Ivory bridges : Connecting science and society by Gerhard Sonnert with the assistance of Gerald Holton, The MIT Press, 5, Cambridge Center, Cambridge, MA 02142, USA, 2002, pp. 227, $ 30.

Ivory bridges is a product of research by a sociologist of science assisted by a physicist, both situated in the Department of Physics, Harvard University. Their study, centered on developments in USA, is about the two separate avenues connecting (hence the expression, bridges) science to society. The two avenues are delineated by 1) the Government support to science, and 2) the activism of scientists' public interest organizations. The introductory chapter is followed by three more chapters. There are four appendices besides notes and references, which together occupy nearly half the full text. The book is dedicated appropriately to a named 'citizen-scientist'.

In relation to government policy influencing science funding, the first bridge across science and society, the author provides a background to the US presidential science advisory setup and refers to its variegated contributions during the tenure of different Presidents (A historical account of the Presidential Science advisory structure is given in an appendix). Such an apex advisory setup got going in USA in 1951, initially in a defense department, as a result of a Report titled 'Mobilizing Science for War' by William Golden. Following the shock administered by the successful launch of the Sputnik in 1957, President Eisenhower upgraded the setup to one directly advising the President. Coincidentally, around the same period, Prime Minister Nehru conceived of an Apex Advisory Committee for Coordinating Scientific Work (ACCSW), which was serviced by the Cabinet Secretariat. Prime Minister himself was its first Chairman during the years 1948–1956. Nehru was then concerned not with war but with national development. The Advisory Committees have assumed different shapes from time to time in the last 50 years. Currently, the apex advisory mechanism functions through the Principal Scientific Advisor to the Government of India.

Debates on support to science have invariably generated divisions into basic science, applied science and strategic science. This has been happening all the time and everywhere in the world. America is no exception to this tendency. 'Science, the endless frontier', an all time great report of 1945 by Vannevar Bush, shaped the 'golden age' for American basic research and imparted an enduring impetus to public support to science. The report was conditioned by a frame of thought that required for its expression mentioning basic and applied scientific research separately and may thus have been responsible for a perennial classification of science into these two modes. Fifty years later in 1994, the Clinton administration labored to state in their report on 'Science in the National Interest' that "we depart here from the Vannevar Bush canon which suggests a competition between basic and applied research. Instead, we acknowledge the intimate interrelationships among and interdependence of basic research, applied research and technology, and appreciate that the progress in any one depends on advances in the other".

With reference to what seems an inevitable categorization, the author crafts an interesting triangular framework comprising 1) Newtonian science, 2) Baconian science,

and 3) Jeffersonian science. The motivations in respect of the three types of science respectively are 1) search for scientific knowledge, 2) serving a societal need by application of known knowledge, and 3) serving a societal need through new knowledge. Using valuable references and illustrations, the author explains in Chapter 2 the distinction between the Newtonian and the Baconian sciences. The points made, or the instances referred to, do not differ from the widely held notions about basic and applied research. However, the Jeffersonian kind of science in the author's framework requires elaboration. The concept here is one that was advanced by Frank Press who became President Carter's Science Advisor. He advocated the requirement of basic research in order to accomplish practical missions of the governmental agencies. In other words, the path to fulfilling these missions, according to him, was paved through search for new knowledge. With Presidential consent, the various Federal departments and agencies were directed to examine and come up with a list of critical problems where basic research was essential for Federal responsibilities to be discharged more effectively. The following small list of research problems gives a flavour of what constitutes Jeffersonian science: 1) Discovering antiviral agents to fight viral diseases, 2) Achieving better understanding of science of combustion in order that fossil fuels can be used with maximum efficiency and minimum impact on the environment, 3) Can man–machine interfaces be made so simple as to allow real-time translation? 4) How can productivity be enhanced by automation and artificial intelligence? 5) Can materials be found that exhibit superconductivity at room temperature? and 6) To what degree can biological fixation be enhanced? (A master list of these problems is given in an appendix.)

Frank Press's brilliant articulation of the concept of serving societal needs through new knowledge (his own list of research problems is given in another appendix), labeled here Jeffersonian science, underlined a legitimate purpose to governmental funding of science in a way that could carry conviction with the society at large. This made possible a revival of Federal support to science as a high priority for President Carter's administration. Extremely interesting in this context is a research question formulated by the US Department of Agriculture: "what are the mechanisms within body cells which provide immunity to disease? Research on how cell modified immunity strengthens and relates to other known mechanisms is needed to more adequately protect humans and animals from disease". As the author points out, this basic research question framed in 1978 was to become "a life and death issue for millions a few years later with the onset of the HIV epidemic". This instance provides a dramatic proof of principle embedded in the Press–Carter approach to governmental funding of identified science programs.

A large part of the rest of the book is taken up by the third chapter entitled 'Organization for the Common Good'. This is a fascinating account of the collective efforts of the citizen-scientists (those outside the government) considered the second bridge between science and society. Displaying a genuine concern for the common good as their motive, the voluntary scientists' organizations grew in number and stature during three spells. The first was in the wake of the Manhattan project (1940s). The second originated as a protest to the link between the academic research institutions and the military. The high point of this protest was research stoppage by thousands of research

scientists led by those of MIT Cambridge at the time of the Vietnam War Out of this groundswell of protest was born the Union of Concerned Scientists (1960s), which developed subsequently into a multi-issue organization. The third spell was in response to the intensification of the cold war marked by the Strategic Defense Initiative (SDI) (early 1980s). With the end of the cold war, new issues have loomed up. Environmental concerns like that about the degradation of the biosphere, and rapid advances in information technology, biotechnology and genetics are causing the activist scientists to form new associations to make their presence felt and combat unsavoury trends in the use of science and technology. (Profiles of scientists' associations have been compiled in a separate appendix.)

The story of the atomic bomb is a sublime example of the scientists' rebellion. Concerned with the future uses of nuclear energy, the Manhattan project scientists themselves formed in 1945 the Association of Los Alamos Scientists. Soon thereafter appeared the *Bulletin of Atomic Scientists*, which became their important voice. Then followed the powerful Albert Einstein declaration advocating a global legal order as a means of preventing nuclear war. Bertrand Russel later collaborated with Albert Einstein on a manifesto, which was signed by Einstein two days prior to his death! In response to this manifesto released in 1955, the series of Pugwash Conferences was initiated in 1957 and built up to such worldwide reputation as to attract the award of a Nobel Peace Prize (Joseph Rotblat in 1995). A Nobel Prize had earlier gone to a nongovernmental organization working in the same area, albeit with a different orientation, namely the International Physicians for the Prevention of Nuclear War (1985 Peace Prize). These prizes won by nongovernmental entities are a measure of their influence and impact when they embrace a just cause and operate meaningfully.

It is not hard to note the distinction between professional scientists' organizations and public-interest scientists' organizations. The author's work shows that the activist scientist did attempt to work through the existing professional organizations. However, such attempts, made even with reputed organizations like the American Association for the Advancement of Science (AAAS) and the American Physical Society (APS) were rebuffed. The professional organizations were not prepared to take a public stand on the so-called issues of concern. The activist scientists willy-nilly had to proceed in each case of a failed attempt to form their own association. These encounters, it must be added, did not leave the professional organizations cold. They in turn worked to institutionalize mechanisms and divisions within themselves to address matters of public interest. The relevant examples are: AAAS constituted a unit on the Social Aspects of Science and launched another program on Science and Human Rights while the Forum on Physics and Society was instituted by the APS.

Ivory tower, as the author traces, is a metaphor that goes back to the ninth century when Charles Augustin Sainte-Beuve recorded the term to denote the "self-absorbed lifestyle of those who dedicate themselves single mindedly to ethereal pursuits". In the present context, ivory tower symbolizes autonomy of the scientist. Ivory bridges signifies his connection to society and thus may be taken to stand for responsibility. The last chapter is a brief, readable essay on autonomy and responsibility.

Fundamentally, the study reveals that neither the activist scientist, nor the government policy, militates against the independence of the serious researcher. The quarrel of the activist scientists is with what they perceive as undesirable use of government funds for pursuing research that spells, at its worst, danger to society and, at its best, does not serve the common good. This was forcefully manifest in the work stoppage led by the MIT scientists in abhorrence of work on missile guidance being done at one of MIT laboratories at the time of the Vietnam War. More generally, the analysis indicates that the government has been, as it ought to be, sensitive to the public mood as reflected in the nature of Jeffersonian science that was shaped by the Press- Carter policy and funding. The study concludes that overall what the activism of the citizenscientist has achieved is a healthy balance between autonomy and responsibility. In the process, the scientists' organizations have admirably resisted themselves becoming a cult, so to say, and have largely acted as a knowledgeable 'dissenter'.

The book offers enjoyable reading and includes useful references and compilations in the appendices. It is gladly recommended for personal acquisition as well as by the libraries. Having said this, where do we stand today in regard to the core concerns with which the citizen-scientists have grappled? The nuclear related issues and the public reactions to them have not ceased to this day. At the same time, the present generation concerns relate to such issues as stem cell research, human cloning, network and information security, which have come to the fore in a world overtaken by a phenomenal pace of developments in the science of biology and the technology of communication. How is one to regulate science or, more properly, the use of science, is a question that will take some effort to answer and effectively implement the solutions.

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