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The meaning of 'public understanding of science' in the United States after World War II

Bruce V. Lewenstein

In the United States after World War II, the term 'public understanding of science' became equated with 'public appreciation of the benefits that science provides to society'. This equation was the result of the independent, but parallel, social and institutional needs of four different groups with an interest in popularizing science: commercial publishers, scientific societies, science journalists, and government agencies. A new, more critical era of popular science began in the 1960s.

As a number of sociologists of science have shown, popular science can be understood as part of a continuum of science communication.[1,2] Yet historically, popular science—and especially science journalism, the part of popular science which presents science 'news' through the mass media—has been considered a process in which 'science' is translated into a new, 'simpler' idiom.[3]

Practitioners of this 'translation' model claim that they create popular science that consists entirely of technical information recast into words and images accessible to people who do not have the specialized training and vocabulary of working scientists. Because popular science produced by the translation model focuses on technical aspects of science, it rarely provides information about the social context of scientific activity, and only incidentally explores the social implications of scientific knowledge.[4] As such, according to its critics, the translation model produces popular science which can be viewed as serving the institutional interests of science: if science is presented as an activity independent of social pressures, it can claim special treatment by the public at large.[2,5]

Practitioners, on the other hand, tend to present their motives in less Machiavellian terms. Most frequently, they claim that they are interested in general public 'understanding' of science, a goal which they present as neither good nor bad, but simply part of the general enlightenment appropriate and necessary in the modern world.[6] They rarely specify precisely what they mean by 'understanding', however. Do they mean increasing the public's level of knowledge of particular scientific facts and discoveries? Do they mean increasing the public's grasp of the scientific method? Do they mean improving public attitudes toward science? Or do they mean increasing the public's ability to criticize scientific institutions?

In this article, I will argue that in the United States in the generation after World War II, advocates of popular science who used the term 'understanding' were in fact

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seeking public *appreciation* of science. That is, they were seeking to improve the attitude of members of the public toward science as a body of knowledge, science as a way of knowing about the world, scientists as individuals, and the particular requests for support and funding that came from scientific institutions. All of these concerns were lumped together under the label of 'science'. Advocates of popular science varied in their commitment to direct and indirect ways of achieving appreciation. Some people believed that increasing public knowledge about scientific discoveries would necessarily yield better public appreciation, while others thought that popular science should be aimed specifically at improving public attitudes toward science.

Regardless of the path to public appreciation that individuals advocated, however, I will show that they agreed in their overall equation of the term 'public understanding of science' with 'public appreciation for the benefits that science provides to society'. This agreement led to a significant coalition of groups advocating a common approach to popular science in the generation after World War II. I will show that this coalition was strengthened by the social and institutional needs of the various groups with an interest in popular science, and that it represented a broad social response to the need for information about science and technology in the modern world.

Some origins of popular science

Since the nineteenth century, the United States had been developing a variety of institutions devoted to presenting information about science to the general public outside of the formal educational system. The Lyceum and Chataqua movements, which offered short courses and lecture series on a variety of topics in cities throughout the country, were joined by less systematic public lectures in a thriving public discourse throughout the nineteenth century. As literacy expanded, books and pamphlets about science began to appeal to broader audiences. Vigorous magazines had developed that were devoted to presenting science to nonscientists, and newspapers were beginning to find science an appropriate topic to cover if they were to appeal to broad middle-class audiences.[7–9] By the late nineteenth century, the 'great men' of science had become renowned not only for their science, but also for their ability to present to the public their vision of a rational world ruled by science.[10] Published material about science tended to reflect the need for science to establish itself as an objective, independent force in social affairs.

In the first decades of this century, scientific organizations discovered that organized news bureaus and public relations campaigns could serve useful institutional purposes. The American Medical Association created its first news bureau in 1910, spurred by its campaign against quacks and nostrums.[11] Chemists used a variety of institutional homes to launch a 'Chemists' Crusade' that ran from World War I for nearly twenty years.[12] In 1920 three major institutions of American science (the American Association for the Advancement of Science, the National Academy of Sciences, and the National Research Council) co-sponsored the founding of Science Service, a syndicated news service devoted to dissemination of objective and responsible information about science.[13]

By this time, science had acquired social authority. Everyone from radical socialists to conservative politicians turned to objective science to justify their activities.[8,14] In addition, the practical benefits of science and technology were becoming widely

accepted, and the confirmation of Albert Einstein's theories of relativity in 1919 and the development of quantum mechanics in the 1920s provided new occasions for the introduction of scientific ideas into general intellectual discourse.[15]

In the 1920s and 1930s, journalists began to take up full-time science reporting. Spurred by the efforts of Science Service, several of the major newspapers and newspaper chains had by the 1930s added full-time science writers to their staffs. By 1934, a dozen science journalists in the United States had discovered that they had enough in common to create the National Association of Science Writers (NASW). Members of the NASW believed that it provided science writers with some legitimacy and recognition as an independent group with independent standards, both within journalism and among the scientific community. Despite its independence, the new science journalism community continued to espouse beliefs welcome to the scientific community. According to Watson Davis, longtime director of Science Service, 'Science reporting and interpretation does not accomplish its purpose . . . if it does not bring about an appreciation and a utilization of the method of science in everyday life'.[16,17]

By the time World War II began, the NASW's size had more than tripled. As the pressures of specialization and growth in science began to restrict the ability of scientists to be active popularizers themselves, this new community of science journalists took on more and more of the responsibility and initiative in science popularization.[18] This became the context for popular science in the United States at the time of World War II. Although there had been a tradition of 'great men of science' who would lecture and write about science for the general public, that tradition had gradually been overtaken by the institutional needs of organizations such as the American Medical Association and the American Chemical Society, and by the pressures of specialization and growth in science itself. As the war ended, a network of organizations and journalists devoted to science was ready to respond to new opportunities.

We shall see that four major groups did respond: commercial publishers, scientific associations, science writers, and government agencies. But it is important first to see the broader social context in which they responded.

After World War II

As World War II ended, national leaders in the United States began to worry about a 'pent up' demand for information necessary for 'scientific progress and industrial applications of our science by industry'.[19] There was 'considerable discussion . . . about the remolding of the world by science and technology, [and] about the importance of the scientific method', one educator wrote in 1947.[20] It was a time, according to historian Walter McDougall, when the 'spectacular achievements of wartime R&D . . . encouraged the belief that conscious application of "Manhattan Project" methods to problems of poverty, health, housing, education, transportation, and communication might eliminate material want'.[21]

From that belief emerged a moral certainty about the social importance and efficacy of science, especially basic research. In his famous report 'Science—The Endless Frontier', presidential adviser Vannevar Bush wrote that:

> basic research is performed without thought of practical ends. It results in general knowledge and an understanding of nature and its laws. . . . Today it is truer than ever that basic research is the pacemaker of technological progress.[22]

In a *New York Times* essay, historian of science I. B. Cohen wrote that a member of the general public needed a 'full synthesis' of scientific knowledge.

> Above all, his reading must bring home the lesson that only by following a program of fundamental or basic research aimed at increasing knowledge—even if apparently for its own sake alone—will we in the end obtain the cures for disease and the easier and better lives that the fruits of science will make possible.[23]

Moral certainty in the importance of science allowed leading scientists to focus on meeting a 'demand' for information about science despite a lack of evidence that the demand existed. Astronomer Harlow Shapley, for example, claimed in a *Harper's* article that 'among the voters, it is becoming widely known that the basing of conclusions on observations, on testing and logical reasoning, with a minimum of emotional grasping and evading, is the scientific method'. Reflecting his own concerns, Shapley continued: 'It is also the intelligent method. It works'.[24] Other scientists entirely skipped the claim that a demand existed, merely assuming that because they believed in science, public interest should follow. Because 'applications of science play so important a part in our daily lives, matters of public policy are profoundly influenced by highly technical scientific considerations', wrote Harvard University president James Conant (who was trained as a chemist). 'Some understanding of science by those in positions of authority and responsibility as well as those who shape opinion is therefore of importance for the national welfare'.[25] Democratic ideals loomed large in the rhetoric of popular science.

The scientists were not entirely alone in their commitment to basic science. The *New Republic* (a liberal magazine of political and social comment), for example, devoted part of a special issue on 'The State of the Union: A Program for Liberal America' to a defence of fundamental research.[26] A *Business Week* editorial pushed for public understanding of the nature of basic science because, it said, of the need to construct a way of financing research that would 'somehow avoid the stultifying of basic research by an insistence on early and visible profit from research generally, for basic research is by definition unprofitable'.[27]

Gradually, the underlying consensus of scientific, cultural, business, and other leaders led to the emergence of an ongoing concern with the 'problem' of 'public understanding of science'.[28] Much of that concern can be traced in the *New York Times*, which had long been committed to covering science as news. Science writer William L. Laurence, for example, had achieved fame when the US Army selected him to provide the only first-hand accounts of the dropping of the atomic bomb. Now, after the war, he argued that 'the accurate and objective dissemination' of science was the highest goal to which a writer could aspire, for such information would play a major role in 'preserving our democratic society'. In addition, one of the major functions of science writing 'is to reduce the lag between discovery and application', he told an audience of teachers. He said that penicillin, if discovered in 1950, would not lie 'forgotten and neglected in some technical publication' for even 15 weeks, much less 15 years. This, he said, provided a measure of the importance of addressing the public's knowledge of science.[29]

The *New York Times* also demonstrated its belief in the need for public understanding by providing continuing coverage of developments in the field of public understanding of science. A 1946 notice on 'the first college course in science reporting and editing' at New York University claimed that it had been 'organized to meet a

demand for trained science writers, which has grown out of the war.' A 1947 item reported the growth of lists of science books issued by libraries and 'selected with the aid of experts for readability as well as authoritative treatment of scientific subjects . . . to broaden science understanding'.[30]

Taken together, these expressions of concern about public understanding of science do not demonstrate that a true 'demand' existed. But they were pleas for additional 'supply' that were falling on receptive ears. Few opposed the call for more popular science, for it echoed and amplified a general concern in the public at large. Expressed mainly by scientists with a deeply felt, almost moral certainty in the power of science to address the world's problems, the demand was accepted by the lay community. No explicit demand existed, however—only various individuals and groups advocating various approaches to improving the public understanding of science.

Commercial publishers

The first people to take action on the implied demand for popular science were commercial magazine publishers. Almost alone among the advocates of popular science, they explicitly thought that demand for popular science could be defined in economic, rather than moral, terms. In 1946 McGraw-Hill, one of the largest and most powerful technical trade publishers in New York, created *Science Illustrated*, a glossly monthly magazine in which 'the average citizen [could] find in his own terms a reporting or an interpreting of what the scientists are doing, what they are beginning which will soon be affecting our lives'.[31,32]

The founders of *Science Illustrated* were motivated by the desire for profits: they produced a variety of internal reports showing how to structure a new magazine for the best financial returns.[33] But their reasoning was based on the same moral certainty in the power of science as was being expressed by scientists, by business leaders, and by prominent political figures. 'In virtually every move an individual makes these days is reflected the work and products of our science', wrote J. K. Lasser, a consultant to the magazine. Like other prominent Americans, Lasser drew on the experience of World War II:

> Since scientists set the pattern for the war, they would also set the pattern for the peace. Their hands are on such vital controls that their dominant influence was inevitable. And yet the mental processes, the terminology, objectives, and means of the scientific world were as remote as the stars from the average citizen.[34]

Accepting the common view that technology flows from scientific knowledge, Lasser described the need for a new magazine without identifying a specific demand that the need be met. He argued that an informed public could control the 'products' of science. He told the McGraw-Hill board of directors that:

> a gap existed between science and the public which was both disturbing to the scientist and dangerous to the public—dangerous because the products of science must be dealt with by informed people if the consequences were to be socially useful rather than wasteful. This gap was one of the most remarkable defects in public information.[34]

Over the next four years McGraw-Hill pumped nearly five million dollars into *Science Illustrated*, attempting to reach a circulation of one million, which was the same as *Popular Science Monthly*, the most obvious competitor (although it served a very different audience from that McGraw-Hill hoped to reach). That was a lot of magazines: *Life* magazine at the time had a circulation of about five million; *The New Yorker* had 300 000. Even today, most popular science magazines in the United States have circulations of under one million.[35]

Science Illustrated had a strong start, selling nearly 150 000 copies of its first issue on the news-stands. But then the McGraw-Hill staff made a series of blunders, from an insufficient distribution network to an unfocused editorial stance. The covers of the first issues revealed the indecision: the first three were montages, made up of pictures taken from inside the magazine. At a glance, each was indistinguishable from the last. Finally, in a desperate attempt to regain readers, the fourth issue featured a scantily-clad, buxom young lady reclining provocatively on the beach, representing a story on ultraviolet radiation and suntans. The following issue took up the theme of sex even more blatantly, displaying a new bathing beauty atop a bright red motor scooter—an illustration with essentially no tie to the contents of the magazine, only to a three-sentence new-product announcement near the back.[36] Though the *risqué* cover photos undoubtedly drew in some readers, they also probably alienated many of the more intellectual readers and advertisers. Forty years later, a series of publishing executives from both inside and outside McGraw-Hill commented derisively on the covers.[37]

At the time, advertisers were already unsure about how to economically reach the leaders of the post-war community. Many advertisers accepted the rhetoric describing the post-war world as one based on science, and they had originally hoped that *Science Illustrated* might provide a route for getting to the leaders of the new world. However, the instability in *Science Illustrated*'s format and direction undermined beliefs based solely on rhetoric and reinforced the advertisers' uncertainties. 'Advertisers and agencies at the time of the launching announcement practically universally accepted with enthusiasm the publishing premise of *Science Illustrated* as sound, timely, and one that would be successful', wrote advertising manager George 'Red' Seaman. 'But there was widespread disappointment and criticism of the editorial execution and appearance of the early issues'.[38] The advertisers turned away from the magazine, and the next few years were not easy ones for McGraw-Hill or *Science Illustrated*.[32]

While McGraw-Hill, the experienced trade publisher, was struggling to reach a consumer audience, two journalists trained in mass-circulation publications were taking exactly the opposite approach, aiming at a small, carefully circumscribed technical audience. Gerard Piel and Dennis Flanagan were *Life* magazine editors who saw a need 'to serve the need of the scientist, the engineer, the doctor, the educator, and the intelligent layman for information concerning the progress of science, engineering, and medicine in all their branches and in their application at the social and economic level to the lives of all men'. Defining 'the common denominator of this audience [as] the interested layman: the scientific professional who is a layman in departments outside his own', Piel and Flanagan called their project one of popular science publishing.[39]

The definition of a 'layman' used by Piel and Flanagan is a very tightly drawn one. Piel, Flanagan, and their partners were not altruistic. They recognized that successful commercial publications depended on advertising revenue. But unlike *Science Illustrated*, they chose to limit their audience, to define popular science in such a way

that their business would not depend on reaching an audience with only a tenuous interest in science. As a result, they thought they could appeal more directly to the industrial advertisers who would be most interested in reaching the post-war technocratic élite.

Although the partners initially planned to start a new magazine from scratch (they had a dummy already laid out, using the title *The Sciences*), they ended up buying the 103-year-old *Scientific American* and pasting its logo on top of their dummy. The first issue of the 'new' *Scientific American* came out in May 1948.[40]

The magazine focused almost entirely on reporting new developments in science. Each issue contained stories from the 'three main divisions' of science—physical, biological, and social—as well as stories on engineering and medicine. Flanagan, who served as editor, interpreted science widely and published stories on cybernetics, the H-bomb, the economic relations of science, the National Science Foundation, and the history of science (in addition to more traditional science topics such as particle physics, the biology of aging, and the relationship between temperature and life).[41] But his vision of how to present science did not extend to essays or reflections on scientific method. Piel and Flanagan, as with other science writers, believed that the best way to stimulate the scientific approach was not to advocate it explicitly, but to present the findings of science in comprehensible, responsible form. Science, they were convinced, was so obviously crucial to the modern world that presenting it intelligently would make its relevance and implications for society immediately apparent.[17,42] The magazine was, in essence, a monument to the vision of science as saviour of the world.[43]

Like so many others engaged in supporting or producing popular science, Piel and Flanagan felt an almost missionary zeal to demonstrate the value of science for addressing the problems of the day. 'We believe', they had written in a prospectus, 'that without such information [about scientific discoveries], modern man has only the haziest idea of how to act in behalf of his own happiness and welfare, or that of his own family and community'. They continued, 'We certainly have a point of view. It is that we are for science. With the men of science, we agree that human want is technologically obsolete'.[44] It is not surprising that with opinions like these the partners found the scientific community eagerly supporting them. In 1946, more than 60 well-known scientists had responded to a call for letters of endorsement.[45] Later, one scientist called the new *Scientific American* 'an extraordinarily good journal, too good to survive I almost fear'.[46]

By 1949, it was clear that McGraw-Hill had made a mistake in aiming *Science Illustrated* at the mass consumer audience. The advertising dollars to support it just weren't there. Despite its rhetorical claim to interest in 'the mental processes, the terminology, objectives, and means of the scientific world', *Science Illustrated* had become a gadget and 'gee-whiz' publication. That wasn't the way to attract industrial advertisers. In June 1949, *Science Illustrated* announced that it was folding.[47]

For Piel and Flanagan, however, the missionary approach to the technocratic élite proved profitable, precisely because that *was* the audience the new industrial advertisers wanted to reach. Although it took several years, and more than twice the initial investment of $450,000, by 1951 the new *Scientific American* was financially profitable and embarked on a thoroughly successful publishing track.[40,48]

Thus for the first group—commercial publishers—successful popular science meant disseminating scientific knowledge to a well-educated technocratic élite. Focusing on an élite audience was quite different from the 'mass audience' that rhetoric

about popular science often described, and the emphasis on translating technical knowledge required assuming that 'understanding' would automatically lead to 'appreciation'. The commercial publishers found their success by preaching to the converted.

The scientific community

The technocratic appeal of successful popular science was not lost on the second group that responded to the 'demand' for popular science: the scientific community. Piel and Flanagan knew that. In 1949, when they nearly ran out of money, they had approached both the Geological Society of America and the American Association for the Advancement of Science (AAAS) for help. Pitching their project as one fundamentally directed to the scientific community, they had asked both organizations for money.[49]

Neither organization agreed to help. Nonetheless, the scientific societies did see popularization as one of their goals. That became most explicit at the AAAS, which in 1951 adopted a new policy statement, known as the Arden House statement, that called for the Association to focus on broad, synthetic issues in science. The emphasis on 'over-all problems', said the Arden House statement,

> demands that the AAAS not only recognize but attack the broader external problem of the relation of science to society. It seems to us necessary that the AAAS now begin to take seriously one statement of purpose that has long existed in its constitution. To quote: 'The objects of the American Association for the Advancement of Science are . . . *to increase public understanding and appreciation of the importance and promise of the methods of science in human progress*'.[50]

Written by Rockefeller Foundation officer Warren Weaver, who was then an active member of the AAAS board, the Arden House statement recognized the difficulties of pursuing the goal. But, Weaver argued, 'in our modern society it is absolutely essential that science—the results of science, the nature and importance of basic research, the methods of science, the spirit of science—be better understood by government officials, by businessmen, and indeed by all the people'. Weaver stressed that 'the attendants at the Arden House Conference did not intend that this statement be viewed as a polite rephrasing which suggests only minor changes'. Instead, it called for active reassessment and redirection of AAAS, away from technical topics and toward more synthetic issues within science and more concern with improving the attitude and support for science among members of the nonscientific community.[50] Again, Weaver's goal was to use public presentations of scientific information as a way of strengthening both the intellectual and social authority of science.

Over the next four years, as the AAAS attempted to define what its precise policies should be, programmes for the mass media and for mass public education regularly appeared in the deliberations. These included: renewed attention to *The Scientific Monthly*, a AAAS magazine directed largely to teachers and scientists reading for pleasure in fields outside their own; book projects intended for general readers; expanded support for reporters at the Association's annual meetings; and increases in the number of synthetic or general-interest sessions at the annual meetings.[51]

Many members of the AAAS supported the new initiatives, drawing on the same moral certainty in the efficacy of science used by scientists, commercial publishers and others in their calls for more popular science. 'If we can, as scientists, become well enough organized and our *knowledge* of the great problems of the day be recognized as having more weight than the *opinions* of pressure groups and selfish politicians', wrote one engineering professor, 'we would make a very important contribution to national welfare'. Another scientist wrote that 'I take it as needing no argument that the importance of science to the national welfare, and the consequent imperative need for the people and their elected representatives to understand something of how science operates, makes such public education the prime duty of the AAAS'.[52]

But a significant block of AAAS members worried that attention to the broader public would dilute the association's technical core. 'If we lose contact with the bedrock of specialized research', wrote one, 'we . . . run the danger of shallow, vapid, unfounded generalizations. Be our integrators ever so careful, if they operate without the sharp light of detailed investigations they may fall into facile dilettantism'. Howard Meyerhoff, the Association's administrative secretary (who led the Association on a day-to-day basis), sided with this block, and in a 1953 editorial blasted those who would redirect Association activities. 'Where else but at a AAAS convention', he asked.

> can engineers, biologists, psychologists, industrialists, physical scientists, and public leaders assemble to consider Disaster Recovery? Or the Interface of Land and Sea? Or Problems of the Pacific Rim? It is not the Association that lags, but those who fail to comprehend the scope and impact of its current program. Intellectual bankruptcy and deterioration will indeed set in if the AAAS turns from programming important science merely to ballyhooing the importance of science.[53]

Although Meyerhoff's concern about the distinction between public education and public relations reflected an understanding that the moral certainty of the scientists was not universally shared, his advocacy of this position was sharply limited by a series of personal conflicts with other AAAS leaders. In March 1953, he abruptly resigned from the Association. The resulting turmoil took until 1955 to resolve, and consequently few of the initial plans for increasing the public understanding of science activities were implemented.[54]

After 1955, the AAAS chose not to implement the Arden House policy statement with grand programmatic leaps. Instead, it explicitly opted to judge the programmes and initiatives that it ran across in the normal course of events by whether or not they contributed to Arden House goals. Arden House activities 'were no longer treated as something in addition to or parallel with the rest of the Association's responsibilities, structure, and activities', wrote the new administrative secretary (later, executive officer), Dael Wolfle, in a 1989 memoir. 'Instead, they became integral parts of AAAS planning and activity'.[55]

Among the programmes that evolved were popular book series, co-operative relationships with television producers, internal public relations offices, co-ordinated activities with science journalists, and changes in the structure and content of the annual meetings. These programmes were justified by the same belief in the moral superiority of science that others had expressed earlier. One memo said that the concerns of the Arden House conference had been 'validated by events' (without specifying which events). Echoing phrases used since the advent of institutionalized

popular science around World War I (and still appearing today), the memo said that in recent years,

> the direct results of scientific research have become of increasingly immediate concern to the public. Yet, there has occurred a simultaneous decline in the public influence of the scientist, and public education about science, which must ultimately come from the scientists, has suffered. There is, therefore, an unprecedented need for bringing science to the public, which has not yet been met by means adequate to the task, or to the opportunities.[56]

One AAAS staff member, John Behnke, described a vision of popular science that saw 'science' as essentially different from the individual sciences. He implied that science was morally better than virtually any other topic, including the specific sciences such as chemistry and physics. 'Each special organization has vested interests and a circumscribed field which it, consciously or unconsciously, must "sell"', he wrote. The AAAS, on the other hand, 'could and should be "selling" science in its broadest and highest sense'. Most organizations focused on 'new gadgets and discoveries', Behnke claimed. 'We have a deeper interest and a special role in educating the public . . . in *basic science*. This should be the keystone and the keynote of our program'.[57]

Behnke served as the staff member most intimately involved in the AAAS popular science activities, and he helped initiate several series of popular science books and, when those series proved difficult to sustain, a book distribution system. He also co-ordinated the creation of an internal press office and contacts with editors and broadcast programmes. In 1957, he helped prepare proposals to seek funds for 'working with newspaper, magazine, radio, television, and motion picture authors and producers in ways that would help to guide their presentations concerning science'. This guiding help would not be entirely neutral, the AAAS proposals noted, for the staff member involved would push popular science products 'in the directions that [his] knowledge and experience . . . and his contacts with the scientific community indicate would be the most desirable'.[58] Behnke's certainty in the value of science brooked no doubts. To him, as to other members of the scientific community, any activities that increased public knowledge of technical scientific information were necessarily good for society.

In 1960, the AAAS hired E. G. Sherburne, who had experience in educational television, to direct its public understanding of science activities. Using money raised from the Sloan Foundation, to which Warren Weaver had moved as an executive, Sherburne helped television producers create specials from AAAS annual meetings, arranged for seminars on science to be presented to newspaper editors and reporters, and supplied information to producers of television drama shows (hoping to interest them in including science on television). The response from television producers was so good that Sherburne's boss, executive officer Dael Wolfle, seriously contemplated opening AAAS offices in Hollywood and New York to serve the television community.[59]

Despite the broad reach of these activities, the AAAS was careful to maintain a stance that supported the primacy of science in public affairs. By the beginning of the 1960s, the early environmental and antinuclear movements had begun to grow; political and social concerns were developing that suggested that science, rather than solving problems, might be creating them. Science was coming under attack.[60] In that context, the AAAS board responded cautiously in 1963, when AAAS staff member Daniel Greenberg proposed establishing a new magazine to cover the general area of science policy. Warren Weaver, then a senior statesman in the AAAS, was pleased

with the project and warned that 'it would be fatal if [the magazine] started out with the arrogant premise that scientists are always right (on public as well as scientific matters)'. The majority of the AAAS board, however, was concerned about diluting scientific authority; it was especially disturbed by Greenberg's highlighting in a prototype issue of the phrase 'science is too important to be left solely to the scientists'. In an angry discussion sparked by the phrase, the AAAS board voted to terminate plans for the magazine.[61]

The AAAS is only one example of the many scientific organizations that worked closely with reporters and expressed a commitment to public understanding of science in the years after World War II. As noted earlier, the Geological Society of America had expressed interest in the *Scientific American*. In 1956 the American Institute of Physics established a new office of information and public relations, and hired a well-known science writer to run it. Throughout the 1940s, 1950s, and 1960s, organizations such as the American Chemical Society and the American Medical Association continued to actively support their press offices and related activites.[62]

But the AAAS was certainly the major scientific organization to make public understanding of science a basic organizing tenet of its operation. It expressed broader goals than did the publishers of *Scientific American*, claiming that it wanted to reach an audience not fundamentally or professionally interested in science. Nonetheless, its commitment to the ideology that science was purely a social good led it to initiatives that the technocratic élite would almost certainly support. As with the commercial publishers, the AAAS proved successful with programmes that proclaimed the benefits of science to all of humanity. And although these activities were clearly motivated by the phrase 'public appreciation' in the official AAAS charter, the activities were carried out under the label of 'public understanding', thus allowing the AAAS to claim that it was responding to a post-war demand for more popular science.

Science writers

By stressing the distinct visions of these groups, I do not mean to imply that the visions were incompatible. Links often existed between scientific organizations such as the AAAS and commercial publishers such as Gerard Piel (who in the 1980s would serve as president and chairman of AAAS). In a similar way, there were links between both of those groups and the third group: the science writing community.

In working with the media, AAAS executive officer Wolfle told his board of directors, 'we have chosen to co-operate on "leverage" projects where we work with the mass media staffs, rather than trying to reach the public directly ourselves'.[63] Wolfle and other AAAS leaders reasoned that helping professional science writers was more productive than trying to write, produce, and distribute material completely from scratch. This leverage was relatively easy to exert, because the National Association of Science Writers (NASW) was a formal affiliate of the AAAS.

Although the NASW had been created in the early 1930s it had only 63 members at the end of World War II. But by 1950 that number had doubled. It doubled again by 1955, and almost again by 1960, when the NASW had 413 members.[64] Its members were committed to promoting science as the saviour of the world. It is 'not enough that scientists discover and invent', wrote George W. Gray, a science writer who had been called 'one of the ablest popularizers of science writing in English'. Instead, Gray wrote, 'it is absolutely essential to balanced progress and social welfare and equilib-

rium that their results be interpreted into the vernacular and made a part of the thinking as well as the doing and acting of civilization'.[65]

The NASW was an organization devoted to obtaining 'wider prestige and respect for the profession of science writing', and to promoting 'the overall prestige of NASW as the spokesman for the entire field of science journalism in this country'. The NASW had a rigid rule requiring substantial experience in covering science before granting membership, thus limiting its membership to those with proven professional credentials. In addition, to protect the NASW's claim to unbiased journalism (a fundamental commitment of American journalism at the time), it pushed several members into 'associate' or 'honorary' categories when they began working as public relations officers for scientific organizations. Another way of promoting professionalism was a series of seminars for which science writers would receive credits, much as teachers in the US today get 'continuing education' credits that count toward salary increases and professional promotion and status. In 1953, the NASW arranged to have a prestigious award for medical journalism presented at the meetings of the American Society of Newspaper Editors (instead of at the American Medical Association meetings). 'The thinking in this case is that presentations before such groups would stress the value of science writing more directly to editors and publishers', said a notice of the arrangement. Through activities such as these, the organization was largely concerned with maintaining both the image and reality of professionalism.[66]

As the NASW grew in the years after World War II, it began to organize its campaign for respectability on a broader scale. One element of that campaign was the *NASW Newsletter*, first published in 1952. On the very first page of the first issue of the newsletter, editor John Pfeiffer wrote that 'Some medical and technical journals apparently are not aware that NASW exists', which was leading to 'occasional editorials which criticize American science reporting in vague, sweeping terms and throw off uncomplimentary comments as if there were no organization ready to present the facts'. The NASW was ready to defend its members with information about the facts of science writing—and also to defend science writers' dedication to the facts of science.[67]

Members of the NASW periodically complained that scientists did not like to co-operate with the press, and that editors did not like to print responsible science news (that is, science news with the caveats and explanations that science writers, conditioned by their commitment to scientific ideals, believed were necessary). But the NASW itself provided evidence to the contrary on both charges.

On the scientific side, the *NASW Newsletter* frequently reported on the co-operation NASW members received from various scientific organizations, such as the California Medical Association and the American Psychological Association, as well as the relatively high opinion that many scientists held of newspaper science reporting. In one survey, for example, nearly 95% of the researchers responded favourably to stories publicizing their work.[68] In retrospect, it is easy to see that many scientists—especially leaders of the community like Warren Weaver—understood the value of good public relations. Studies of the American physics and chemistry communities, of the National Institutes of Health, and even of individual scientists like biochemist Wendell Stanley, have shown that.[69] But even at the time, a 1952 NASW survey of American scientists (reported in the *NASW Newsletter*) revealed that more than half gave 'unqualified support to contemporary newspaper reporting of science developments'. Another survey found that 86% of the scientists polled believed that science stories in the newspapers were 'reasonably accurate'.

Evidence compiled by NASW suggested that charges against editors were also exaggerated. A 1950 survey of newspaper managing editors found that 85% of them had increased the amount of science covered by their papers by at least 50% in the previous decade. Much of that news came from medicine, public health, atomic energy, agriculture, 'new inventions for the home', and aviation. But nearly 20% of the editors reported that basic research was a special interest of theirs.[71]

To a degree, the NASW's campaign for respectability worked. Science writers came to be a distinct—and at least partially élite—group within journalism. Two members of the Association were called as representatives of science writing to testify before Congress during hearings about science and secrecy. Journalism school theses began to address 'science reporting in the American press'. And in 1956, the *NASW Newsletter* reported that President Dwight D. Eisenhower accepted as plausible the idea of appointing an NASW representative to the board of the new Library of Medicine. 'This doesn't mean, of course, that NASW has won a seat . . .', said an NASW officer. 'But it does point out one way we can gain official recognition to promote the overall prestige of NASW as the spokesman for the entire field of science journalism in this country'.[72]

Indeed, the campaign for élite status worked so well that one general news reporter complained that science writers 'gave me the impression that they looked down their noses at me. They gave me nasty looks when I asked some dumb question, but, Hell, I had to make sure I knew what the guy was talking about. Sometimes they talked as though they were more interested in showing the scientist what they knew than in finding out what he knew'. An active NASW member concurred, adding, 'My God, sometimes you'd think [science writers] had invented science and were doing all the research personally rather than just writing about it and interpreting it'.[73]

Not only did the science writers form an élite, but they viewed themselves as advocates for science. In 1955, when it still appeared that the AAAS might never implement its Arden House policies, John Pfeiffer—by now president of NASW—wrote that it 'seems clear that the AAAS is not likely to take the leadership or even to spark developments in such matters. That leaves things up to the NASW'. He recommended that NASW 'find out whatever became of those ambitious plans for expanded public relations in science. After that, we might consider . . . how the nation's science writers and editors, working with the AAAS, could help get things under way'.[74]

And the science writers' concerns about accuracy reinforce the picture of reporters more concerned with accepting the scientists' judgment than their own. When a proposed NASW ethics code included a commitment to 'factually correct' information, two members proposed adding a requirement that scientists be given an opportunity to read and comment on manuscripts. Citing their own experience, freelance magazine writers Ed and Ruth Brecher said that 'the number of errors we have . . . avoided [by submitting manuscripts for review] must by now run into the hundreds—many of them not errors of fact but of emphasis'. Though the Brechers expressed confidence that 'most of the corrections make little difference to editors or readers', it is notable that professional journalists found occasion to believe that matters of news emphasis should be left up to the scientists instead of the news professionals.[75]

To members of the NASW, better science writing meant more science writing. Just as the commercial publishers and scientists believed that increasing the amount of information available about science would automatically improve the public's attitude toward science, so the science writers believed that increased information would lead

to greater support for science. 'Understanding' and 'support' were so often linked in statements by NASW leaders that they are hard to disentangle, leading to the conclusion that the leaders saw little difference in the terms. One *NASW Newsletter* item reported that:

> NASW members may be called on increasingly for advice on scientific education in foreign countries. During the spring, *Watson Davis* [director of Science Service] visited Cairo . . . cooperating with the Egyptian Ministry of Education. Premier Nasser's government has thus officially recognized that science journalism must play a significant role in its plans to modernize its nation and win public support for research and technology.[76]

Two years later, the NASW's 1958 president, John Troan, said that one of his major goals was to 'Promote greater recognition . . . of science writing as a major communications skill which can be drawn on for expert advice in formulating programs designed to encourage support and understanding of the basic aims of all science.'[77]

Despite these commitments to the scientific worldview, the NASW did take a broader view of the audience for popular science than did either the commercial publishers or the AAAS. During a 1956 meeting between AAAS and NASW representatives, AAAS leaders worried that aiming information at 'the general mass of newspaper readers, and TV and movie viewers . . . necessarily involved a dilution and distortion of scientific information'. After the meeting, NASW president Pfeiffer concluded that AAAS efforts 'are being devoted exclusively to an audience considerably smaller than "all the people" [the phrase used in the Arden House statement]—an audience of scientists and "intelligent, responsible" laymen. . . . Nothing is planned for the 50 000 000 or more people who obtain their science news from the newspaper science reporters, press services, and popular magazines'. Pfeiffer recommended that NASW sever its affiliate relationship with AAAS, though the NASW did not pursue the idea.[78]

To achieve its goals, the NASW frequently sought foundation funding. Once again, Warren Weaver proved to be a faithful friend of science writing. From 1955 to 1958, he committed Rockefeller Foundation funds to three separate surveys of newspaper readers, each intended to elicit information about the demand for science news. These surveys revealed strong demand and—after the Sputnik debacle, which led to an outcry in the United States about losing the space race to the Communists—a strong need for more science writing.[79]

In the late 1950s, the science writers found that they needed to put more organizational resources into the promotion of science writing than a professional membership organization could sustain. So they created in 1960 a new, nonprofit foundation called the Council for the Advancement of Science Writing (CASW). At first the CASW was just an extension of the NASW, listing its purpose as 'the interpretation of science and its meaning to society'. But within a year the CASW had become even more committed to treating science as the scientists would like to have it treated. A revised statement of purpose was explicit about the underlying conviction that more information about scientific developments was the key to improving the public's appreciation of science, linking the word 'understanding' with 'appreciation'. The new statement called for increasing the 'quantity and quality of scientific information in the public press'. Such information would 'heighten the public's understanding and appreciation of scientific enterprises'.[80]

In another example of the constant linking of 'understanding' with 'appreciation', CASW president Earl Ubell told one correspondent that 'the CASW is not only willing but anxious to help any organization arrange programs or get going on other activities which would increase the flow of scientific information to science writers and to the public'.[81] Ubell and others clearly believed that 'the vitality of science in a democracy depends in large measure upon public appreciation of science'—appreciation that science writers could provide.[82]

The CASW owed much of its initial momentum to, once again, Warren Weaver. Weaver had reached the Rockefeller Foundation's mandatory retirement age, but he was immediately recruited by the Sloan Foundation (which, then being run by the 85-year-old Alfred Sloan, had no retirement age). The CASW applied to him for money, saying that its activities would 'change the climate of appreciation for scientists and the scientific enterprise'. He provided $110,000 to support science writing seminars over the organization's first three years.[82,83]

To decode the historical meaning of the term 'public understanding of science' requires understanding Warren Weaver's vision of popular science. Luckily, Weaver wrote in 1960 a 'wonderful discussion of some of the philosophy that underlies the CASW'.[84] In that piece, called 'A Great Age for Science', Weaver argued that 'it is imperative that the individual citizens of our democracy have an improved understanding of what science is, how it operates, and the circumstances that make it prosper'. Why? Because dealing with the 'difficult and important social and political problems' that involved science (such as nuclear weapons, air and water pollution, and the population explosion) required scientific knowledge—'and these problems, in a democracy, must be the concern of the citizen'. Weaver also noted the financial demands that science now made on government agencies, and the corresponding need for political support. Finally, he discussed the problem of the two cultures, which C. P. Snow had recently defined, arguing that 'all citizens would be given a richer inner life if they could have a chance to appreciate the true nature of science and the scientific attitude'.[85]

It would be easy to label Weaver's words as merely rhetoric and to wonder about his real motivation. Weaver was a scientist and represented the scientific community; he can be expected to have supported his colleagues for both economic and social reasons. But it may be overly cynical to not believe that Weaver and his contemporaries would act on deeply held beliefs. Weaver clearly could not conceive of a situation in which it was not appropriate for science to prosper. To him, 'science is not technology, it is not gadgetry, it is not some mysterious cult, it is not a great mechanical monster. Science is an adventure of the human spirit. It is an essentially artistic enterprise . . . based largely on faith in the reasonableness, order, and beauty of the universe of which man is part'.[85]

For Weaver, and for people such as Gerard Piel, a simple and fundamental patriotism motivated the concern that the United States—especially a *democratic* United States—should not fall behind in science. The triumph of good over evil in World War II reinforced the belief in basic American democratic ideals, and sociologist Robert Merton had recently enunciated the equation of science with those ideals. (Merton, who had been one of Piel's tutors at Harvard, first published his famous norms of science in an article called 'Science and Technology in a Democratic Order'.) It was an easy step for Weaver to complete the syllogism and argue that support of America required support of the scientific enterprise.[86] And Weaver firmly believed that the most productive way to support science was to support basic research. 'The

whole history of science', he claimed, 'shows most impressively that the scientists who are motivated by curiosity, by a driving desire to *know*, are usually the ones who make the deepest, the most imaginative, and the most revolutionary discoveries—and those which . . . eventually turn out to be the most practical'.[87] Since Weaver acknowledged the growing governmental role in providing material support for science, and since, in a democracy, the decision to provide that support rested ultimately with the entire population, he concluded with the vague and yet all-encompassing recommendation that 'We should vastly increase and improve all ways of giving every citizen a better understanding of science'.[88]

Despite Weaver's goal of reaching the entire citizenry, and the apparently similar goal of the science writers, the CASW continued to aim some of its efforts above the heads of those it hoped to reach. After its first couple of annual science writer seminars, one editor complained that the programme 'is rather on the sophisticated side for achieving its goal of bringing deeper understanding of science'. In general, he wrote, 'the improvement of science writing by qualified writers is a worthy goal. But I would be more interested in trying to reach the unqualified, the general assignment man covering science part-time. . . . These are the people whose eyes can be opened by an exposure to science'.[89]

Although science writers were affected by these limitations, they clearly had a broader definition of the audience for popular science than did the commercial publishers or the scientific societies. But their vision of 'public understanding' was similar: it was inextricably linked to the desire to promote the public appreciation of science and its benefits. Once again, a different group had arrived via a different route—to the same place.

Government agencies

The sense of interlocking directorates and parallel interests continues in the history of how US government agencies responded to the demand for popular science. First, the same people keep appearing in the story, especially NASW members. In 1949, one of NASW's first members, Herbert Nichols, left his job as science editor of the *Christian Science Monitor* to become public information officer for the United States Geological Survey. A few years later, in 1956, another of NASW's original members, Jane Stafford, finished 30 years of reporting for *Science News* and moved to the public information office of the National Institutes of Health. In 1957, a new NASW member, Howard Lewis, helped the National Academy of Science set up its public information office. He was motivated by a deep revulsion against the shallowness of most fields outside of science. He said he hoped to use his new position to further 'the notion that a knowledge of scientific method is one of the mightiest weapons against myth and ignorance, the twin sources of evil in the world'.[90]

The most important figure to reappear, however, was Warren Weaver. In the spring of 1958 (just half a year after Sputnik) while serving on the National Science Foundation's (NSF) board of directors, Weaver criticized the lack of attention that the NSF was giving to 'public informational activities'. Within a month, NSF staff had prepared plans for a 'Public Understanding of Science' programme with a budget of $1.5 million.[91,92]

The NSF plan was motivated by the same moral certainty in science that had characterized earlier responses to the demand for information about science. The NSF, said the document proposing the new programme,

> must develop programs designed to arouse citizens to the need for re-examining their attitude toward science and science education. Through such improved public understanding a basis will be created for a sound national policy to improve science and education. Enlightened national policy toward science and education will quickly evolve when citizens—particularly parents, are prepared to act on the basis of incontrovertible facts.[93]

The NSF staff identified the new plan with President Eisenhower's recent charge to the President's Committee for Scientists and Engineers to 'publicize the problem [of public knowledge about science] and possible solutions in order to stimulate widespread understanding and support'—a charge that had once again tied increased knowledge to the goals of improved public attitudes and thus support.[93] The new plan was adopted, apparently without debate, and by the fall of 1959, the NSF was actively supporting conferences for science writers, newspaper editors, and others.[94]

The NSF was not alone in its response to advisers like Weaver who advocated popular science, although some advisers were less broad-minded in their visions. When the Atomic Energy Commission (AEC) was established in 1947, its General Advisory Committee urged it to adopt a policy of active dissemination of information, particularly to further the goal of convincing the nation that atomic energy could play an important role in peaceful projects. Such a policy would allow the AEC to control the image of atomic energy, the General Advisory Committee suggested, because it would 'remove pernicious public misconceptions such as those current on the power aspects of atomic energy and super bombs'.[95]

Despite the clearly self-serving nature of the AEC's activities, science writers approved of its work. The *New York Times* praised one of its first projects as 'a broad-scale public seminar in just what the atom is all about'. Volta Torrey, a prominent member of the NASW, also praised the AEC, saying that good science writers 'think of their periodicals as channels of communication between the specialists and the public and are constantly trying to improve them'. He called the physicists who often helped science writers explain nuclear science 'missionaries for science', expressing approval of their activities.[96]

Most of these government activities (such as the United States Geological Survey and the National Institutes of Health press offices) could reasonably be considered as public relations for the agency involved. Indeed, one crusader tried in 1963 to pillory the NSF for its support of 'science writing junkets'. But the NSF's goals were different. Although the original response to Weaver's demand for a programme was written by the NSF's public relations officer, the NSF quickly removed the programme from his office, for it recognized the inherent conflict between public relations and education. The NSF's goal was not public relations for the NSF. It *was* public relations for science as a whole. The same was true at the AEC, where the goal was also clearly not public relations for the agency itself, but public relations for the field of atomic energy.[97]

We can best understand these activities as formal government commitments to the same ideal as that held by the scientists and the science writers: to disseminate scientific information for the purpose of increasing public *appreciation* for science. The NSF argued that

> progress in science depends largely upon public understanding and support of adequate programs of science education and basic research. With few exceptions, the adult public learns little about science other than that which is

> concerned with the more spectacular results of applied research and technology. As a consequence, very few of our adult citizens acquire an adequate understanding of the role of basic research and science education and their relation to further progress in engineering and technology.[98]

In government, just as in the other groups that responded to the demand for popular science, the concept of 'public understanding of science' came to mean committing resources to improving the public's appreciation of the benefits that science provides.

Conclusion

By the early 1960s, four major groups had responded to the post-war demand for popular science, each for its own reasons. Each group—the commercial publishers, the scientific organizations, the science writers, and the government agencies—defined 'public understanding of science' in slightly different ways, to serve their own needs.

Yet each group, despite different rationales, adopted similar definitions, focusing on disseminating technical information about the discoveries of science. It seemed to each of these groups that this was what 'the public'—whatever public they happened to be talking about—wanted. And this was a field in which what the producers of information defined as 'wanted' was what got produced, with little sense of what the various publics might choose on their own. Each definition focused on promoting an *appreciation* of science, and especially the 'benefits' of science to society. Though much of the rhetoric of these groups talked about improving the public's *understanding* of the relationships between science and society, in practice they meant improving the public's *appreciation* of the benefits that society received from science.

Thus, though the terms 'popular science' and 'public understanding of science' meant different things and implied different actions to the different groups, the groups ultimately came to consensus about their goals. Each could use the terms as it wished, without dramatically conflicting with the interpretations preferred by the other groups.

A new era for popular science began in the early 1960s, when criticism began to appear of the unbridled enthusiasm for science that had reigned in the United States for the previous 20 years or so. In 1963, Rachel Carson published *Silent Spring*, her devastating indictment of our tarnishing of the environment. Also that year, biologist Barry Commoner—who had been an editor at *Science Illustrated* and active in the AAAS's public understanding of science activities—organized the Scientists' Institute for Public Information, which was then an organization distinctly critical of how science was pursued in the United States. With the rise of a new, politically-oriented environmental journalism, the close ties between science journalism and mainstream scientific institutions began to break down.[99]

In sociologist Dorothy Nelkin's survey of contemporary American science journalism, *Selling Science*, she says that 'public communication [of science] is shaped by the co-operation and collaboration of several communities, each operating in terms of its own needs, motivations and constraints'. Her comment on the contemporary situation clearly holds as well for the historical context that existed in the 20 years after World War II.[100]

In part, these different communities could work together because they often consisted of the same people, just wearing different hats. Gerard Piel is the best example: he was the founder of *Scientific American*, he was an active member of the NASW and CASW, he co-operated frequently with the AAAS in the mid-1950s, and in 1986 he was chairman of the AAAS. But many others crossed over between groups, as demonstrated by people like Herbert Nichols and Jane Stafford, experienced science writers who went from media outlets to government agencies.

And moving throughout these stories is Warren Weaver. Too many intelligent people were involved in these activities for too long for a 'great man' theory of history to be appropriate. But Weaver was a catalyst in many of these activities and we cannot understand how science writing in the United States achieved the form that it had by the early 1960s without understanding him and his interests. Those interests are the ones with the deepest and most important implications: the complex interactions and communication necessary in a society based on both mass political support and on the achievements of a scientific, technological, and intellectual élite.

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Author

Bruce Lewenstein is Assistant Professor in the Departments of Communication and Science & Technology Studies, Cornell University, Ithaca, NY 14853, USA where he directs the undergraduate Science Communication sequence. After earning an AB in humanities at the University of Chicago in 1980, he worked as a science writer for several years, toiling mostly on heavily illustrated coffee-table books and for advertising agencies with high-tech clients. In 1987, he earned a PhD in History and Sociology of Science (and Science and Technology Policy) at the University of Pennsylvania. His research interest is in the role of popular science in the relationship between science and society. That interest led him to help create in 1989 the Cornell Cold Fusion Archive, a resource for historians and other scholars, and he is now writing a book on the cold fusion saga. (He's also father of two, husband of one, lover of chocolate cakes, and has been known to forego scholarship when the wind for sailing is just right.)