. Furthermore, I know of few books with *environmental philosophy* in the title, whereas my shelf of books on environmental ethics, after several expansions, has spilled out into piles on my floor. I have been jogged out of my complacency, however, by a new book—*Environmental Philosophy: From Theory to Practice.*

From the specific topics covered to the overall perspective taken, Sahotra Sarkar's book is startling to me—as I expect it will be for others with at least a passing interest in environmental ethics and environmental values. In some subject areas, the overlap with environmental ethics is obvious, as in "Ethics for the environment" (chapter 3) and "From ethics