C. P. Snow in the Rede Lecture, *The Two Cultures and the Scientific Revolution* (Cambridge Univ. Press, Cambridge and New York, 1959). I recommend his book, although with certain reservations. See also E. Ashby, *Technology and the Academics* (Macmillan, London, 1958) and F. Burkhardt, *Science and the Humanities* (Antioch Press, Yellow Springs, Ohio, 1959).

7. See, for example, the disturbing findings of M. Mead and R. Metraux, "Image of the scientist among high-school students," *Science* **126**, 384 (1957). I have presented the approach in this middle section in the "Adventures of the Mind" series, *Saturday Evening Post*, 9 January 1960.
8. It is, however, also appropriate to say here that there has been only a moderate success in persuading the average scientist of the proposition that the privilege of freely pursuing a field of knowledge having large-scale secondary effects imposes on him, in his capacity as citizen, a proportionately larger burden of civic responsibility.
9. See, for example, C. Frankel, *The Case for Modern Man* (Beacon, Boston, 1959).
10. E. A. Burtt, *The Metaphysical Foundations of Modern Science* (Doubleday, New York, ed. 2, 1932), pp. 238–239.
11. For a striking recent example see the virulent attack on modern science in the final chapter of Arthur Koestler's *The Sleepwalkers* (Macmillan, New York, 1959).

Science Reporting—Today and Tomorrow

It's better than you may realize, but improvements are needed—and here's how they're being achieved.

John Troan

In its report "Education for the Age of Science" (*1*), the President's Science Advisory Committee notes:

"A democratic citizenry today must understand science in order to have a wide and intelligent democratic participation in many national decisions.

"Such decisions are being made now. They cannot be postponed for 20 years while we are improving our present educational system so that its products will constitute a significant fraction of the mature voting population.

"There is, therefore, no escape from the urgency of providing high-grade and plentiful adult education in science now, planned for those who are unprepared even in the fundamentals."

The committee makes it clear it is not referring strictly to classroom instruction for adults. Indeed, it lays emphasis on the mass communications media—newspapers, magazines, books, radio and television—for, like it or not, this is how most Americans receive their "postgraduate education."

How well are these instruments of informal education playing their part in making the American public scientifically and technologically literate? They are doing much better than many scientists and engineers realize. Yet they are not doing as well as many editors, publishers, and producers believe. Certainly, both the quality and quantity of science reporting in the United States have improved during the past quarter century. But there remains much room for further improvement—and serious efforts are being devoted to this end.

The author is science writer for the Scripps-Howard Newspaper Alliance, Washington, D.C.

Growth of Science Writing

Twenty-five years ago there were only 12 full-fledged science writers in this country—men who spent all or most of their working hours reporting news of science and technology. Today, the National Association of Science Writers (NASW)—founded in 1934 by these 12 to "foster the dissemination of accurate information regarding science"—has 372 members who are principally engaged in this endeavor. They form the backbone of the "science reporting team" in the United States. They write for newspapers and magazines. They write books. They edit magazines, books, journals, and newspapers. They serve as science information officers for universities and colleges, government and private research institutions, industrial research laboratories, pharmaceutical manufacturers, voluntary health agencies, medical societies, and other professional organizations in various fields of science. They give lectures. They teach science journalism.

In the group are reporters who specialize in writing science news for 48 newspapers in 32 metropolitan areas—Albany (N.Y.), Atlanta, Baltimore, Boston, Buffalo, Chicago, Cleveland, Columbus, Dallas, Detroit, Fort Worth, Houston, Kansas City, Los Angeles, Memphis, Milwaukee, Minneapolis, Newark, New Orleans, New York, Oakland (Calif.), Phoenix, Pittsburgh, Portland (Ore.), Salt Lake City, San Bernardino (Calif.), San Diego, San Francisco, Syracuse, Toledo, Washington, and Winston-Salem (N.C.). Also in this group are science writers for six major news agencies which serve virtually every daily newspaper in the United States. In addition, there are 18 nationally distributed magazines and two book-publishing firms represented.

Together, these science writers could reach almost every adult American reader. Yet, in reality, they don't. One reason is the fierce competition for space in newspapers and magazines. After all, readers are not interested in science alone. They are interested also in politics, sports, business, labor, society news, neighborhood doings, accidents, crime. And they want to be entertained, too—with comics, crossword puzzles, novels, other features. Thus, much science news which is written fails to get into print. It is shucked aside in favor of other news items which are deemed to be more appealing to the readers. To the scientist, this may seem deplorable. But it is a fact that cannot be wished away.

What Readers Want

How can this be remedied? First of all, more editors must be convinced that their readers want more news about more aspects of science than they now receive. Surveys (*2*) conducted for the NASW, under grants from the Rockefeller Foundation, have shown that many readers actually desire more science news—particularly on medical subjects but also on nonmedical topics—and would be willing to sacrifice some other news to make room for this.

Thanks to the Soviet sputniks, space allocated to news of science and technology has been increased appreciably in recent months. Of newspaper editors queried by the NASW and New York University (*2*), over 38 percent said they have *at least doubled* the space previously allotted to such news. Much of this represents increased coverage of "satellites and outer space." Other subjects which rate high among newspaper editors are "medicine and public health" and "atomic energy."

As might be expected, basic research receives relatively little news space. This is understandable. It is exceedingly difficult to explain to the lay reader, in clear and interesting fashion, that the Doppler shift is not a new football play, that nonconservation of parity has nothing to do with the farm soil-bank program, and that a pi meson is not something which can be eaten à la mode. Yet the truth is, a newspaper or magazine story stands little chance of being printed—and even less chance of being read—if it is not both clear and interesting.

Eugene Rabinowitch, editor of the *Bulletin of the Atomic Scientists*, has said (*3*): "Good science reporting is impossible as long as its purpose is assumed to be entertainment and not education. They [stories] cannot be only what people want to hear; they often must be what they ought to hear." There is an old saying, however, that even though you can lead a horse to water you cannot make him drink. Mere publication of a science news story is no guarantee it will educate anyone or make the general public more literate about science. To do any good, a story must capture the reader's interest and sustain that interest. In other words, it must be interesting as well as informative—entertaining as well as educational.

Ritchie Calder, a founder of the Association of British Science Writers, puts it this way (*4*): "Through entertainment you can get people interested in information; through information, in education; through education, in the intellectual exercise which is science."

"Whatever medium is used," the President's Science Advisory Committee points out, "science must, first of all, be made as interesting to the bystander as it is exciting and inspiring to the scientist. Citizens will not submit themselves to adult education in science simply as a response to bugle calls to duty. The excitement and interest of science must somehow be transmitted."

Scientists Must Help

An increasing number of science writers are ready and eager to do this. But the science writers cannot do the job alone. They need, to a much greater degree, the assistance of the scientists.

"Until more scientists whose reputations are high *as scientists* manifest a personal interest in public education in science," the President's Committee observes, "the stigma which now is often attached to the popularizer will never be removed—nor will the doubts of those who put the task aside as hopeless."

Calder insists: "The first essential in making science understandable to the public [is] that the scientist should be persuaded to forget his jargon and make his work, or help others to make it, intelligible to the layman."

As the editor of the *Bulletin of the National Society for Medical Research* once put it (*5*): "The only way to prevent understanding of science is to interpret it as though it were a secret ritual practiced only by obtained scientists."

Warren Weaver has summed up this problem very succinctly (*6*). "[Some] scientists," he says, "feel the urge to attach to each general statement of a popular exposition all the cautionary qualifications, all the modifying details, and all the scholarly footnotes that they would use in a technical report." This, of course, is not only impossible; to attempt it is absurd. As Alton Blakeslee, science reporter for the Associated Press, has expressed it (*7*): "We must remember that not all of us 'speak chemistry' or 'speak psychiatry' or Hindustani or French. Our knowledge does not become a communicated idea if it must push through a briar patch of sticky words."

"The scientist's facts are inalienably his," Calder says, "but their presentation [to the lay audience] must be subject to the knowledge and skills of those experienced in a communication of ideas, whether in the newspapers, on radio or television, or in films."

Weaver suggests that scientists, in describing their activities to the public, "consider the concept of communicative accuracy. . . . A statement may be said to have communicative accuracy, relative to a given audience of readers or hearers, if it fulfills two conditions. First, taking into account what the audience does and does not already know, it must take the audience closer to a correct understanding. . . . Second, its inaccuracies (as judged at a more sophisticated level) must not mislead, must not be of a sort which will block subsequent and further progress toward the truth. Both of these criteria, moreover, are to be applied from the point of view of the audience, not from the more informed and properly more critical point of view of an expert."

In brief, the scientist cannot indulge in intellectual incest. To get his ideas across to the ordinary citizen he must employ the language of the ordinary citizen. In this vital endeavor to hurdle the barrier between scientist and layman, the science writer is more than willing to perform the role of what Kathleen Lonsdale (*8*) calls "the scientific liaison officer."

Of course, the path is strewn with hazards. Because a science writer cannot put all of the ands, ifs, and buts into his story, 100 percent technical accuracy frequently is not achieved. "This problem," notes Arthur J. Snider, science editor of the Chicago *Daily News*, "can never be wholly solved because there is no exact lay translation for the precision of science. Science requires that findings be carried out to 10 decimal places; newspapers like round figures."

Nevertheless, the conscientious science writer is anxious not to misquote, not to misstate, not to mislead. After all, his own reputation as a writer and reporter is at stake. He doesn't want to make a fool of himself in public if he can help it.

How Writers Keep Abreast

To decrease the risk of error, science reporters constantly are boning up on the subjects about which they write. Many of them read more scientific journals, visit more research laboratories, and attend more scientific meetings than most scientists can. They go to special "background briefings" which are being offered to newsmen by an increasing number of scientists, especially in the large metropolitan areas. (In Washington, for example, scientists with the National Aeronautics and Space Administration, Naval Observatory, U.S. Public Health Service, National Bureau of Standards, American Institute of Biological Sciences, and Department of Defense have briefed newsmen, in recent months, on such subjects as celestial mechanics, the lunar sciences, radiation, rocket propulsion, space flight, cellular biology, bioastronautics, free radicals, and molecular engineering.)

They attend "open houses" at industrial research laboratories where they can hear lectures and witness demonstrations on such topics as thermoelectricity, computers, electroluminescence, infrared and ultraviolet, cancer chemotherapy, and antisubmarine warfare.

They attend science seminars—such as the recent ones sponsored by the Nieman Foundation, Massachusetts Institute of Technology, Harvard University, and the American Institute of Physics. (Sample program of one three-day seminar: Science education, nucleic acids, genetics, virology, brain chemistry, hormones, transplantation of tissue, geology, astronomy, magnetohydrodynamics, meteorology, radioactive fallout, solid-state physics, interplanetary communications, metallurgy, anthropology, nuclear disarmament—and how to go without sleep for 72 hours.)

They attend science writers' institutes—sessions devoted to improving the techniques of communication as well as adding to the knowledge of the reporters—such as those sponsored recently in Syracuse and Cincinnati by the American Medical Association and the NASW, and at New York University and the University of North Carolina by the National Science Foundation.

In between, they also manage to do enough writing to keep their jobs—although some get sabbatical leaves to go back to school for a year, as, for example, under the Nieman Fellowship program at Harvard and the Advanced Science Writing Program at Columbia University, which is sponsored by the Alfred P. Sloan and Rockefeller foundations.

How About the Editors?

The fact that so many science reporters are able to undertake so many "extracurricular" activities is, in itself, evidence of their desire to improve the quality of their own work. It is also a barometer of the increasing interest their editors are displaying in the coverage of science news.

Yet the speciality of science writing is of such recent vintage that most editors, particularly those in the smaller cities, have not had personal experience in this type of reporting, as they have had in reporting politics, crime, and other news. It is only natural, then, that they are somewhat less science-oriented than a scientist would wish them to be. Fortunately, the National Science Foundation is helping to remedy this. Recently, under an NSF grant, the University of Louisville, the Louisville *Courier-Journal*, and the Louisville *Times* sponsored a "science news workshop" to which editors, as well as reporters, were invited.

As a result, the editors themselves got to rub shoulders with the scientists. They were able to visit some research labs and to exchange views with the researchers. They even "tried their own hands at scientific reporting" during the two-day-workshop (*9*).

One of the editors at this session remarked he was "a little bit stronger for basic research after hearing this gentleman"—a scientist—describe a study involving "heat-carrying qualities of thin metallic films at different temperatures."

Also noteworthy was the fact that most of the editors, without any prompting from outsiders, seemed to agree with William P. Steven, executive editor of the Minneapolis *Star* and *Tribune*, that "there is no shortcut to science coverage" and that such reporting must be made a journalistic specialty; "you've just got to have a man whose interests and intelligence equip him for explaining new things."

This "seed money" from the NSF is bound to bear rich fruit, for it has been planted in a fertile field. Workshops of this sort should encourage more editors to provide more space for science news and to assign the coverage of such news to better qualified reporters. In the end, the public should acquire a greater and broader understanding of science and technology. Thus, the public cannot help but become more scientifically literate.

The NASW Program

But the problems of communicating science to the public are so varied and so complex that there is no single, simple solution. This is why the NASW, after a special study, initiated in 1958 a nine-point program to improve the quality and quantity of science writing in the United States.

This "program for the public understanding of science" (*10*) pin-pointed nine "areas of need," which were summarized thus:

1) The further training and development of established, experienced general reporters on newspapers and of magazine and TV-radio writers—men who have demonstrated their ability to write and report effectively and now are interested in becoming full-time science reporters.

2) The further training and development of established, experienced general reporters on smaller daily newspapers, to equip them to handle science news—especially local science stories—on a part-time basis, to assume editorial responsibility for the paper's use of syndicated or news-service science material, and to share responsibility for editorial comment on science-related public problems.

3) The development of science-writing curricula for undergraduate journalism students, the design of science-writing courses, and the inclusion of more academic science training in the programs of all journalism students, whether or not they indicate any desire to specialize in some phase of science reporting.

4) The development of science-writing curricula and seminars, including some academic training in science and "on-the-job" experience in science reporting, in graduate schools of journalism.

5) Support for established, experienced science writers of demonstrated

merit who wish to devote a half-year or more to study, travel, formal or informal contact with scientists, and so on, to increase their competence.

6) The design of programs to train additional writers to serve public information functions in science for research institutes, medical schools, industrial scientific and technological concerns, voluntary health agencies, and other organizations which conduct programs of scientific research and development.

7) The elaboration of programs to develop science-writing techniques, and trained science-writing personnel, for television, together with research and development aimed at increasing use of audio-visual aids for other forms of science reporting.

8) The organization, on a systematic and continuing basis, of press institutes and seminars to inform newspaper and magazine publishers, managing editors, and newspaper city editors of current developments in science, of the importance of science news, and of the possible methods of presentation of science news and comment.

9) Continuing research on the science-news audience, on the effectiveness of varied techniques and methods of presentation, and on what might be called the "social digestion" of science news—the ways and the groups in which specific information on science is discussed, debated, and evaluated in the citizen's decision-making processes.

To implement this program, a new nonprofit organization was incorporated under the aegis of the NASW last January in the state of New York. Called the Council for the Advancement of Science Writing (CASW), it is empowered to encourage, promote, initiate, coordinate, and even direct projects designed to increase the quantity and improve the quality of science reporting in the United States—or, for that matter, anywhere else in the world.

The board of directors of the CASW (*11*) will include representatives of the NASW, the American Association for the Advancement of Science, the National Academy of Sciences–National Research Council, journalism schools, the medical profession, newspaper editors, and the magazine, book, and radio-TV industries.

At its charter meeting, the CASW assigned top priority to points 2 and 8 on the NASW list, reflecting a conviction that these are the two areas of primary concern at the moment. But no opportunity to advance the scientific literacy of the American public will be overlooked. For as Glenn Frank, the late president of the University of Wisconsin, once stated (*12*): "The practical value of every social invention or material discovery depends upon its being adequately interpreted to the masses. The future of scientific progress depends as much on the interpretative mind as it does upon the creative mind. . . . The interpreter stands between the layman, whose knowledge of all things is indefinite, and the scientist, whose knowledge of one thing is authoritative. . . . The scientist advances knowledge. . . . The interpreter advances progress. . . . History affords abundant evidence that civilization has advanced in direct ratio to the efficiency with which the thought of the thinkers has been translated into the language of the masses."

References and Notes

1. President's Science Advisory Committee, "Education for the Age of Science" (1959).
2. H. Krieghbaum, *Science* **129**, 1092 (1959).
3. President's Committee on Scientists and Engineers, *News Round-up* **1**, No. 15 (1957).
4. R. Calder, "News in the field of science—The case for presentation," *World's News Press, Suppl.* (1959).
5. Personal communication.
6. W. Weaver, *Science* **127**, 499 (1958).
7. A. Blakeslee, *Mental Hospitals* **10**, 13 (1959).
8. K. Lonsdale, *Bull. Atomic Scientists* **14**, 242 (1958).
9. J. Meehan, *Editor and Publisher* **93**, 11 (1960).
10. Report of the Committee on Fellowships and Scholarships, National Association of Science Writers, "Science, the Press and the Citizen" (1958).
11. The board of incorporators of the Council for the Advancement of Science Writing consists of: Roland H. Berg, *Look* magazine; Victor Cohn, Minneapolis *Tribune*; Donald J. Dunham, Cleveland *Press*; Pierre C. Fraley, free-lance science writer, Phoenixville, Pa.; H. Jack Geiger, Newspaper Enterprise Association; Nathan S. Haseltine, Washington *Post and Times Herald*; Hiller Krieghbaum, New York University; Martin Mann, *Popular Science Monthly*; John Troan, Scripps-Howard Newspaper Alliance; and Earl Ubell, New York *Herald Tribune*.
    The board of directors, which is to take over direction of the CASW from the incorporators, is in process of completion. Among those elected so far are: Howard Allaway, editor of *Popular Science*; Paul Block, publisher of the Toledo *Blade*; Leonard Carmichael, secretary of the Smithsonian Institution; John R. Dunning, dean of engineering, Columbia University; Irving Gitlin, program executive, creative projects, Columbia Broadcasting System; Gerald Holton, professor of physics, Harvard University; Sidney S. Negus, professor of biochemistry, Medical College of Virginia; Irvine H. Page, Cleveland Clinic; W. Bradford Wiley, president, John A Wiley & Sons; Geiger, Krieghbaum, Troan, and Ubell.
12. This statement was quoted by L. R. Hafstad in a talk on science, technology, and society at the annual meeting of the AAAS, 1956.

Science in the News

Cut in Funds for Stanford Accelerator More Apparent than Real

Some confusion has accompanied the Joint Congressional Committee on Atomic Energy's refusal, for the second year in a row, to fully authorize construction of the giant Stanford electron accelerator. For, despite a fearful looking slash from the $107 million requested to the $3 million finally approved by the Joint Committee, the project will probably go through with no more than a negligible delay.

This single project will roughly double the government's program in support of research in high-energy physics, and the machine is only the first of several very expensive ultra-high-energy accelerators which will probably be started within the next few years as scientists probe deeper and deeper into the ultimate nature of matter.

The machine will be housed in a tunnel 2 miles long. A beam of electrons will be shot out of an electron source at one end of the tunnel with an initial energy of a few thousand electron volts. When they hit the target 2 miles away they will be traveling at speeds in the range of 99.99 percent of the speed of light, and will carry energies of 10 to 15 Bev (10 to 15,000,000,000 electron volts). The machine will be built so that it can be modified at some later date to