Does this mean that the broader public interest is also advanced? Basically, Dunnet's view is that "Television is light entertainment and escapism" (p. 224). Consistent with this he sees no great problems of political control arising from the media conglomerates dominating the future direction of the industry. These conglomerates are sufficiently "apolitical" and "rivalrous" to limit such concerns, in his view. Similarly, he feels that while threats to national identity and worry about the media promotion of materialism and other values of concern may be there, they can be exaggerated. And compared to the benefits from huge amounts of low-cost popular entertainment and from the dramatic expansion in the global flow of information through television, these negatives are judged to be either not fundamentally damaging or at least possibly able to be met by a bit more imaginative and innovative policy-making. For instance, Dunnett finds recent developments in public broadcasting in the UK and elsewhere promising and argues on that basis that public service broadcasting should not be vertically integrated and should be an outlet for independent suppliers. However, as regards issues of explicit violence and sex being portrayed on television and influencing behaviour, he admits that "no country has found a really satisfactory and acceptable way to regulate a code of conduct" (p. 225).

Overall, the book is a sober and clearly argued and documented paen of praise for the role of modern technology and of the forces of the market in "an age of abundance in determining who will supply the consumer with television" (p. 227). Of course, in this market-place, life may not be easy for some producers, as the consumers will choose a mix of media distribution vehicles that suit themselves. And the recent history of pay television, interactive television and possible already DBS and HDTV show there are many traps ahead in predicting technological demand patterns, quite apart from content. But all seems well for the consumer, at least in the view of the Canadian academic author of the book under review. No doubt there will be others who are less sanguine on the benefit to the public-interest of this market-led process, including this reviewer. The book is strong on explaining and understanding the role of technology in markets, but there remains considerable scope for a more serious engagement with those political and social effects of television that universally motivate public policy concern and which will no doubt continue to do so in the future.

Glenn Withers
Latrobe University and EPAC, Canberra.

Lawrence and His Laboratory: A History of the Lawrence Berkeley Laboratory, Vol.1. *by J.L. Heilbron and R.A.W. Seidel*
(University of California Press, Berkeley, California 1991), pp.xv + 586, US$29.95, ISBN 0-520-06426-7.

This is both a remarkable and a forgettable book — remarkable in its meticulous completeness, its footnote references to the source of every statement, the extent of its bibliography and, in contrast, the relative poverty of its index; forgettable in that the detail overrides dramatic quality of many of the events it describes, and for its lack of critical discrimination between the scientific importance of the work of individuals, or to recognise, in some rather glaring instances, the difference between intrinsic value and self-advertisement by those who stand upon the shoulders of the real achievers. However, it does place the achievements of Lawrence and his laboratory in context of the development of nuclear physics throughout the world. It shows how the inspiration and determination of a gifted individual, ever following a goal which he has set himself, can create, inspire, and control a team of prima donnas which achieves far more than would those same creative minds working as individuals.

In the year 1895 the French physicist Bequerel discovered that the heaviest of all chemical elements, uranium, emitted spontaneously and continuously radiation which could penetrate paper and blacken a photographic plate. This momentous observation that the atoms of substances were not eternal ball-like objects, was to revolutionise the whole of chemistry and physics, change completely knowledge of the Earth, the Sun, and the whole Universe. It was the fuse which initiated the study of nuclear physics, to which Ernest Lawrence devoted his life in Berkeley.

In the following year, 1896, the German Roentgen, observed that an electrical discharge through a gas at low pressure produced another penetrating radiation, X-rays, which, apart from their use in medicine, were destined to reveal the structure of solid and liquid materials, and the physical processes of life itself.

Then, in 1897 J J Thomson proved the existence of the electron, the unit of negative electric charge, which is the basic element of the extraordinary development of modern electronics, and of the triumphs of computing.

An early observation of the properties of X-rays was that they produced electrical conductivity in air and other gases. Thomson invited his research-student, Rutherford, to join him in investigations of this phenomenon. He made rapid progress, demonstrating that the conductivity was due to the same electrically charged atoms or molecules which carried the electric current in the electric discharge through gases, and in the photo-electric effect. He went on to determine whether the electrical conductivity produced in gases by the radiations from uranium was of the same nature. It was. But Rutherford noticed that there were two types of ionising radiation present which he called alpha and beta rays, from the first letters of the Greek alphabet. The alpha-radiation was absorbed in a sheet of paper, while the beta rays were one hundred times more penetrating. Rutherford had found his life's work, founding the field of study which was to be called nuclear physics. His work in Montreal with Soddy, a chemist, unravelled the complex steps by which an atom of uranium changed into an atom of lead, as did that other heavy radioactive element, thorium, into lead with different atomic mass.

When Rutherford moved to Manchester he studied the scattering of alpha-particles in collision with the atoms of various gases and solids. The surprising observation that sometimes the alpha-particles were scattered backwards indicated that they must experience an enormous electrical force which reversed their direction of travel without appreciable change of energy. He calculated the distance between the alpha-particle and the known positive charge on the atom at which this force could exist. It was ten thousand time smaller than the radius of the atom itself. Thus, he showed that the atom must consist of a tiny central nucleus, carrying almost all the mass and all the positive electric charge, surrounded by electrons with total negative charge equal to the positive charge on the nucleus.

Continuing these observations, Rutherford was surprised to observe that occasionally a fast alpha-particle penetrated into the nucleus of a nitrogen atom, which then split into an oxygen nucleus and a proton, the nucleus of a hydrogen atom. Rutherford and his colleagues showed that similar transformations occurred with other light elements, but it was laborious work because of the very limited amount of radioactive material emitting alpha-particles available to them. Nevertheless enough information became available for Rutherford to speculate about the structure of the nucleus, the mass of which was greater than that of the protons revealed by the positive electric charge. He suggested that some of the mass could be due to electrically neutral particles, such as protons much more tightly bound to electrons than in hydrogen atoms. He and Chadwick searched for such neutrons without success. In 1932, Chadwick, realised the significance of some observations made by the Joliot-Curie's in Paris, and showed that they were due to the missing neutron.

Rutherford and his colleagues realized that if only light particles could be accelerated artificially to energies corresponding with those of the alpha-particles, such transformations of one species into another might be brought about more frequently. It was not till 1932 that Cockcroft and Walton, in Rutherford's Cavendish Laboratory, were able to bring about such transformations at much lower energies than expected, because of the wave-mechanical penetration through the nuclear electric potential-barrier.

Meanwhile, in Berkeley, that other Ernest, Lawrence, had realized that, because an electrically charged particle moved in a circular path perpendicular to a uniform magnetic field with a period independent of its energy, it could be accelerated periodically by an alternating electric field of the same frequency and phase. With colleagues whom he imbued with the same energy and dedication, Lawrence used this concept to build a small cyclotron to prove the validity of his concept, followed by larger cyclotrons producing protons of ever increasing energy and number. They also accelerated the nuclei of heavy hydrogen, deuterons. With their aid radioactive isotopes of most atomic species, with relatively enormous activity, and various half-lives, were made. Some of these reactions produced large fluxes of neutrons, the nuclear reactions of which were also measured.

Many of the radioactive isotopes produced proved of great value as tracers in medicine and in chemical reactions. The most outstanding discoveries in this field were probably carbon of mass 14, and the transuranic element plutonium, of mass 239, the first by Kamen and Rubin, the second by McMillan, with help from Seaborg and his colleagues, Kamen has told the story of the discovery of C14 and its uses in his book *Radiant Science, Dark Politics*. The production of plutonium, and the demonstration that it was fissionable by neutrons of all energies produced in the fission process, was crucial for the development of nuclear weapons.

Hans Bethe, in Cornell, calculated that the relativistic increase of mass with velocity would cause the charged particles accelerated in the cyclotron to drop out of phase with the accelerating field, limiting the maximum energy which could be achieved to about 20 million electron-volts, two to four time the energies of naturally occurring alpha-particles as used by Rutherford. Lawrence rejected this conclusion. He was confident that with high accelerating voltages and improved electrostatic focussing, the limit would be 100 million electron-volts or more. He backed his judgement, and obtained the money to build a cyclotron with a pole diameter of 184 inches and a weight of about 2000 tons, in a new laboratory up the hill behind the campus of the University. The steelwork was in place when Lawrence was persuaded to join the Manhattan Project, the name of the American organisation established after Pearl Harbour to develop the nuclear weapon. There, this book ends, with the promise of another to cover the war years and the subsequent work of the Lawrence Radiation Laboratory in Berkeley.

Anyone who shared these great years of achievement, even in part, will find this book both interesting and nostalgic, if longer than necessary to provide adequate cover of the achievements of the Laboratory. Others may find it too comprehensive, prolix, and even boring — too much like reading a dictionary, or the list of papers and citations submitted by an candidate for a professorship.

Kamen's, *Radiant Science, Dark Politics: A Memoir of the Nuclear Age* (University of California Press) also is far too long and detailed. Kamen was responsible in the Radiation Laboratory for the chemical side of production of radioactive isotopes for use in physical, chemical, and medical experimental work and treatment. A remarkable viola player of Russian-Jewish parentage, he was dismissed from the Manhattan Project as a security risk. I value his friendship.

Mark Oliphant
Griffith, ACT

Science, Technology and Society in Postwar Japan *by Shigeru Nakayama.* (Kegan Paul International, London and New York, 1991), pp. xv + 259, £ stg.45.00, ISBN 0710304285.

The energence of Japan as a major force in world technology has prompted many attempts to unravel the secrets of Japanese technological dynamism. Too often, however, these studies, in their search for lessons from Japan, overlook the fact that rapid technological change has been a topic of intense controversy within Japan itself. Although there can be little doubt that Japan's economic and technological miracles have improved material well-being in many ways, they have also involved enormous social costs. Could the costs have been avoided? Could scientific and technological knowledge have been used in less environmentally damaging ways? What social forces influenced the choice of technologies by private firms and government policy makers? Questions like these, which have been central concerns of recent debates on the social shaping of technology, too often seem to be put aside when Japanese technology is being considered.

It is refreshing, then, to find a study of Japan which takes the social shaping, and the social implications, of Japanese science and technology very seriously. Nakayama Shigeru, who is one Japan's leading historians of science, gives an illuminating and often suprising overview of the controversies surrounding the development of science and technology in postwar Japan. Nakayama argues that, in the second half of the twentieth century, science and technology have become indistinguishable. Rather than trying to separate science and technology, therefore, he divides the scientific and technological complex into four catergories, defined by the audience to which research is addressed. These categories — academic science, private science, public science and service science — provide the basic structure around which the book is organised.

The first chapters deal with the changing university system and its impact on scientific research in postwar Japan. The most fascinating aspect of this