1945. "First atomic bomb dropped on Japan, missile is equal to 20,000 tons of TNT; Truman warns foe of a 'rain of ruin,' " the headlines boldly declare. Just below, in more restrained type, the *Times* declared that "one of the scientific landmarks of the century had been passed" and that the bomb had ushered in a new age of atomic energy, "which can be a tremendous force for the advancement of civilization as well as for destruction."

In those first days and months of the atomic age, the dichotomy between peaceful and military uses derived from harnessing the power of the atom became woven into the social fabric of American life. By examining America's cultural response to the bomb in the postwar period, Paul Boyer not only explores the origins of what one historian has termed "The Great Nuclear Debate," he has also provided a critical retrospective analysis for America's current intellectual wrestling match with the Strategic Defense Initiative.

Boyer, a cultural historian at the University of Wisconsin, Madison, describes how government officials, scientists, writers and religious leaders attempted between 1945 and 1950 to come to grips with the enormous power and promise of the atom. His account of the dilemma of the atomic scientists ends on a provocative note. The collective parents of the bomb, many of them veterans of the Manhattan Project, concluded that it was their responsibility to shape policy on atomic energy. "Many of the post-Hiroshima cultural developments," Boyer argues, "cannot be fully understood without attention to the remarkable public role played by the atomic scientists." The initial product of the scientists' movement came in the early summer of 1945 from a group at the University of Chicago. The Franck report, named for physicist James Franck, sought a demonstration shot before direct military use. Although not heeded by government policymakers, the report announced the entrance of the scientists into the political arena.

By 1946 scientists from Oak Ridge, Los Alamos and Chicago had organized the Federation of Atomic Scientists, and the Chicago group had founded what would become the most influential journal on atomic energy in the period, the *Bulletin of the Atomic Scientists*. Edited by Eugene Rabinowitch, the *Bulletin*, with its famous clock on the cover, exerted enormous influence on American officials and educators. Boyer argues that for a time between 1945 and 1957, the pronouncements of the atomic scientists on the awesome destructive power of the bomb were received in an atmosphere of almost religious attention. But the crusade failed, a victim of America's preoccupation with a greater fear—communism—and more pressing daily concerns. Indeed, Boyer believes that the scientists' use of fear "created fertile psychological soil for the ideology of American nuclear superiority and an all-out crusade against communism."

Until now scholars have focused on the political, international, technological and scientific aspects of the nuclear debate. *By the Bomb's Early Light* is the first important history of the intellectual and cultural ferment that has fashioned that debate for nearly half a century. As a result, Boyer's exhaustive study of the multifaceted components of American life that shaped our cultural courtship with atomic energy constitutes an important contribution to understanding our current nuclear dilemma.

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Superstrings: The First 15 Years of Superstring Theory, Volumes 1 and 2

Edited by John H. Schwarz

1141 pp. World Scientific, Singapore (Teaneck, N. J.), 1985.
ISBN 9971-978-66-0 $86.00 hardcover;
ISBN 9971-978-67-9 $44.00 paper

The recent interest in superstrings as candidates for unified theories has been made possible by the work of many researchers, spanning almost 20 years, and it is worthwhile to acquaint students with these contributions. *Superstrings* is a collection of reprints of most of the seminal papers published from 1971, when superstrings were conceived, to 1985. This collection is edited by John Schwarz, who has organized the presentation into 13 (half of 26) chapters. Each chapter starts with an introduction that sets the historical background and describes in nontechnical terms the work done in the reprinted papers, as well as in other papers that the editor felt to be of peripheral interest. These introductions are well written and informative, providing the reader with many historical vignettes and with a glimpse into the inner workings of some string theorists in their lean years.

The first chapter starts with a review by the late Joel Scherk; it serves as a summary of the previous work from which superstrings emerged. Then the original papers on superstrings are presented, followed by papers on the "no ghosts" theorem and on the first quantized superstring interaction. These serve to illustrate the "old approach" to superstring theories. From the calculational viewpoint the technical achievements of these papers have yet to be surpassed. Chapter 5 contains the original papers linking string theories to gravity. The next two chapters focus on papers that exploit the new symmetry implied by the original superstring papers (supersymmetry), both on the world sheet and in space-time. The emergence of the new "type II" superstring theories is then documented.

The second volume begins with a presentation of some of the original papers on the light-cone string field theory, followed by the detailed papers on the field theory formulation of type II theories. Chapter 12 presents the original papers on anomalies in superstring theories, including the groundbreaking paper of Michael Green and John Schwarz that originated the renaissance of string theories. This set of reprints ends with the first attempts to establish a bridge between our world and the 26-dimensional one of the superstring.

Like many collections of reprints, this one is heavily influenced by the tastes and views of the editor; thus one can argue that many papers that are more conceptual than calculational in nature are not included, and that in certain instances the presentation follows too closely Schwarz's own work. Nevertheless, the advantages of this book far outweigh whatever drawbacks it may have. Schwarz has succeeded in assembling in these two volumes most of the important papers depicting the saga of superstring theories from their emergence, through their dark ages and into their glorious renaissance. This two-volume set also exposes the starting student to the calculational techniques developed in the early papers. The existence of this excellent book of reprints covering the beginning of the superstring era suggests a need for a similar effort to document the era when strings were known as dual resonance models. No serious student of superstring theories should be without this set of reprints, and I am recommending it to my students.

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The Making of American Industrial Research: Science and Business at GE and Bell, 1876–1926

Leonard S. Reich

309 pp. Cambridge U. P., New York, 1985.
ISBN 0-521-30529-2 $24.95 hardcover

From at least the time of Joseph Henry, American scientists and scholars of

science have pondered the relationship between basic, "pure" research and industrial productivity. It has often been argued that, paradoxically, the only way to make fundamental discoveries—that is, discoveries that affect our basic understanding of the way the world works and at the same time lead to practical devices—is to engage in pure or basic research, research with no end product in mind save the gain in knowledge itself.

Now here is a book by Leonard Reich that not only sheds light on these questions, but nails down how, in practice, large American corporations such as AT&T and General Electric came to establish research laboratories shielded from the immediate needs of production and competition. Reich discusses how those labs evolved over time, and how in the long run the labs played a key role in the rough and tumble of so-called free market competition. In this superb study, Reich hews out a path that many of us have stumbled to find for the last 20 years.

Reich begins by considering the state of research in the 19th century and the changing state of business—especially industrial business—at that time. This in itself is a unique contribution. Reich convincingly argues that it was not the knowledge that research had provided that led to the establishment of industrial research laboratories. Rather it was the perceived needs of business and the recognition that the old ways of trust and monopoly would not suffice anymore that forced the captains of industry to turn to the research enterprise as a way of fending off the competition.

Reich then examines in detail how competitive pressures and demands led to the founding, almost accidentally, of two of the earliest and most revered American research establishments: General Electric's Research Labs and the corporate precursors of the Bell Telephone Labs. Each got a foothold in the corporate structure by providing early patent protection for technological advances over the aggressive competition. At first, research problems were narrowly defined and carefully controlled. But with success, the best researchers at both laboratories were given considerable latitude in defining the direction and scope of their work.

Reich concludes his study by showing the dynamic role played by both GE and AT&T research groups in the struggle for corporate control of the radio and broadcast industries. Alert, active, innovative research organizations by themselves were not sufficient. What was required was close cooperation and sympathetic understanding between those responsible for research and other corporate departments, especially the legal and sales staffs.

Reich's definition of the industrial research laboratory as "set apart from production facilities, staffed by people trained in science and advanced engineering who work toward deeper understanding of corporate-related science and technology, and who are organized and administered to keep themselves somewhat insulated from immediate demands yet responsive to long-term company needs," is a distillation of what Reich considers to have been necessary if such laboratories were to be effective.

Perhaps the most important conclusion that can be extrapolated from Reich's study is the observation that it is not so much the motivations of the researcher that determine the significance of the outcomes of research, but the environment in which the research is done. The leaders of research at GE and at AT&T learned early on that allowing the best of their research people a maximum of freedom was bound to pay: in product and process patents, in respect and in reputation.

STANLEY GOLDBERG
Smithsonian Institution

Introduction to Flight

John D. Anderson
Second edition. 560 pp. McGraw-Hill, New York, 1985.
ISBN 0-07-001639-9 $46.95 hardcover

This book is a comprehensive, elementary introduction to the technology of heavier-than-air flight written by a professor of aerospace engineering. It is novel in that it includes a great deal of historical material that adds much interest to the main technical material.

In the preface, John Anderson says he has "made every effort to talk to the reader in a fashion that is readable and completely understandable—the way of explaining ideas is constructed with the uninitiated reader in mind." From personal experience I am aware of the difficulty in fulfilling such a worthy aim, and I believe that one needs to blend physical insight with technical formalism to reach most readers. Anderson's book is weak in presenting physical principles and explanations. For example, he introduces the concept of the lift of a wing by dimensional analysis, after the simple statement that lift occurs when the air pressure surrounding the wing gives rise to a net upward force on the wing. This is hardly more than a truism. It would be much more instructive to point out that a moving wing imparts a net downward momentum to the air it intercepts, and that lift results as a reaction. The time rate of change of the momentum of the