BOOK REVIEW

Selection of books for review is based on the editor's opinions regarding possible reader interest and on the availability of the book to the editor. Occasional selections may include books on topics somewhat peripheral to the subject matter ordinarily considered acceptable.

The Man-Made Sun—The Quest for Fusion Power

Author	T. A. Heppenheimer
Publisher	Little, Brown and Company 34 Beacon Street Boston, Massachusetts 02106
Pages	347
Price	$19.95
Reviewer	Stephen O. Dean

In *The Man-Made Sun*, subtitled "The Quest for Fusion Power," at last we have a book aimed at the nonscientist, published and distributed by a major publisher of books for the general public. Author Tom Heppenheimer has good credentials for this venture, having previously published two popular books on the future: *Colonies in Space* and *The Real Future*. He has also contributed a number of articles to *Omni* magazine. Heppenheimer has been a frequent visitor to fusion laboratories and meetings over the past few years, gathering materials and interviewing fusion personnel.

Although the reading becomes a little "heavy" at times for someone with no fusion background, it is generally well written in clear and often colorful prose. His approach is to describe how scientists and managers are going about the task of "challenging nature itself, wrestling with the most difficult problems physics has ever faced." In the process Heppenheimer sheds light (for those who don't already know) on how large-scale science projects are conducted in this country. In spite of the fact that project directors and government managers are often portrayed in the book as overly self-seeking, the program itself emerges as one that is "intelligent and generally well-managed."

His penchant is for the personal, although the book is also filled with colorful and imaginative descriptions of plasma physics and fusion devices for the layman: "The plasma, for its part, behaves like a Cheshire cat, fading away and disappearing. When it does this, however, it leaves no smile. Rather, it leaves worried frowns on the faces of the physicists, who would like to know how it got away and what it has been up to this time."

Heppenheimer describes both the magnetic and inertial fusion programs but does so by concentrating on those parts of the programs receiving the largest budgets: tokamaks, mirrors, and lasers.

Describing the Princeton Large Torus (PLT) device, Heppenheimer says, "Since a torus is a thick ring, like a doughnut or life preserver, you might expect, entering the PLT room, to see something like the tire of some colossal truck. What is actually there is more nearly reminiscent of the inside of your car's engine compartment, blown up to the size of a house. An auto engine is basically a set of pistons within cylinders, a rather simple mechanical arrangement. But this basic simplicity is surrounded by so many auxiliary mechanisms and equipment that only a trained mechanic can dig down through the complexity to the pistons and cylinders at the core. That is how it is with the PLT."

In a chapter titled "Doing It With Mirrors," Heppenheimer describes the process by which Ken Fowler came to conceptualize the tandem mirror: "For Fowler, the idea really came together a day or two later, on July 4, the day of the bicentennial: 'I was lying on my belly on my living room floor and my kids wanted to go see the fireworks. I was calculating away, and the numbers came together that night, before we went off to the fireworks.'"

In a chapter titled "Arms and the Man" describing laser fusion, Heppenheimer recalls that early predictions that fusion breakeven might occur with a kilojoule of laser energy have given way to expectations today that about a megajoule will be required. Nevertheless, Heppenheimer correctly notes that "a laser in the megajoule range may well be more feasible (today) than was a one-kilojoule laser in 1970."

But Heppenheimer's real purpose is to describe the more personal aspects of the saga and to generally educate the layman on the maneuvering of the more politically motivated people in the program. Thus, the book begins as if it were a play, with a section titled "Dramatis Personae." Here you can find Heppenheimer's view of who the key players are and what was their role. Here fusion researchers can find many of their friends, cryptically described, right up front: Steve Bodner, Keith Brueckner, Sol Buchsbaum, Bob Bussard, John Clarke, Steve Dean, John Deutch, John Emmett, John Foster, Ken Fowler, Harold Furth, Mel Gottlieb, Bob Hirsch, George Keyworth, Ed Kintner, Mike McCormack, John Nuckolls, Doug Pewitt, Don Repici, James Schlesinger, Al Trivelpiece, to name a few. Not all will agree that their

characterizations are accurate or complete, let alone agree with how their roles are described later in the book.

Not all men are created equal by Heppenheimer, however. Bob Hirsch gets a chapter named for him. Bob Bussard also gets a chapter unto himself, although his chapter is titled "The Entrepreneurs."

Heppenheimer hits the peak of his stride in describing two traumatic events in the life of Ed Kintner: the "PLT weekend" of 1978 and the events leading to Kintner's resignation in 1981. The PLT weekend refers to the weekend of August 12, 1978 when news of PLT surpassing the minimum temperature required for fusion ignition broke big in the national and international press. The U.S. Department of Energy (DOE) secretary James Schlesinger was so upset that he was not in control of the release of the news that he threatened to fire Ed Kintner and Steve Dean. Of that weekend, Heppenheimer reports of a phone call to Mel Gottlieb from Schlesinger's press officer James Bishop accusing Gottlieb "of having invented the PLT story and blown it up for his own purposes." Says Heppenheimer: "Bishop's phone call thus was a direct challenge not only to DOE directors Kintner and Dean but to the professional integrity of Gottlieb and of his entire Princeton lab. Certainly Gottlieb's people hadn't been working their tails off merely so that some high level Washington ignoramus could abuse him by telling him that his people had done nothing."

Heppenheimer was encouraged to write the book by Ed Kintner, but Ed is probably not satisfied with the description of the circumstances surrounding his resignation. The immediate cause of Kintner's resignation was that Tom Palmieri of the Office of Management and Budget (OMB), at the suggestion of Steve Bodner of the U.S. Naval Research Laboratory (on loan to OMB), was directing Kintner to redirect funds from the Mirror Fusion Test Facility B construction to use for strengthening the physics research programs. Heppenheimer maintains that Palmieri and Bodner were "bluffing" and says of Kintner, "Now he was suspicious of even his closest associates."

Heppenheimer is not reluctant to "zap" those he believed "stonewalled" him in the interviews. Of DOE Director of Energy Research Al Trivelpiece, Heppenheimer says: "Trivelpiece had learned his Washington lessons well. He knew exactly what to do when presented with a live mike, in our interview. This is not to say he clammed up; quite the contrary. His lips moved; he uttered strings of articulated sounds that could be identified as human speech. But he conveyed no information beyond what was available in standard DOE press handouts. He gave a virtuoso performance of granting a half-hour interview while keeping all his beans safely unspilled. Clearly, here was a man who would go far."

The book gives eloquent testimony to the tight coupling that exists between machine building and fusion progress. The ever more powerful devices, tokamaks and lasers especially, are clearly seen to be the *sine-qua-non* that has resulted in fusion progress. Thus, the book would make good reading for members of Congress, their staffs, and some members of the executive branch who believe that the fusion program should cease building advanced facilities for the foreseeable future. This latter policy has been in effect since 1981 and recently was reinforced by congressional action on the FY 1985 budget.

Having taken the trouble to research and write this book, you might ask whether, in the end, Heppenheimer believes in fusion. Here is his closing paragraph:

> Fusion is unquestionably one of the key technologies that will shape the coming millenium. Today we see it as a man-made sun about to rise; tomorrow we will stand in the radiance of its bright promise. Those who say we are in the sunset of our age are surely mistaken, but they can be forgiven; early dawn may look much the same as dusk. We stand today amid the landscape of the future, but we do not perceive it in detail. There are only vague forms and shadows, some of which appear as looming threats. But let us be patient; morning is at hand, and the landscape in all its intricacy will soon be disclosed. For now it is enough to know that the sun is there, its rise appears imminent, and if we look closely we can even now see its glow reflecting off the distant clouds near the horizon.

If you are a fusion researcher, you will undoubtedly find many important events of which you are aware that were omitted from this book, especially if you are not from Princeton or Livermore. Nevertheless, Heppenheimer has written an entertaining and mostly accurate account that brings the fusion story closer to the present than another recent book by Bromberg.[1]

Stephen O. Dean received his PhD in physics from the University of Maryland in 1971 and is presently president of Fusion Power Associates, and manager of the fusion power division of Science Applications International, Inc. He has worked on both magnetic fusion and inertial confinement fusion. Previously he worked in the magnetic fusion program at DOE and the laser fusion program at the U.S. Naval Research Laboratory. He served as director of the magnetic fusion confinement systems division, DOE, from 1972 to 1979. Some of his activities during the 1970s are described in the book.

REFERENCE

1. J. L. BROMBERG, *Fusion*, MIT Press, Cambridge, Massachusetts (1982).