♦Sharing Ways to Communicate Science

Scientists and scientist-editors are, by nature, a curious lot, always looking for new ideas and new ways to approach problems and tasks. For those curious about the strategies their colleagues are using to communicate science to various segments of the public, we invited some of the more successful practitioners to share their ideas and approaches.

MM Tacker

AAAS: Keeping the Public in Mind

Floyd E Bloom
Editor-in-Chief
Science
Washington, DC

Cynthia Lollar
AAAS News & Information
Washington, DC

At *Science*, it has always been the editor's purpose to improve the public's understanding of science. The magazine was launched in 1880 by a science journalist, John Michels, and the American inventor, Thomas A Edison—2 men who not only loved science for its own sake, but who understood that their personal livelihoods depended on the public's enthusiasm for what they did. In fact, in the early years of the journal, American science was practiced as much by regular citizens as by professionals. These educated amateurs collected rocks, watched the stars, and contributed to findings presented at local scientific societies. The professionals themselves were strongly motivated by a sense of public service—science was going to help bring America out from the long shadow of its European forebears. And so it has.

Today, public funding of science accounts for a significant portion of the enterprise. It therefore behooves us as journal editors to keep the public not only informed but intrigued with how science affects their everyday lives and the future of human society. As the primary conduit through which information about science reaches the general public, science journalists remain our strongest ally. Rather than simply carping about those who do the job poorly we should be actively encouraging excellence in the field. More than 700 reporters from around the world receive weekly summaries of upcoming research in *Science*, complete with access to advance copies of the manuscripts and other forms of help. The American Association for the Advancement of Science (AAAS), which publishes *Science*, administers an annual science journalism award for broadcast and print media that is considered by many science journalists to be the pinnacle of their profession. AAAS has also launched a new Website called EurekAlert! that is designed to bring news about advances in science, technology and health from around the world to 1 place on the Web, so that journalists can do their jobs even more efficiently and accurately, and the public can further satisfy its appetite for science news.

Remembering the importance of the general public reminds us that science doesn't occur in a vacuum—it requires the energy and ideas of young thinkers. Encouraging young people into careers in science is perhaps not a primary purpose of *Science*, but it is an important corollary to our publication strategy. One way we have approached this is through certain features added to our newly launched online version of the journal: *Science's Next Wave*, a kind of virtual water cooler where young scientists can gather and exchange information with more established scientists on how to build their careers, and the *Science Professional Network*, which provides information about jobs, careers, and scientific meetings. Another feature, *ScienceNow*, offers brief, readable summaries of the day's most significant science news. Moving *Science* online was itself indicative of our interest in reaching a wider audience. The Internet has proven to be one of the most democratic mediums yet devised by science. It only makes sense to pull up a chair at this increasingly bountiful—and accessible—table.

In the end, though, perhaps journal editors need only 1 reason for making an extra effort to communicate science to the public. We love science, with all its mysteries, pitfalls, and promises. And like any passion, it demands to be shared.

CDC: Getting the Word Out About Health

Vicki S Freimuth
Associate Director for Communication
Centers for Disease Control and Prevention
Atlanta, Georgia

Chronic and infectious diseases kill or affect hundreds of thousands of people each year, despite existing information on ways to prevent and detect these diseases. Effective communication about health requires a translation of complex and technical science into content that can be used and understood by the public.

Scientific information may reach the public indirectly in a number of ways. The first is through gatekeepers who control access to mass-media channels, often science reporters and their editors at major broad-

cast and print organizations. Typically, a scientific organization has an office that translates research findings into a form appropriate for these gatekeepers and the public they ultimately serve. At the Centers for Disease Control and Prevention (CDC), for example, the Office of Communication serves this role. The Office translates for a general audience each article published in the *Morbidity and Mortality Weekly Report (MMWR)* into a single paragraph that highlights the major messages. These summaries, along with names of scientists who may be interviewed, are delivered to the major media outlets before the *MMWR* is released. The gatekeepers decide whether these articles receive any coverage and what the slant will be.

Tensions often exist among scientists, science reporters, and editors as to what health information is appropriate to cover. Scientific research is a slow process in which knowledge is built incrementally, and yet media like to cover sensational, fast-breaking events. Mass media depend upon the revenue of their advertisers, making them vulnerable to that influence. Many researchers claim, for example, that mass media's coverage of the dangers of smoking has been limited because of the fear of alienating large cigarette advertisers.

Despite these tensions, new scientific findings do get considerable, but sometimes ineffective, coverage in the news media. Because air time and print space are at a premium, information must be tightly packaged, which can result in oversimplification of health messages. Coverage is rarely sustained for more than a few days, and it seldom focuses on what individuals should do to improve their health.

Another route to informing the public and influencing individual and community decisions that enhance health is through carefully planned communication programs. Strategies include targeting messages to specific segments of the public, using multiple channels to reach these audiences, and sustaining these efforts over a long period of time. Some examples are HIV and cancer-prevention campaigns; high blood pressure and cholesterol detection and control programs; and anti-smoking, anti-violence, and anti-substance-abuse campaigns. These approaches afford more control over the content of the messages, but they still rely on gatekeepers to air or print the messages. Usually these communication programs also depend on community involvement.

Fortunately, a discipline called health communication has developed around the challenges of communicating complex technical and scientific information to the public. Health communication draws from a number of principles in the fields of mass communication, health education and promotion, social psychology and other social sciences, and marketing. By combining the successful strategies of a variety of disciplines, it plays a critical role in reaching the public and improving health status.

NASA: Reaching for the Stars

Rosalind A Grymes
Manager
Space Life Sciences Outreach Program
Life Sciences Division
NASA Ames Research Center
Moffett Field, California

The NASA Life Sciences Division Outreach Program has innovated a diverse and comprehensive suite of projects designed to communicate science to its shareholders, the American public. Several ongoing projects provide training to teachers (grades K-12 plus community colleges) and demonstrate singular approaches we hope others will adopt. Our STELLAR workshop brings teachers into laboratories at Ames Research Center as colleagues of life-science researchers and engineers. This experience, which enhances the capabilities of classroom educators and is unusual, receives remarkable enthusiasm among both teacher and mentor participants. STELLAR also engages the teachers in creating, evaluating, and refining classroom activities based on their NASA experiences, which are disseminated (hardcopy and electronically) nationwide, increasing the number of teachers who receive the STELLAR experience.

The teachers' workshop in the Johnson Space Center's Life Sciences Electronic Classroom combines space life-sciences information and activities for the classroom with training and support in the current ways to share information. NASA works at the information-systems frontier; daily we use personal computers, distributed systems, remotely acquired data, and video and teleconferencing. Our familiarity with these technologies and communications skills matches precisely the needs of K-12 teachers, particularly those serving remote rural communities. To help underserved communities, this project highlights partnerships with schools serving Native American students.

Other projects bring NASA to the public. The Scott Carpenter Research Station is a space/ocean analog demonstration habitat being constructed at Kennedy Space Center. It will bring live research to public and classroom audiences. Completely contained and transportable, the Habitat will be installed at Florida's Sea World; the aquanaut inhabitant will simultaneously be in communication with classroom participants (and to astronauts aboard the Shuttle, as downlink time allows). These real-time exchanges can foster comparisons between the undersea Habitat and the Space Transportation System that

remind students of the challenges that beckon us onboard Spaceship Earth and beyond.

Telecommunications are the key to a project bringing NASA's Life Sciences expertise to the Navajo Reservation. Navajo Community College, a tribally controlled community college, serves a 26 000 square-mile area with campuses and ancillary sites, and is a resource central to the Navajo people. After implementing effective Internet and intranet hardware connections, we are now in the 2nd phase of the project funded by the Air Force Office of Scientific Research. In this phase, we are concentrating on matching Space Life Science interests in remote learning and telemedicine with the needs and capabilities of the community college.

Our major effort to distribute the results of the Space Life Sciences enterprise to our shareholders uses the Internet. In designing and populating our Website (http://weboflife.arc.nasa.gov), we tried to illustrate human exploration themes and provide 1) relevant materials to educators, 2) interesting, timely, and informative articles, 3) selective links, 4) a scientific and technical newsroom, and 5) interactive projects for space-flight missions (check out http://quest.arc.nasa.gov/smore). Our Website is continuously under improvement; watch this site, and pardon our (interstellar) dust.

In these projects, and more, partnership is the key to success. Partners leverage resources, invigorate ideas, broaden support, and reach complementary audiences. We welcome new partners; contact the author via rgrymes@mail.arc.nasa.gov or call 415-604-3239.

Howard Hughes Medical Institute: A Successful Series on Science

Robert A Potter
Director of Communications
Howard Hughes Medical Institute
Chevy Chase, Maryland

The public understanding of science is a phrase that has been around for so long that most of us tired of it long ago. Like the weather, it's talked about a lot, but nobody ever does anything about it. To top it off, as Dan Greenberg, the *enfant terrible* of science journalism in Washington, DC, said to me many years ago, "The reason people don't understand science is that they have better things to do."

Public understanding is a constant topic of conversation in science organizations and at gatherings of scientists in this country and, increasingly, around the world. I had a visit during the past summer from the communications director of a large government funding agency for science in Germany; the subject was the public understanding of science.

It is no secret that scientists and science administrators begin thinking seriously about the public understanding of science when funds start dwindling. It is a natural connection: If "the people" understood us and what we are doing, then we would certainly have no trouble finding money to finance our research or other activities. It was this problem that brought my visitor from Germany to the United States to find out how organizations here are so successful in creating support for funding; in Germany, her agency is supported by several of the individual German states, as well as by the federal government.

Ten years ago, I joined the staff of the Howard Hughes Medical Institute, whose headquarters is just outside Washington, DC, in Chevy Chase, Maryland. As their 1st director of communications, I have been able to build rather than inherit a program. Fortunately, the president of the Institute, Purnell W Choppin, has been supportive of a public-education function for the office of communications. As a result, we have been able to create a series of publications that is a model for any organization interested in a serious effort in public understanding, no matter the particular field of science.

The series comprises, to date, 6 reports "for a general audience" on various aspects of molecular biology; all of the reports are 4-color, beautifully designed, and filled with exciting illustrations and photographs. The first, titled *Finding the Critical Shapes,* was about structural biology and included a bound-in stereopticon that could be used to see a series of computer-simulations of the structures of important biological molecules, including one that won a Nobel prize. Subsequent reports have been on genetics, early childhood development, blood, the senses, and infectious diseases.

The Institute was fortunate to persuade Maya Pines to join the staff as a senior science editor who conceptualizes, plans, and brings these reports to fruition. She is one of the most outstanding science writers in the United States, and if you think that is hyperbole, just take a look at these marvelous reports. Through this series, Pines demonstrates what can be done when a creative writer and editor is given the freedom and the resources needed to attack the public understanding of science in a serious way.

We set out to produce reports that would make the scientific work of the Institute accessible to a wide audience. The Institute is the largest philanthropic organization in the United States, with an endowment that is approaching $10 billion. It is not a foundation, but a medical-research organization that hires scientists at universities, academic medical centers, and other research organizations throughout the United States. These scientists, who must have a faculty appointment, are employees of the Institute working in Institute laboratories

with an Institute budget that supports their research, equipment, and so forth. There are currently 280 Hughes investigators, all of whom work in genetics, cell biology, neuroscience, structural biology, or immunology. The publications, however, are not limited to reporting the work of Institute investigators.

The level of writing that we aimed at was that of the *New York Times*' Tuesday science section, which means that something—but not too much—is required of the reader. The vocabulary can be difficult, but it is spoon-fed to the reader, and most people can get through the articles readily, if they stick with it.

We printed 30 000 copies of the 1st report, the one on structural biology, and distributed it to a general mailing list including senators, members of Congress, medical-school deans, corporate research directors, among others—and high-school teachers of biology. The response from the teachers was amazing, and within weeks we had reprinted an additional 15 000 copies.

When we published the 2nd report, titled *Blazing a Genetic Trail*, we started out at 45000 copies and ended up publishing a total of 90 000; in addition, it was translated into French and, much later, a portion of it was republished by the National Institute for Genomic Research. We ended up binding in a card that enabled teachers to request up to 3 more copies by mailing it in, together with instructions on how to obtain a classroom set of 30 copies. The latest report, *The Race Against Lethal Microbes*, had a print run of 150 000 copies.

More than 5000 class sets of the individual publications have been distributed, primarily in the United States, but also to teachers in many countries around the world. The public schools in Scotland requested a classroom set for every biology teacher in the country, a request that we politely declined. We did, however, agree to treat Scottish teachers the same way we treat American teachers: We sent all of them 1 copy, and if they were interested they could request a classroom set.

We have done 3 surveys of the teachers who requested class sets to find out how they were used. The results were gratifying. The teachers, by and large, keep careful track of the publications and use them year after year. Indeed, many teachers have requested replacement sets because the original copies had become too scraggly. It is clear that the publications are used in a serious way in the classrooms and that many teachers design subsequent modules that center on the Institute reports.

It is not just teachers who use the publications, however. We receive (and honor insofar as possible) hundreds of requests from universities, medical schools, biotech companies, and similar organizations that hold open houses and offer educational experiences for the general public. We have sent thousands of the publications to science museums, such as The Exploratorium in San Francisco, for use in special events.

The reason the teachers are so enthusiastic about these reports is that they are lively, well-written, up-to-date, and sometimes even exciting. The fact that they are free is important, but it does not explain the incredible demand we are experiencing for the reports—in fact, many teachers offer to pay for them out of their own pockets.

We would be happy to send copies to anyone who is interested. We are more than willing to talk with anyone about our experiences in producing and distributing this wonderful series of publications of which we are inordinately proud. Please contact Robert A Potter, Director of Communications, Howard Hughes Medical Institute, 4000 Jones Bridge Road, Chevy Chase MD 20815-6789 (Tel: 301-215-8856).

NAS: An Experiment in Communicating About Basic Research

Donna M Gerardi
Director
Office on Public Understanding of Science
National Academy of Sciences
Washington, DC

As professional editors, you are committed and challenged to bringing accurate, timely, and high-quality scientific information to your readers, most of whom are not only interested in but are well-informed about science. They know some of science's facts (we can never know them all!), but more important, they know its nature and processes and its tentativeness, especially at its frontiers.

A greater challenge is to provide interesting and accessible information about science to the nonscientifically trained lay public, with the goal of helping them understand what science is. I believe that there is an appetite for this information, since by many measures, although the public is quite interested in science, it does not understand science very well. There are many reasons for wanting to provide high-quality and accessible information: it is interesting, intellectually challenging, and important that people have an appreciation of the ways that science and technology influence their lives. Whatever the reason(s) might be, the question eventually becomes, how do we do this?

Since the middle of 1996, the National Academy of Sciences (NAS) has been producing brief case studies about basic research through a project called "Beyond Discovery: The Path From Research to Human Benefit". This project emerged out of a concern by senior scientists that many sectors of the general public did not really understand the value of basic research.

"Beyond Discovery" is intended to identify and trace the origins of important recent technologic and medical advances and to reveal the crucial role played by basic research, the applications of which could not have been anticipated at the time the original research was conducted. An advisory committee of Academy members selects topics that, collectively, cover the breadth of science. The first 4 topics describe the basic research that led to human-gene testing, discovery of the ozone-depletion phenomenon, the global-positioning system, and modern communication: the laser and fiber-optic revolution.

Developing each topic is an iterative process that includes senior scientists who were involved in the discoveries being described working with professional science writers who aim to write compelling articles for a nonexpert audience. Those manuscripts are then subject to extensive reviews by many other scientists. Their usefulness as a vehicle for helping the public, as well as policymakers, science educators, and scientists reading out of their fields, is now being tested.

The main audiences are policymakers (to inform them about the contributions of basic research to current technologies and human benefits); science educators (to supply information and models for communicating or teaching about basic research); scientists (to increase interest in and models for communicating about research to the public); and the college-educated, nonscientifically trained lay public (to build awareness of the value of basic research). We now print 10 000 copies of each topic, which are distributed to policymakers, science and technology centers and museums, science educators, and a growing list of scientists. Our distribution strategy continues to evolve, and we have plans to target audiences that have a particular interest in a given area. For example, the human-gene testing document was distributed broadly to cancer-research centers and disease-related advocacy groups.

All topics are accessible in both HTML and PDF formats through our Website (http://www2.nas.edu/bsi), where we are in the process of making links to other related Websites. We also invite feedback directly to an e-mail address, a strategy that has produced scores of useful comments.

As this project continues, I, as project director, would be most interested in hearing your feedback about the utility of this kind of information. You can 1) access the Web versions of each topic by going to the Website noted above, and 2) request hard copies of the topics produced to date by sending an e-mail to bsi@nas.edu. After you have had a chance to review the topics, you are invited to send your comments directly to me by e-mail (dgerardi@nas.edu).

♦Resources on Popular Science Communication

Barbara Gastel
Associate Professor
Texas A&M University
College Station, Texas

Jason E Moore
Graduate Student
Texas A&M University
College Station, Texas

Many books and articles offer practical guidance in presenting science to the public. Likewise, a considerable body of scholarly research exists on popular science communication. Listed below are written materials that offer guidance and research as well as anthologies, newsletters, and electronic resources in the field. Although not exhaustive, the annotated list includes many of the main US resources on popular science communication and some British writings. We welcome suggestions of major resources to include in possible future versions of this list.

Guidance

Medical journalism: the writer's guide to getting published. T Albert. New York: Radcliffe Medical Pr; 1995. 127 p. American adaptation of British primer on popular medical writing; intended primarily for physicians but also suited for other readers.

Science writing today and tomorrow. P Barnes-Svarney. The Writer 1994 Nov;107(11):15-7. Basic guidance from a scientist turned science writer.

Late night thoughts about science writing. A Blakeslee. Quill 1994 Nov/Dec;82(9):35-8. Pointers from a longtime science journalist.

A field guide for science writers. D Blum and M Knudson, editors. New York: Oxford Univ Pr; 1997. Science-writing handbook intended largely for students and young reporters; includes guidance on writing for various media and covers various fields.

News & numbers: a guide to reporting statistical claims and controversies in health and other fields. V Cohn. Revised ed. Ames (IA): Iowa State Univ Pr; 1994. 190 p. By a long-prominent science reporter; especially strong on topics such as evaluating study design.

Writing science & medical nonfiction: it's easier than you think. MS Dahir. Writer's Digest 1995 Nov;75(11):29-31. Basic guidance for those new to popular science writing.

Presenting science to the public. B Gastel. Philadelphia: ISI Pr; 1983. 146 p. Intended mainly for scientists; includes guidance on working with reporters and on communicating science to the public directly.

Health writer's handbook. B Gastel. Ames (IA): Iowa State University Press; in press. Guidance on popular medical writing; areas addressed include information gathering, writing style, ethical issues, and careers.