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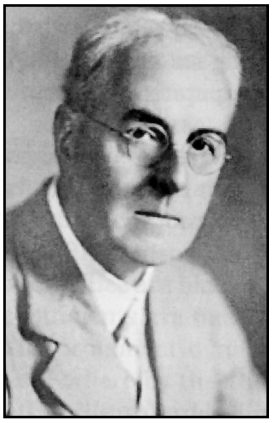
# Biting the Bullet

**Mathematics and War.** *Bernhelm Booß-Bavnbek and Jens Høyrup, editors, Birkhäuser, Basel, 2003, 416 pages (with many photographs and diagrams), $59.95.*

BOOK REVIEW

*By Philip J. Davis*

The link between science/technology and war/defense has been well publicized. Physics, chemistry, biology, and medicine have long traditions of addressing ethical as well as technological issues. A similar link between mathematics and war/defense is understressed, treated euphemistically, or perhaps even consciously suppressed.* After all, mathematics has the reputation of being the purest, the most abstract of the sciences. How could it then be anything but ethically neutral, or at worst ambiguous? And if mathematics is thought to be the most rational of the sciences, how could it be anything but a guiding light to the notion of human progress? I am told that a prominent and much honored mathematician in England once remarked: "Theorems? Theorems can't be lethal. No way!"



*Led by his deep convictions as a Quaker to study the statistics, dynamics, and reasons for the onset of war, Lewis Fry Richardson advanced the first mathematical theory of armed conflict.*

With World War II, the interaction between mathematics and war changed dramatically. In the mid-'50s we used to hear that World War I was a chemists' war and World War II a physicists' war, but a third world war would be a mathematicians' war. While there is no lack of information on the math/war interaction, it is dispersed in short articles†; and while many mathematicians currently work on DOD contracts, they give hardly a thought to the possibility that their theories and computations might actualize in a battle arena. To my knowledge, no book prior to the one under review has viewed the topic in its widest ramifications.

From August 29 to 31, 2002, the Blekings Tekniska Hogskola, Karlskrona, Sweden, hosted an international conference on mathematics and war. The conference was unique in that it brought together 42 people from a wide variety of professions and points of view. For the most part, the speakers and participants were connected with European universities; they ranged in age from new PhDs to several old timers (such as myself) who were adults during World War II. Among those present were mathematicians, historians of mathematics, military analysts and historians, philosophers, ethicists, students of international relations and law. I had been invited to speak, perhaps on the strength of having written a few pages on the topic with my co-author Ruben Hersh in *The Mathematical Experience*. The book under review, one outcome of the conference, consists of 20 papers plus an introduction by the editors—Bernhelm Booß-Bavnbek, a mathematician, and Jens Høyrup, a philosopher and historian of mathematics, at Roskilde University, Denmark.

Although "war gaming" is not infrequently mentioned in the open press, the interaction between mathematics and war is often hidden behind such phrases as "developments in operations research," and an untrained public consequently does not draw the connection. When it is drawn, the connection can strike a raw nerve. The representative of the Karlskrona Municipality who gave a short welcoming speech to conference participants seemed to be quite twitchy as to just what the gathering was up to. I conjecture that such reactions are fed by a common perception of mathematicians as people who deal with strange symbols and then perform arcane and somewhat dubious acts with them.

I believe that the motivation of the conference organizers and of the resulting publication was twofold: firstly, to alert a wide audience to the relevance of mathematics to many aspects of war, and secondly, to come to grips with the conflicting demands on individual mathematicians of patriotism (particularly during wartime), ideological strivings, humanistic feelings, and the satisfactions that come from producing theories that influence events.

The conference stressed three areas: the contributions of mathematics to war as seen from (1) the perspective of mathematicians, (2) the perspective of the military, and (3) ethical perspectives. Only a few of the articles in the book are technical, and it can be read with considerable understanding by those with little mathematical knowledge. The book is such a rich trove of information, opinion, and references that I am able to mention in this review but a small part of its contents.

Among the perspectives from mathematics we have a close analysis of Alan Turing's war work from the pen of Andrew Hodges, a Cambridge mathematician and a biographer of Turing. Setsuo Fukutomi (of Tokyo University for Agri-culture and Technology) describes World War II coding efforts of the Japanese military of which he was a part. Thus it was that mathematician confronted

*Testifying before a U.S. House of Representatives appropriations committee on April 9, 2003, American Mathematical Society president David Eisenbud mentioned only cryptography as relevant to the military.

† E.g., J. Barkley Rosser's "Mathematics and Mathematicians in WWII," *Notices of the AMS*, Vol. 29, No. 6 , 1982.

Readers might be interested in *Wissenschaft im Krieg—Krieg in der Wissenschaft*, Martina Tschirner and Heinz-Werber Gobel, eds., Eigenverlag AMW, 1990. This is a collection of 41 contributions to a symposium held on the occasion of the 50th anniversary of the beginning of World War II. It emphasizes science/technology/medicine/humanities/higher education in Nazi Germany; mathematics is only one of the many subjects covered.

A recent outside view of this period can be found in John Cornell's *Hitler's Scientists* (Viking, 2003).

mathematician across battle lines.

R.V. Gamkriladze (a member of the Russian Academy of Sciences and of the Steklov Mathematical Institute in Moscow) traces the history of Pontryagin's discovery of the maximum principle in control theory. Albert N. Shiryaev (of the same institutes) surveys the work of Kolmogoroff on the theory of firing.

Tinne Hoff Kjeldsen (a historian of mathematics, Roskilde University) describes mathematical disciplines that emerged from World War II. Concentrating on game theory and linear programming in the USA, she alludes to the work of George Dantzig, Harold Kuhn, David Gale, Albert Tucker, Theodore Motzkin, and Werner Fenchel. Fenchel was from Copenhagen, but his stay in the USA in 1950–51 influenced the development of convex programming.

Kathleen Williams (a military historian at Bronx Community College, New York City) discusses the careers of two American mathematicians, Grace Hopper and Mina Rees, both of whom made notable contributions during World War II and the Cold War. Williams has just completed a full-length biography of Hopper (Naval Institute Press).

My own paper deals with the confluence of mathematics, computer graphics, and simulations that has proved useful in military training. To lay minds, the mixture of mathematics, arcade-type entertainment, and the military is a strange ménage à trois.

Several authors bring up the personalities and the work of Lewis Fry Richardson, John von Neumann, Claude Shannon, Norbert Wiener, but none of these mathematicians is treated separately.

*Carl von Clausewitz, the first modern commentator on war strategies. From* Mathematics and War.

A number of Scandinavian and German authorities treat the military perspective. Colonel (ret.) Svend Bergstein (Royal Danish Air Force; Minister of Research and Technology, 1994–95) gives cogent reasons for believing that "the outcome of a war and the overall progress of the activities in it . . . cannot be calculated with mathematics . . . no more today than in von Clausewitz's day." This opinion should resonate in view of the disturbing and unsettling sequelae of the war in Iraq. On the other hand, Svend Clausen (of the Operations Research Department, Danish Defense Research Establishment), in a talk titled "War Can Be Calculated," discusses mathematical strategies for the modeling of combat outcomes.

Paradoxically, there is little inconsistency in the two positions. (With apologies to King Henry IV, Part I, Clausen might say, "I can call results from the vasty data." And Bergstein would reply: "And so can any man. But will they jibe with reality when you do call for them?")

Helge Lőfstedt (of the Swedish Defense Research Agency) speculates on the ways in which warfare through 2020 will be influenced by technological changes. While advocating increased studies in military science, he notes that

"Asymmetric wars will develop where one combatant uses high technology and the other combatant uses guerilla or terror means."

To which we may surely add: means that are increasingly sophisticated. It takes years or decades before facts of military engagements become known, clarified, and evaluated, and the reader (as well as some of the conference participants) might regret and feel impatience at the inability of the contributors to this book to present sharp descriptions and assessments of the role of mathematics in recent conflicts.

Among the articles dealing with ethical issues, space restrictions allow me to mention only four. Finn Aaserud (director of the Niels Bohr Archive in Copenhagen) details Bohr's political and philosophical stance during World War II. He discusses Bohr's *Open Letter to the United Nations* (July 9, 1950), a publication that argued for free scientific discourse as a means of promoting détente. Was this position naïve? Irrelevant? Aaserud's contribution gains interest from the debate stimulated by Michael Frayn's evocative Pulitzer Prize-winning play *Copenhagen*.

Tetu Makino (of Yamaguchi University) gives a Japanese perspective, both technical and ethical, of that nation's history in the 20th century. Makino tells us how the mathematician Kinnosuke Ogura (1885–1962) "was trapped into the crazy spiritual mobilization of the Tennoist [i.e., imperial] warlike power."

Ib Martin Jarvad (of the Department of Philosophy and Science Studies, Roskilde University) traces the rise of international law through Hugo Grotius (1583–1643), its "father," pointing out that Grotius introduced a kind of axiomatization in the spirit of contemporary mathematics from which he derived a variety of laws. Jesper Ryberg (of the same department) discusses the complexity of an ethical assessment of military research, concluding that

"There is no simple relation between the legitimacy of war and the rightness or wrongness of military research."

I have heard that numerous mathematicians bridle at the juxtaposition of mathematics and war as presented in this book. Why should the connection be made? they have asked in statements that reveal a strong wish for complete denial. Their rejection reminds me of a line ascribed to nobelist in literature Elias Canetti: "Don't tell me who or what you are. I just want to adore you."

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