



Best Practices for Communication of Science and Technology to the Public

CONFERENCE PROCEEDINGS

March 6-8, 2002 • Gaithersburg, Maryland • USA



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Communicating the Future: Best Practices for Communication of Science and Technology to the Public

Conference Proceedings
March 6-8, 2002

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This publication contains transcripts of speakers' remarks at the conference on Communicating the Future: Best Practices for Communication of Science and Technology to the Public held at the National Institute of Standards and Technology, Gaithersburg, MD, on March 6-8, 2002. The opinions expressed in this report should be attributed to the conference steering committee or individual conference speakers and do not imply endorsement or agreement by the National Institute of Standards and Technology.

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Abstract

Communicating science and technology to the public has become an essential enterprise for research universities, government agencies, science museums, foundations and granting agencies, other non-profit scientific organizations, and corporations. To advance the state of the art, a conference on Best Practices for Communicating Science and Technology to the Public was held March 6-8, 2002, at the National Institute of Standards and Technology in Gaithersburg, Md., with major funding provided by the U.S. Department of Energy Office of Science.

This report of the conference proceedings includes a summary statement by the conference steering committee, transcripts or other text summarizing the remarks of conference speakers, and abstracts for 48 "best practice" communications programs selected by the steering committee through an open competition and a formal peer review process. Additional information about the 48 best practice programs is available on the archival conference Web site at www.nist.gov/bestpractices.

Keywords: science communication, technology communication, public communication, science journalism, public relations, media relations, public information, best practices, science literacy, Web sites, World Wide Web, exhibits, news media, science museums, evaluation, communications research.

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select the best practice communications programs, and review and author the conference summary. Thanks to the speakers and poster presenters for sharing their "best practice" programs with us and for providing materials for both this report and for the archival conference Web site at www.nist.gov/bestpractices. And finally, thanks to staff members of the National Institute of Standards and Technology for hosting the conference and handling production of this report and the conference Web site, especially Patrice Boulanger, Jennie Covahey, Stephanie Edwards, Susan Ford, Sandy Gray, Rebecca Green, Gail Porter, Crissy Robinson, Sharon Shaffer, Kim Snouffer, and Kelly Talbott.

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Communicating the Future: Best Practices for Communication of Science and Technology to the Public

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Conference Summary

Tonight Show host Jay Leno is walking around the streets of Los Angeles asking random adults questions about science.

"How long does it take the Earth to go around the sun?" he asks. "Twenty-four hours," two people in succession reply.

"What causes the tides?" he asks. "Boats?" his next victim replies. "Fish?"

Leno's informal survey was highlighted by Paula Apsell, executive producer of the public television program *Nova*, in a keynote talk to the 280 participants of the conference, Communicating the Future: Best Practices for Communication of Science and Technology to the Public.

Held March 6-8, 2002, at the National Institute of Standards and Technology (NIST) in Gaithersburg, Md., with major funding from the U.S. Department of Energy, the conference provided a forum for science communicators, educators, and researchers to share both their successes and their frustrations in communicating the results of research advances to lay audiences.

The at times startling ignorance of average U.S. adults of basic scientific facts has been well documented by annual surveys conducted by the U.S. National Science Foundation.¹ For example, 50 percent of U.S. adults surveyed don't know that it takes a year for the Earth to orbit the sun. Similarly, 50 percent of respondents believe that early humans lived at the same time as the dinosaurs and that atoms are smaller than electrons. Jon Miller, director of NSF's science literacy surveys for many years and director of the Center for Biomedical Communications at Northwestern University Medical School, concludes that fewer than one in five Americans meet a minimal standard of civic scientific literacy.²

Many in the scientific community believe that a lack of knowledge about science and technology is a major obstacle preventing increases in government funding of research. Another commonly held view is that science literacy is a major factor in discouraging students from choosing science or technology careers. Still others point out that widespread science illiteracy makes a large segment of the public vulnerable to the claims of charlatans who promise "miracle" results in

losing weight or for improving life's decision-making through the wonders of astrology.

However, connections between science literacy and the well-being of the nation's research enterprise or society in general that may seem like common sense are, in fact, more complex than the simple statements above imply.

A wide range of scientific institutions—from corporations to hospitals to government agencies—have initiated science communications programs for the public because they believe that increased knowledge of the organization's role in advancing research will improve the institution's reputation, making it easier to gain public support for other organizational goals. Finally, many public science and technology communications programs—particularly those conducted by government laboratories or universities—are grounded in the principle of the "public's right to know." Since a large percentage of scientific and technical research is funded with tax dollars, the institutions and the researchers using those funds have an obligation to explain to the public in understandable language how that money has been used.

Regardless of *why* research institutions and other organizations carry out science and technology communications programs for the public, the Best Practices conference steering committee (see page vi) of science communicators, journalists, and researchers approached its task of identifying model communications programs from the following perspective:

Given that many research institutions and other science-oriented organizations such as museums *do* conduct public communications programs, what does the communications research literature tell us about the most effective ways to carry out these programs, and how can we apply this knowledge to help select model programs or "best practices" that can be adopted by a wide range of institutions?

Historical Context

In 1998, the Space Sciences Laboratory at the National Aeronautics and Space Administration's Marshall Space Flight Center in Huntsville, Ala., chartered a 16-member working group to identify the most compelling questions still to be answered by the

academic science and technology communications research community.³ The group also was asked to compile examples of best practices in science and technology communications programs as implemented by research institutions across the United States or abroad. The laboratory planned to use the committee's findings to determine high-priority communication research areas for future funding and to apply best practice lessons learned from other organizations to improve its own and NASA's communications programs.

The Research Roadmap for Communicating Science and Technology in the 21st Century Working Group included science communicators, communications researchers, journalists, and scientists. Dubbed the R2 group, the panel met eight times over the next three years. Locations for these meetings included La Jolla, Calif.; Woods Hole, Mass.; Washington, D.C.; Chicago, Ill.; Santa Cruz, Calif.; Durham, N.C.; Huntsville, Ala.; and Jacksonville, Fla.

Each meeting was hosted by a different research organization.⁴ Science communicators, journalists, and researchers from government laboratories, universities, newspapers, foundations, non-profit organizations, public relations firms, and museums were invited to make presentations to the committee about their programs, science coverage, and communications research efforts. The meetings were open to attendance by journalists and the public. In addition, the R2 committee solicited comments from members of groups such as the National Association of Science Writers, the Council for the Advancement and Support of Education, and the International Association of Science Writers.

The R2 group also used part of its NASA Marshall funding to sponsor five original research projects. These projects included comprehensive reviews of the science and health communication research literature;⁵ a study of U.S. public attitudes toward biotechnology and implications for improving science communications;⁶ a review of communications programs conducted by federal research organizations;⁷ and a study of how public information officers broker information exchange between scientists and journalists.⁸

The R2 group's major findings and recommendations were published in a special issue of the research

journal *Science Communication*, in a paper authored by R2 chairman, Rick Borchelt.⁹ The same issue of the journal included several papers describing research projects funded by the panel. (See a bulleted list of findings on page 6.)

With the research agenda portion of its mission complete, the R2 panel had planned to host a major peer-reviewed conference to feature model science and technology communications programs. Funding constraints at NASA Marshall, however, forced postponement of these plans until alternative funding for the conference could be secured.

A 'Best Practices' Conference

In April 2001, the U.S. Department of Energy's Office of Science and the National Institute of Standards and Technology formally agreed to co-sponsor the conference originally envisioned by the R2 panel, with major funding being provided by DOE and primary staff support and conference facilities by NIST. A steering committee for the conference was selected that included many members from the previous R2 panel, as well as new members selected to ensure that the committee could competently review proposals from a wide variety of institutions and to ensure that results from the conference would be effectively disseminated to DOE national laboratories.

The steering committee, co-chaired by Joann Rodgers of the Johns Hopkins Medical Institutions and Earle Holland of Ohio State University, met in Chicago in May 2001 to establish criteria for selecting communications programs as best practices, to determine what types of institutions would be eligible to submit entries, and to agree on a strategy for maximizing the number of entries. From the outset of its deliberations, the Best Practices Steering Committee decided to limit entries to communications programs sponsored by or conducted by research-oriented and public-education institutions. While numerous awards exist to honor science journalists from media organizations who communicate well with the public, there are fewer opportunities for science communicators based at research and other science and technology institutions to receive such recognition. The committee included communications programs aimed at children

but decided to limit entries to programs that take place primarily outside of classroom instruction.

Poster session entries to the conference were solicited via ads in science-writing, higher-education, and public-relations trade publications (e.g., *PR Week*, *Chronicle of Higher Education*); direct mail, e-mail and phone solicitation of public-affairs specialists in research institutions and science and technology museums; and announcements to listservs.

Entries were welcomed from research-sponsoring institutions such as universities, government agencies, corporations, or non-profit organizations; from public education institutions such as museums or non-profit Web-based enterprises; or from third parties such as public relations agencies engaged by these entities in their communications efforts. To help encourage entries from universities, non-profits, and other organizations with limited travel funds, up to 50 selected presenters were eligible for a \$750 manuscript fee to help offset travel costs, as well as free conference registration.

Entries were solicited in the following categories:

- direct-to-consumer programs,
- programs for specialized media,
- scientist-based programs,
- programs for legislators and opinion leaders,
- programs for the general media, and
- programs intended for children (outside of classroom instruction).

Entries were solicited through an on-line form posted on the conference Web site (see Appendix A). The form requested a 500-word narrative description of the communications program, as well as information on the intended audience, budget, staffing, and any research conducted before or after the program to improve its design or evaluate its effectiveness. The committee also accepted supplementary materials, such as brochures, videotapes, photographs, and summary reports by regular mail.

The steering committee received more than 150 entries. In July 2001, the committee met at the National Institute of Standards and Technology in Boulder, Colo., to formally rate and rank each of the entries. Forty-eight "best practice" communications programs were selected based on the following criteria:

- content and clarity of explanation,
- identifies a discrete audience,
- uses appropriate formative and evaluative research,
- illuminates both the process and product of science or technology, and
- easily adapted for other settings or organizations.

The presenter for each selected communications program was asked to prepare a poster to be displayed at the conference, to write an abstract for the conference proceedings, and to provide documents and images from the poster to be archived on the conference Web site. [www.nist.gov/bestpractices.]

The conference was originally scheduled for September 26-28, 2001. But after the terrorist attacks of September 11 shut down Reagan National Airport and disrupted travel plans for government employees, the committee decided it was in the best interest of the conference to postpone the meeting for six months.

When the conference convened on March 6-8, 2002, the meeting was subscribed fully, with almost 300 participants attending. They represented institutions from all across the United States and several foreign countries, including Canada, the United Kingdom, Brazil, Australia, Belgium, Trinidad, and Japan. Participants included science communication specialists from universities, national laboratories, research institutions, and hospitals; journalism professors; communication researchers; science museum curators; scientists; educators; and government officials.

The 48 featured posters were displayed for the duration of the meeting. Morning and afternoon plenary sessions on March 7 and 8 consisted of keynote addresses, topical lectures, and panel discussions on topics ranging from evaluation of science communication programs to targeting hard-to-reach audiences. An opening reception, conference dinner, continental breakfasts, and lunches provided opportunities for informal networking among participants (see Appendix B).

Research-Driven Communications

While institutions routinely review past research in a given technical field before funding additional proj-

ects in the same area, few organizations systematically use the results of research already collected in the field of science communication to design their programs. In many cases, managers of public communications programs come from related fields such as journalism, political science, education, or a specific scientific or technical discipline and are not aware that this research literature exists. In other cases, the daily stress of continually producing the products of science communications programs such as newsletters, Web pages, magazines, exhibits, or broadcast programs fully consumes science communicators to the detriment of long-term planning for or evaluation of those programs.

Some federal agencies that provide grants for science communication programs, such as the National Science Foundation (NSF), require that formal evaluations of funded programs be conducted. However, the results of these evaluations are not made publicly available by NSF. (NSF does encourage grantees to publish their findings themselves and recently supported creation of a new Web site to facilitate this.)¹⁰

A major goal of both the Research Roadmap panel and the Best Practices Steering Committee has been to improve dissemination of science and technology communications research results to science communications practitioners, as well as to better inform communications researchers about specific areas of science and technology communications practice that can benefit most from academic research.

For example, a 10-year, comprehensive effort sponsored by the International Association of Business Communicators (IABC) Research Foundation to determine the defining characteristics of excellent public relations programs produced a wealth of conclusions, many of which are relevant to improving science communications programs.¹¹ However, few practicing science communicators at the Best Practices Conference were aware of the study.

Excellence in Public Relations

James Grunig, professor of communications at the University of Maryland and the director of the IABC Excellence project, described for the conference attendees the methodology for the study, which involved conducting surveys and interviews with public rela-

tions managers, practitioners, and CEOs for more than 300 organizations.

The most important function of public relations, Grunig noted, is building relationships with, not just communicating to, strategic publics. The most effective communications strategies involve two-way communication. An organization's effectiveness (and its reputation) depends on its ability to reconcile its goals with the expectations of its strategic publics—those groups outside the organization that affect its operations.

The Excellence project concluded that the best public relations programs had the following qualities in common:

- Public relations is a unique management function that helps an organization interact with the social, political, and institutional components of its environment, and serves a strategic managerial role as well as a technical role.
- Public relations departments strategically plan, administer, and evaluate public relations programs.
- Public relations helps to shape the underlying conditions of organizational excellence (for example, through employee communications programs).
- Public relations is empowered by the dominant coalition (the people with the most power in an organization) and is not subordinated to marketing or other management functions.
- Public relations is two-way and symmetrical.
- Public relations executives serve as ethics counselors and internal advocates of social responsibility (the "conscience," or "thinking heart" of the organization).

Traditional metrics of communication have measured one-way communication:

- Communication: how many people receive the message, show up at an open house, how many press clippings mention the institution, etc.
- Message retention: not only did the message get out there, but did they retain it?
- Cognition/understanding: did they make sense of the message?

- Attitude: do they agree with you?
- Behavior: do they say good things about you, buy your product, etc.?

In implementing public relations programs as a two-way process, the role of public relations is not just to affect the public, but also to bring in information from the public to inform the decisions that management makes.

Two-way communication involves:

- Disclosure: not only is the organization open about its activities, but the public comes to the organization when it sees there is a problem.
- Accuracy: the public can predict what the organization is thinking, and vice versa.
- Understanding: the organization and its strategic publics share understanding about the organization and its mission.
- Agreement: The organization and its strategic publics agree that something is good or bad, something should be done about it, and they evaluate it in the same way.
- Symbiotic behavior: the public helps the organization accomplish its mission, but the organization also behaves in such a way that it makes the community a better place to live and the organization a better place to work.

Methods for measuring the success of a communications strategy involve conducting surveys and interviews, as well as observation (such as watching visitors interact with exhibits) and focus groups.

Counting the number of media clippings is a poor measure of the success of a communications program, except possibly for monitoring the performance of media relations staff. General surveys of attitudes, image, and reputation are also poor metrics of communications programs because they are affected by many other things such as day-to-day decision making by an organization's management that are beyond an organization's public relations programs. The Excellence project found that the use of advertising equivalencies (describing the value of news stories generated by public relations efforts in terms of the dollar value of paid ads of the same size) was so inherently misleading a practice that public relations professionals should consider use of such comparisons as unethical.

A further discussion of successful management strategies for public relations can be found in a paper authored by Grunig and Larissa Grunig for the Department of Energy's Brookhaven National Laboratory.¹²

The Science-Attentive Public

In today's complex world it is no longer possible for any citizen to follow and stay informed about the full range of public policy issues. One way of characterizing how people approach science and technology information has been suggested by Miller. He identifies three strata of the public that differ in their interest in and understanding of science and technology. Using the National Science Foundation's Science and Engineering Indicators studies as a base, Miller has estimated that approximately 15 percent of American adults have—over the last decade—had a high level of interest in science and technology issues and have felt that they were reasonably well informed about those issues. Miller refers to these citizens as being attentive to science and technology.¹³

Based on a combination of self-reported level of interest and level of understanding, Miller classifies public science audiences into three groups:

- Science attentive: Those who express a high level of interest in a particular science and technology issue, feel very well informed about it, and regularly read newspapers and magazines with relevant information.
- Science interested: People who claim to have a high interest about a science and technology issue but do not feel very well informed about it.
- Residual public: People who are neither interested, nor very well informed about science and technology issues.

In the 2001 NSF survey, about 10 percent of respondents met the criteria for being science attentive, a drop of 4 percent since 1997. Forty-eight percent of respondents were classified as science interested, while 42 percent were classified as residual.

Even if only about 10 percent of the U.S. population is science attentive this still represents an audience of 20 million people. Adults who are attentive to science are more likely to watch science television shows, visit science Web sites and science museums, and buy

science books. Communication with this audience can have the effect of spreading the message more broadly since science attentives tend to be more politically active than average, have higher than average levels of education and income, are comparatively well informed about science and technology issues, and have a high level of cross-talk with other audiences.¹⁴

Science Communication and Trust

Two recent studies focused on the issue of science communication and trust. Both found that trust tends to reside in social institutions and processes.

Using data from a survey of 1,000 U.S. respondents in 2000, Priest analyzed the relationship between people's willingness to encourage biotechnology research in a number of different agricultural and biomedical areas.¹⁵ She found nearly 30 percent of respondents projected that genetic engineering would not benefit society during the next 20 years—about the same percentage of persons (but mostly different respondents) who were similarly critical of nuclear energy. As education in science goes up (as measured by the number of college courses in science), respondents' substantive understanding of biotechnology increased, using a simple true-false test. Priest found that a respondent's confidence or trust in scientists, farmers, and government regulators (all representing the relevant institutional leaders for biotechnology) was the strongest predictor of people's willingness to encourage biotechnology research.

A separate analysis of the 1998 U.S. national survey by Miller and Kimmel found that the strongest predictor of encouragement for agricultural and medical biotechnology (measured separately) was a belief in the promise of science and technology to improve the quality of life.¹⁶ This generalized faith in science and technology is similar to the confidence in scientific institutions found by Priest. The second strongest predictor of encouragement for both agricultural and medical biotechnology was attentiveness to biotechnology, followed by the level of biomedical literacy.

Taken together, these two studies suggest that favorable attitudes toward the encouragement of new science and technology are built on long-standing trust or confidence in major social institutions such as science, universities, government, and business. Short-

term media exposures were not good predictors of a positive attitude toward either agricultural or medical biotechnology. The take-home message of these findings is that science communicators should not attempt to package and sell trust like soap, but rather continue to provide the factual information and education the public needs to understand complex topics like biotechnology. The development of trust takes time and cumulative effort.

Research Roadmap Findings

In its review of the science communications research literature and its discussions with practitioners, journalists, and researchers over the course of a three-year study, the Research Roadmap panel found additional support for many of the conclusions reached by the research efforts highlighted above.¹⁸

The R2 panel concluded that:

- There is no such thing as a “general audience” for science and technology communication; rather there are many people with many different uses for science and technology information and many different levels of understanding. Communication programs should be designed to address and serve the needs of each group; there is no “one-size-fits-all” message or method of communication.
- Public understanding of science is not the same as appreciation of science or of research-performing institutions. Public understanding of science is often touted as the goal of a communications program really designed to enhance the reputation of a particular research institution. The goals—public understanding or public appreciation of science or of a particular institution—should be explicit at the outset of any science communications program, and metrics for measuring the desired outcome should be designed appropriately.
- Science and technology communication programs should be directed to addressing an audience's needs and interests, not by the research enterprise's ideas about what the public “should know.”
- Active involvement by scientists and engineers is critical to the success of any science communica-

tion program. Scientists have an obligation to interact with publics outside their peer community and should be integrated fully into decision-making regarding science communication issues.

- In order to best foster mutual respect and trust between scientists and external publics—essential to effective communication—public affairs representatives need unfettered access, and preferably a direct reporting relationship, to the head of the agency or institution they represent.
- The changing nature of the media—the proliferation of new media and fragmentation of existing media—will continue to change how and to whom science is communicated.

Twenty-first Century Communications

The changing nature of communication media may be the biggest single challenge—and opportunity—facing communicators. Just as the advent of television added images to sound and brought about a revolution in the way organizations communicated with their constituencies, the Internet's direct interface with consumers has brought about a profound change in the nature of communication itself.¹⁹

The ability of organizations to publish materials directly to a world wide audience through the Web has reduced dramatically their previous dependence on intermediaries such as television or newspaper reporters to carry messages to important publics. A corollary to this change is the much larger number of media choices now available to consumers. Network television news no longer dominates public discourse and a spot on the evening news no longer should be viewed as a major benchmark of communications success.²⁰

The events of September 11 illustrated how dramatically journalism has changed. People tuned in to watch events unfolding before their eyes and they have kept watching. Since September 11, the audience for news has increased, in general, but more people are getting that news from the Internet, where it is available 24 hours a day and where Webcasts can be replayed whenever it is convenient to do so.

The splintering of video programming among broadcast, cable, satellite, and the Internet has opened up more choices for the consumers and more news

markets for science communicators. Among these increased programming choices are channels like Discovery Health, National Geographic Channel, and the History Channel, as well as such highly targeted cable and satellite channels like the Research Channel and the University Channel. While more science and technology programming should be good for science communications, the portion of that material that is in fact pseudoscience is a cause for concern.

The trend in television newscasting is toward shorter and shorter segments, with more medical and weather coverage. More time is spent on weather than any other story in a local newscast, which makes weathercasters a potentially prime conduit for passing on environmental and other weather-related science news to consumers.

At the same time, niche programs like public television's *Nova* are holding their own by emphasizing challenging content and storytelling for topics like genomics, cosmology, and string theory, which increasingly are visualized with high-end computer graphics.

Hallmarks of Good Science Communication programs

In reviewing and selecting topics to be presented as posters at the conference, the Best Practices Steering committee was struck by a number of repeating themes, elements, or techniques that many of the best programs had in common. Programs that used the following elements tended to be more engaging, more relevant, more substantive, and often more creative—all characteristics that boosted success as measured by such factors as size of audiences, number of Web hits, longevity of support, and other factors. Not coincidentally, many of these same themes emerged in the keynote talks and topical lectures presented during the conference program.

These programs were judged "best practices" by the conference panel, and all either presented posters or gave talks at the conference. Some examples of programs that illustrate the common themes include:

Illustrates both the process and product of science

The Internet has made it possible for an audience to directly view science as it happens, both the daily

frustrations and the exciting discoveries. The Exploratorium in San Francisco mixes live Internet broadcasts and streaming media with interactive presentations in the museum's theater. The programs showcase the settings and extraordinary people making scientific discoveries, and invite audiences to share in the process of discovery.

In the same vein, the Woods Hole Oceanographic Institution's *Dive and Discover* expeditions take Internet viewers on a virtual sea voyage. This live-from-the-sea Web site involves viewers in the daily activities and discoveries of scientists, and is aimed primarily at middle-school students and their teachers.

Taking a different tack, the Center for Interdisciplinary Studies at Virginia Tech sponsors forums on scientific and technological advances to examine, in a balanced manner, the ethical and social issues they create, as well as the often highly complex historical, philosophical, social, and legal components. Topics of the daylong *Choices and Challenges* forums have included genetically modified foods, the human genome project, diet and disease, water supply, and quality of life at the end of life. More than 500 people attend in person and the programs also are broadcast nationwide.

Science magazine and the American Association for the Advancement of Science sponsor a Web site that explores scientific controversies. *Science Controversies, On-Line Partnerships in Education* (SCOPE) brings the scientific process and unresolved scientific questions into middle-school classrooms. The dynamic nature of the Web site allows students to see how researchers' ideas, questions, and conclusions evolve over time.

Involves scientists in a substantial way

Adler Planetarium includes professional astronomers on its exhibit-development staff, which allows the museum to facilitate the rapid integration of new discoveries into its exhibits and programs. Adler currently has eight Ph.D. astronomers on its staff, six of whom have joint appointments with the University of Chicago or Northwestern University. Instead of becoming experts in undergraduate teaching, these astronomers focus on becoming experts in public education for a range of audiences from children to adolescents to adults. Adler's astronomers contribute

directly to museum exhibits and programs, as well as provide a link to other professional researchers.

Considers political climate and/or involves decision makers

The Kansas Geological Survey conducts an annual three-day field conference, which takes policy makers to locations where natural resources are produced or used, to see first-hand the resources they make decisions about. Attendees are legislators, agency staff, teachers, business leaders, and environmental leaders. The field conferences usually focus on specific topics, such as energy, or particular regions of the state.

Knowing that the biggest potential obstacles to a groundwater reclamation project would be political, the Orange County (Calif.) Water District took its message directly to political and business leaders and active community members to forestall opposition to the project. The project will reclaim water from sewage to replenish diminishing groundwater resources, essential for the county's economic future. The project is critical to the county's future but the Water District acknowledged its high "yuck" factor. The public relations campaign began years ahead of the implementation of the project, beginning with explaining the project and its necessity to political leaders. With straightforward explanations and simple graphics, the process was compared with techniques used for making bottled water, which reassured people. The Water District also found, through focus groups, that people trusted what doctors and scientists said, so it is recruiting doctors and scientists as supporters and spokespersons for the project.

Uses multimedia/illustrations/interactivity when appropriate to bring science to life

The Weather Discovery Center at Mount Washington brings the science of weather to museum visitors. Mount Washington has what many people believe is the worst weather in the United States and has had a continuously staffed weather observatory on the summit since 1932. The museum, located in a more benign weather environment, the valley town of North Conway, N.H., has exhibits that include data on real-time developing weather; a telecommunications link to observatory staff on the mountain's sum-

mit; a camera atop the summit; an interactive role-playing exhibit that invites visitors to become weather forecasters; and a showcase for current research projects.

The Howard Hughes Medical Institute sponsors a Web site, *Cool Science for Curious Kids*, that contains science activities, including animation, sound, and quizzes. The activities, originally developed in print form at five children's and science museums, encourage kids to explore science.

The Cornell Theory Center has developed a "virtual world," which combines online chat, gaming technology, and Web features to construct a 3-D virtual environment where users interact. The goal is to create a hands-on virtual science center in cyberspace that engages high school students and Cornell undergraduates, along with researchers and graduate students.

Relates science to the everyday environment or *culture scientifique*.

Bruce Lewenstein, associate professor of science communication at Cornell University, introduced this term, *culture scientifique*, to the conference attendees to describe how science books have emerged in the last 20 to 30 years as important carriers of culture and of broad public discourse. Beginning with Carl Sagan's *Cosmos* and including books like Stephen Hawking's *Brief History of Time*, and E.O. Wilson's *Sociobiology*, these books generate wide discussion and help to create what we think of as American culture. They illustrate that rather than being separate from everyday life, science is deeply intertwined with it.

Joseph Schwarcz, professor of chemistry and director of Chemistry and Society at McGill University in Montreal, hosts a weekly call-in radio program to take questions from listeners about science. He tries to help listeners combat pseudoscience by helping them come to conclusions based on observations and evidence, rather than rhetoric. He also helps them cope with everyday science quandaries. Questions he's fielded in his 20 years on the air have included: what solvent to use to get magic marker off a \$5,000 Barbie Doll's face (answer: nothing; anything that will erase the marker will also dissolve Barbie's face) and why carrots burst into flames in a microwave (answer: the microwave sets

up mini-electric currents in the carrots, which ignite volatile oils; this also happens to microwaved pickles).

The Lawrence Berkeley National Laboratory is using the lab's shuttle buses—which run through downtown Berkeley and circle the University of California, Berkeley campus—as rolling billboards to showcase the lab's activities. The lab developed colorful posters for the sides of the buses, each featuring a Berkeley Lab scientist with a leading question related to the scientist's work, for example, "Did you ever wonder about the invisible marvels of the nanoworld?" The posters list the lab's Web site, which links to personal profiles of the featured researchers.

Britain's Graphic Science is creating science posters for both the insides and outsides of buses, developing science-based pub quizzes (popular in the U.K.), and installing science questions at supermarket checkout counters (www.uwe.ac.uk/fas/graphicscience/). For a five-day science fair in Cheltenham in May 2002, Graphic Science director Frank Burnet (science director of the festival) played up the idea that science is part of everyday life. The theme of the festival was "pleasure," and there were events about the science of music, cooking, chocolate, and sex.

London's Central YMCA commissioned, developed, and produced five plays exploring issues arising from advances in biotechnology, including genetic selection, xenotransplantation, the biological basis of mental illness, genetically modified foods, and cloning and stem-cell therapy. Written in consultation with scientists, doctors, and patients, each play is followed by a live debate involving the audience and cast. The Y Touring company performs the plays in schools, theaters, prisons, science centers, and arts festivals, primarily targeting youth.

To introduce food journalists and writers to the American Chemical Society's resources on food chemistry, the society sponsored two workshops on the chemistry of food. The seminars, the "Elements of Chocolate" and the "Formulas for Flavor," were designed to offer food writers a new perspective on the topics they cover. The response to the workshops was enthusiastic and coverage about or resulting from the seminars was extensive.

Avoids parochialism

Based at the University of Wisconsin, *The Why Files* is a non-profit Web site that provides entertaining and informative science content. However, unlike the great majority of university or other organizational Web sites, it typically does not describe the research of its sponsoring organization. Instead it takes the non-parochial approach that good content from any source will be covered and the university will benefit by being seen as performing a useful service to the community. *The Why Files* subjects are often “the science behind the news,” clearly written and with a sense of humor. Topics have included, at the time of Princess Diana’s death, the science of grief; when an ominous asteroid was sighted, how much readers should worry about stray rocks from space; and during the California energy crisis, methane hydrates and nuclear energy.

Views the topic from the audience’s point of view, not the institution’s

Environment Canada developed a successful strategy for communicating science with Canadian aboriginal communities. To the Inu people of northern Quebec and Labrador, “ashkui,” the first areas of frozen ice to open up in the spring in northern Canada, are both supermarket and pharmacy. Environmental scientists studying the ashkui listened to, acknowledged, and incorporated traditional wisdom about the environment in their research. When the researchers met with local elders, they met not in a boardroom-type setting, but in a camp setting where native people had traditionally met to discuss hunting, fishing, and related resource issues. And to communicate the results of the project they printed posters not on paper, but rather on linen, the Inu’s traditional “print” medium for passing on wisdom.

Uses face-to-face methods

Brookhaven National Laboratory turned a crisis into an opportunity, and used face-to-face, two-way communication to improve public trust after confidence in the lab had eroded in the wake of a series of costly environmental crises. The laboratory used a change in managing contractors to initiate a suite of new, formal and informal community relations activities, including creating a Community Advisory Board,

establishing a community ambassadors program, and designating community liaisons. The new programs now inform the organization’s scientific culture and help ensure a commitment to excellence in communications and community involvement. Communications and government affairs offices also were brought together under one manager, with direct reporting to the director of the lab.

The U.S. Geological Survey’s Western Region Center, in Menlo Park, Calif., holds a public open house every three years. At the last event, in May 2000, 14,000 people attended over three days. Open to the general public, the event attracts children and families, college students, teachers, neighbors, and scientists from nearby universities. The open house is a way to share information about local earthquakes, landslides, water quality issues, and other issues affecting people living in the Bay Area, and has helped rally local support for the institution.

Reaches out beyond the science-attentive public

Southern New Mexico’s border region contains a diverse and medically underserved population. A coalition of libraries led by the New Mexico State University library banded together to provide health-related information in electronic and other formats to targeted populations. ¡BIEN!—Border Health Information and Education Network—also wanted to provide information on current health-related research to professionals, educators, and librarians; develop an information network; and provide literacy training to health professionals and consumers. The project provides increased access to quality health information in English and Spanish, in multiple formats.

The National Eye Institute, part of the National Institutes of Health, created a traveling kiosk, designed to be displayed in shopping malls, to provide information about low vision—visual impairment not correctable by eyeglasses, medicine, or surgery. NEI determined that shopping malls, America’s new town halls, provide an ideal venue for communicating health information to a wide audience.

Sponsored by the Thomas Jefferson National Accelerator Facility, Becoming Enthusiastic About Math and Science (BEAMS) brings at-risk middle-

school children and their teachers to the lab annually for a two-, three-, or five-day immersion in the research environment. BEAMS hopes to redress the early loss in K-8 education of minorities and females from the math, science, and technology career pipeline; strengthen the motivation and academic preparation of students; and provide teachers with activities based upon research at the lab.

The High School Biomedical Research Program for Disadvantaged Youth, a full-time, eight-week summer program at the University of Maryland at Baltimore, pairs disadvantaged high school students with scientist mentors for research projects. The project topics include heart disease, cancer, molecular biology, brain disorders, pharmacology, etc. Students not only work in the laboratory but also meet for weekly group activities, such as science seminars, debates, career seminars, and oral presentations. Since 1988, 95 percent of the students (who come from 79 Baltimore-area schools) have gone on to college, with 88 percent majoring in the sciences.

Provides information to the commercial media in easily usable form

The University Corporation for Atmospheric Research provides TV weathercasters with background information on global climate change, visualizations of weather and climate concepts, and stock footage of major weather events. The *ClimateStock* program is designed to encourage coverage of climate change on prime-time TV, since TV weathercasters are often the most visible representatives of science in U.S. households. B-roll is provided free via satellite uplink, and suggested scripts and shot lists are available on the *ClimateStock* Web site.

EurekAlert!, sponsored by the American Association for the Advancement of Science, is a Web site where member organizations (universities, medical centers, associations, and other research organizations) can post science news releases. Its embargoed news releases, press packets for scientific journals, searchable database of experts, and archived news releases provide one-stop shopping for journalists looking for story ideas, background information, or expert sources.

The Mayo Clinic provides video news releases on health-related topics to local television stations.

Medical Edge is a weekly, 90-second news insert made available at no cost on a market-exclusive basis. The segments air regularly on 121 TV affiliates in the United States and Canada, along with stations in Turkey, the Middle East, and Croatia. The program is designed to provide reliable information for the public on medicine and health, increase awareness of Mayo Clinic locations and expertise, and drive traffic to Mayo's Web site. Stations can air the segments as-is, use clips of B-roll for their own stories, or have their own reporters or anchors voice the accompanying script. The segments use Ph.D. scientists and M.D.'s as spokespersons.

Research and Evaluation

Good communications programs are evaluated both before and after a program is designed and implemented, and they are revised or fine-tuned in response to audience feedback. Goals are clearly articulated and the research is designed to measure whether the stated objectives are being met. This formative and evaluative research is one of the most crucial, and most often overlooked aspect of communications. Commercial communicators study their audiences extensively, and now that more non-profit institutions are communicating directly to audiences, rather than through intermediaries such as journalists, public affairs specialists need to study their intended audiences as well.

Methods include conducting focus groups; surveying audience members; counting the number of people who show up to an event; compiling Web statistics; monitoring usage; giving quizzes; holding public hearings; or collecting anecdotal information in a systematic way.

Some of the pitfalls include not clearly stating the goals to be measured; measuring something other than success in achieving the stated goals; not researching the right audience; not targeting a campaign specifically enough; or relying too heavily on sporadic anecdotes as evidence of success or failure.

In general, the quality of research and evaluation reported by applicants was smaller in scope and lower in quality than the R2 conference organizers had expected to find. There were some very good evaluation efforts but they were exceptions rather than the

rule. It is clear that additional effort needs to be focused on both formative and summative evaluation.

Conclusions and Recommendations

Science and technology communication with the public by research, education, and other institutions is undergoing a renaissance of ideas and techniques. Gone are the days when a science communicator could issue a simple printed press release, deliver it to the major networks and newspapers, wait to see if the topic would be covered, and feel confident that she had done her best for her institution.

Today's science and technology communicators need a much broader array of skills. They need to understand both the technologies and the aesthetics of multimedia, interactivity, and the Web. They need to view their job as a facilitator for good relations between their institutions and the various segments of the public important to their institutions. They need to be actively engaged in the day-to-day decision-making of their institutions as a voice for institutional social responsibility. They need be familiar with the robust body of research under way in the field of communications, and they need to keep abreast of new developments lest they find themselves delivering messages to a "general public" years after others have realized that it is a figment of a previous generation's imagination.

Equally critical for the success of science and technology communications is research, before, during, and after a communications program is developed. Conducting communications efforts without research and evaluation is a bit like sending out a fleet of buses without ever bothering to check if they made it to their destinations.

One thing that is not likely to change now or in the future is the central role of clear, engaging, relevant content. As long as there are important public policy decisions being discussed, discoveries being made, and technologies being created, institutions will continue to need effective translators who can drill through the often opaque world of technical achievement to view and describe the fascinating scenes inside.

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Speakers' Talks

Keynote Address: Sense, Nonsense, and Science

Joseph Schwarcz, Professor of Chemistry and Director of the Office of Chemistry and Society, McGill University

Schwarcz: There were five friends who lived in Quebec and one day they decided to go on a trip to visit a foreign country, so they piled into a bus and headed for Ontario. They got across the border and they were looking out the window and one of them, who happened to be a naturopath, upon spying one black sheep on a hill, said, "Look, all of the sheep in Ontario are black."

Next to him was a chiropractor—a somewhat more critical thinker. He said, "I don't think you can really say that. All you can say is that in Ontario some of the sheep are black."

Well, sitting behind them was a biologist—more scientifically minded. He said, "I don't think you guys can really say that scientifically either. All you can really say is that in Ontario, there is at least one black sheep."

But sitting next to him was a physicist. He said, "Well, that isn't exactly right either. If you just want to go in terms of conclusions based upon the evidence, in Ontario, there is at least one sheep that is black on one side."

Sitting behind them, of course, was the chemist—the fount of all knowledge. He said, "No, all of you guys are wrong. You can't really say that. The only thing you can really say is that in Ontario, there is at least one sheep that is black on one side, some of the time."

Well, the point of that little story is the importance of coming to conclusions based upon observations. And that is really what science is all about. But unfortunately, there are far too many people who don't really understand what that means and often jump to all kinds of wrong conclusions even though the evidence is staring them in the face.

And what I want to do with you here today is talk to you and share with you some of my adventures in dealing with the public and show you how much confusion there is and what may be some of the ways of righting it.

Well, where do we start? A couple of years ago on December 23, and I remember this very well because I was at home during the Christmas holidays, a friend of mine called me up and said, "You've got to turn on Dini Petty." Well, I didn't know who Dini Petty was or how I was supposed to turn her on at 9 o'clock in the morning.

Well, she was the hostess of a TV show. There she was locked in conversation with a guest. And obviously they were talking about my kind of things because they had all kinds of foods on the table. And they were avidly engaged in label reading. Just as I turned it on, I was hit over the head by these immortal words.

"If you can't pronounce the words, it's a chemical and I don't know how many people want to be eating chemicals."

As you can imagine, I immediately perked up upon hearing this. I was astounded to discover that the author of these words was a physician, who had labeled herself a nutritional consultant, who was pontificating about the evils of chemicals.

"When you talk about chemicals, even moderate use is too much."

If you can imagine, this was pretty unnerving for someone who has spent a life in chemistry. And I had to do something about it. But what do you do?

You instantly feel this anger when nonsense is being perpetrated. I decided I would call up the Ontario College of Physicians and Surgeons because the show came from Toronto. I figured they must have some way of regulating medical care. She was a doctor uttering nonsense. Something had to be done.

I couldn't get through. The phone was busy. Later I discovered why. The sugar association was calling because she had called sugar, "the great white devil," and they didn't like that.

Eventually, I did get through, I made my complaint. Of course they couldn't do much about it. She really was a legitimate M.D. The college was actually

very receptive and informed me that they cannot guarantee what their graduates will say once they leave the university.

In any case after this, I carried on a rather vigorous correspondence with this physician in which I criticized some of the things that she said. In fact, I decided to target her. I would send her scientific articles about food additives and about safety procedures and regulations, etc., and she would send me back her views on homeopathy, because she had gravitated toward that. She had come to believe that non-existent molecules could cure people. So as you can imagine we did carry on a rather vigorous correspondence until two years ago when one of my letters came back unopened. And it turned out that she had left Canada. She had gone to the U.S. to New York. Obviously pastures are greener there for her particular brand of silliness. I would like to take credit for driving her out of the country, but I don't think that really happened.

Eventually I had the chance of getting on the Dini Petty show myself to try to correct all this. But I don't think I had a real effect because she really wasn't interested in hearing about the safety of food additives. It was much more sensational to talk about all of the horrors and to paint chemicals as devils. So that often is very difficult to fight. But I've been trying to do that for a long time.

Often people ask me how I got into this very bizarre game of communicating science to the public. It actually all started a very long time ago in a most unusual place. It started at St. Joseph's Oratory, which is a large cathedral that dominates Montreal's skyline. And when I was in grade 6, I went up there with a friend of mine to put silver nitrate into the holy water.

For those of you who are not chemically adept, let me explain the beauty of this. The holy water is usually stored at a little container at the entrance to the church. Pilgrims come and dip their fingers into the holy water and then cross themselves on the forehead and then go into the church to pray. Well, silver nitrate is a light-sensitive chemical. So they would go into the church to pray and when they would come out, the sun would expose their forehead and change the silver nitrate into metallic silver and they would

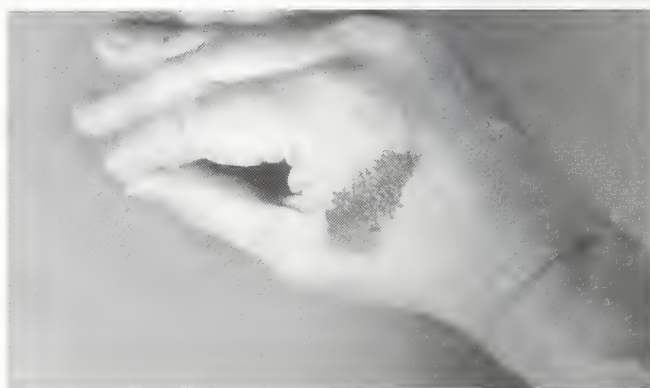


develop these indelible black crosses on their foreheads and they would be convinced that they had seen a miracle. And we who were hiding in the bushes knew that indeed they had seen a miracle—it was a chemical miracle.

It was then that I decided that I would like to grow up so that I too could teach people how to put silver nitrate into holy water and do these marvelous things. But along the way I found out that there was a lot more to do with chemistry than just that. The real magic of chemistry lay not in making indelible crosses on people's foreheads, but it lay in understanding the way our world works.

The medications, the foods that we eat, the cosmetics that we use, the cleaning agents that we all use—these are all chemicals. And they are all fascinating. Of course, they require a little bit of understanding.

So that's where it all started. But the real public interaction began in 1980. It was stimulated by this whole silver nitrate business. Because I had been doing various demonstrations, such as putting silver nitrate on the hand to show how the color developed. And I sort of began to be known for these things.



And then in 1980, a critical event occurred at the descendent of Expo 67, known as *Man and His World*, which was an ongoing summer World's Fair. It had a pavilion. The pavilion was the UNESCO pavilion. They wanted to mount some kind of a science fair display, sort of a mini science museum. And they asked me and a couple of my colleagues to do this and we said, "Sure." We hired some students and we set up demonstrations and we did little performances on colors, on plastics, on fireworks. It was kind of neat. It was pretty small scale. People would gather around and sit on little stands and watch these mini shows as we called them. We thought that we were doing a good thing, making headway in terms of popularizing science and the scientific method of thinking.

Then one Monday morning, which I remember very well, I picked up my morning newspaper. And the page three city column had something about chemistry. Of course, I started reading it. Very quickly I discovered that it was all about us and our efforts at the pavilion—with which the columnist was taking issue.

And he said, while the whole world is worried about a substance called urea formaldehyde used as an insulating material, there are these people at the Expo site telling everyone what a wonderful product it is.

Well, this really annoyed me, because what we were demonstrating was polyurethane, a completely different chemical.

Now, to make polyurethane, you mix together two substances and you get a nice foaming effect. Very interesting material. Good demonstration. But indeed, this was the time when people were worried about urea formaldehyde. But that's not what we were demonstrating. We were demonstrating this. Polyurethane is a foam. It is a very interesting material.

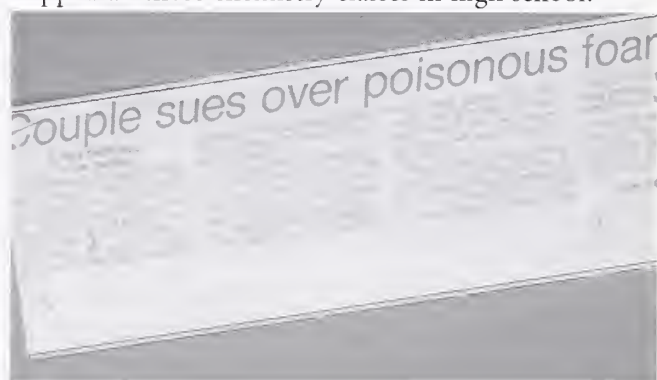
However, this column was about urea formaldehyde, which in those days was being used as an insulating material. In the 1970s we went through the energy crisis, everyone was insulating. And there were a lot of fly-by-night operators who would apply urea formaldehyde foam insulation improperly. It would release formaldehyde, which of course can be toxic. So there was legitimate concern over this. There were legal hassles all over the place. So the columnist was

saying, while everyone is concerned about this, these guys are showing what a wonderful product it is.

Well, by 9 o'clock that morning I had a letter on his desk, together with a large polyurethane egg, about this size that I had made that he was to hang around his neck for penance for having laid such a large scientific egg—not having recognized the difference between polyurethane and urea formaldehyde. The only common feature was that these were both foams. They were chemically completely different.

This is like saying concentrated sulfuric acid is the same as water, because they look the same and they're both liquids. Of course, this was nonsense.

He wrote a very nice retraction the next day, saying that he really was at fault. And the problem was his lack of scientific education. That he didn't know that there was more than one kind of foam and that he had learned something and he wished he that hadn't skipped all those chemistry classes in high school.



Two days later I got a call from a Montreal radio station. CJAD, it happened to be, was asking me if I would like to comment on this controversy. Which, of course, was a non-controversy. It was a non-issue. I said, "Sure." I explained it very much like I've explained it to you. And I talked about the importance of understanding science so that you don't come to these wrong conclusions based upon the evidence. And I guess they must have liked the explanation because a couple of weeks later there was some other scientific question that came up, I don't remember what it was. And they called me to ask if I could explain it, which I did.

And pretty soon they asked, "Would you like to come on the air to do this regularly and answer questions?" I said, "Okay, I will give it a shot." And I've been doing it for quite some time as you can see.



About 20 years. Twenty-two years actually. And it has been a fascinating experience.

I remember the very first day. In particular, one question. I was a little bit nervous then because I didn't know what to expect. Perhaps I wasn't listening all that carefully when one of the questioners seemed to me to be asking, "Is it safe to lick your balls?" Now, I was astounded by that for a moment until the conversation went on and I realized that the caller was asking about golf balls. Because in those days there was a controversy about the pesticides that were being sprayed on lawns, especially on golf greens. And apparently it is the practice of some golfers to lick their fingers and then wipe off the ball to make sure that it's clean. And some were concerned they may therefore transfer some of these pesticides to their body. And when you hear that part of the story, it begins to be reasonable. So we did address it and talk about it. It just shows that you really have to pay attention to what people are asking.

I've now been doing this for a very long time. The questions, of course, change but they are equally interesting. Not long ago a lady called up and wanted to know what was the safest way to burn a laminated picture. Why? It quickly became apparent that she had recently been divorced. She did not want any mementos of her husband. She wanted to burn the laminated picture. But she had remembered that this lamination is done on particleboard, which is glued together with urea formaldehyde. And she was worried that she would release formaldehyde, which is toxic. And she didn't want to give him the satisfaction of harming her after the divorce. So we talked about this and actually came to the conclusion that this is not a totally unrealistic concern. If you do burn parti-

cleboard inside a house and you don't have very good ventilation, you could be exposed to formaldehyde. And if someone is particularly sensitive to it, it could have some consequences. So this is the kind of interesting question that one gets and one has to learn to deal with.

Finally, two years ago, all of these sorts of attempts at communicating science to the public and adventures culminated in the establishment at McGill of the Office for Science and Society, which is a unique enterprise—certainly in Canada, probably in North America—where the university has said that its role does not stop at the gates of the university and its responsibility does not end once students have graduated. There is a social factor here, a social responsibility, to make sure that the public is educated, because, after all, the university lives on public funding. Our mandate is to make sure that good unbiased scientific information gets disseminated. We answer questions via email, or Web site, or by telephone.

The office was actually opened in September 1999 by Principal Shapiro. We have a physical place. We have a location. I have a staff. We deal with all these kind of things. We have a Web site. Of course, these days you're nobody unless you have a Web site and there it is: www.mcgill.ca/chempublic. We put out position papers. We answer questions on the Web site as well. And, something else that we started last year, we put our courses that we teach, under the umbrella name of World of Chemistry. We have four separate courses that essentially deal with the science of everyday life. And those are accessible. They are accessible to everybody through cool.mcgill.ca and you can take

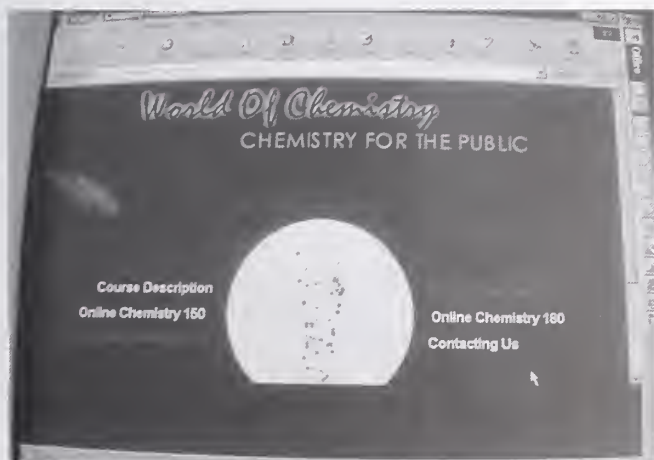




a look at these if you are interested. There is no password. There is no charge of any kind. You just look it up and you click on the lecture that you are interested in and you get the whole visual presentation just like you see here. You hear the voice just as it has been recorded. The only thing that you don't see is the lecture but that, of course, is irrelevant. So you may want to check that out. We have a lot of interesting stuff on there.

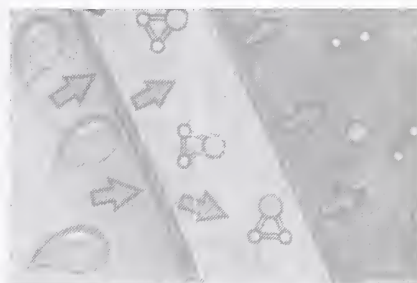
Public outreach, I think, is very needed, because there is such widespread misunderstanding of science and the role of science in our lives. I mean what can you say when you pick up ads like this from circulars. I got this in the mail and it is an ad for underwear.

Now I don't mean to demean this underwear, it may be very good underwear. It suggests that it is a fabric that breathes, that allows moisture to pass through. Maybe so. But look at the claims. " H_2O also known as sweat is attracted to [our long johns] like ants to a picnic. Our constant comfort process sepa-



rates the H_2 from the O making evaporation take place much faster."

Now let's just analyze this for a moment. I mean, obviously the graphic artist that they hired to do this has never had a course in chemistry. H_2O molecules do not look like that. There is no bond between the two hydrogens. Furthermore, the implication that evaporation involves the separation of the oxygen from the hydrogen is absurd. Evaporation is nothing more than a change of state.



If indeed if it were possible to break down H_2O into H_2 and O purely by using underwear appropriately, we would have a solution to our energy crisis, because hydrogen is an extremely effective fuel. It burns very clean. It would be great if we could just rub our underwear and generate it, but alas we cannot do that.

What can one say when we have surveys that tell us that 30 percent of Europeans believe that only genetically modified tomatoes contain genes. I don't have the figures for North America. I think it would be frightening to find the results. I'm not sure what they believe about genetic modification. They think that it does horrific things. And it is my belief that the benefits of genetic modification outweigh the risks and sometimes when I make statements like that people will come up to me and say, "Oh yes, today you guys, you scientists, perhaps you just want to take a gene from a bacterium and put it into a tomato or

into a canola plant. That's today. Tomorrow you'll want to be cloning people."

Well, no, it doesn't work like that. Just because we can put a gene into corn that makes it ward off the corn borer, doesn't mean that we want to be cloning people. Most scientists are responsible and want to work for the public good.

Now it is, of course, to be understood that people have critical analyses of these things and worry about the safety because most people, of course, do not understand what is going on. You tell someone that you are genetically modifying their food. They perceive that you are tinkering with nature—that you are playing around with DNA. They don't really know what DNA is but they know it should not be played around with. And they are very suspicious of genetically modified organisms and, of course, they become all worried when they believe that they are consuming genetically modified foods.

Well, I think that a lot of this worry comes from improper education. I think before genetic modification was unleashed upon the public, there should have been a better campaign of education. So people would have begun to understand what it is. That we mix genes all the time. We do this on a daily basis. The usual product is children. And they don't all come out the way we want them. Right? So you can never guarantee that mixing genes is going to be safe in all ways. But we think that it is a good idea to create children because the possible benefits outweigh the risks. So it is as well with genetic modification. The allegations about this being Frankenstein's harvest and the horrific things that genetic modification does, made by groups such as Greenpeace which disseminates this kind of propaganda to children. Which by the way is wrong. Frosted Flakes are not made from corn that is genetically modified. Corn that is sold for eating purposes is not genetically modified. But they use this as a weapon of terror to scare people away from scientific advances.

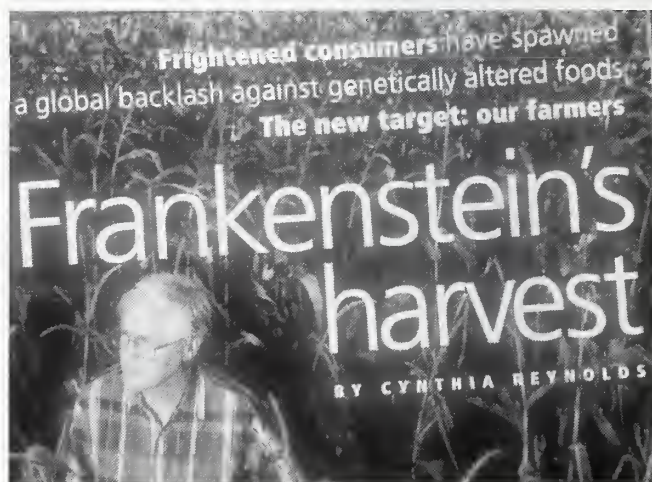


Now, I think any scientist cannot give guarantees to the public about anything. We don't know what may happen. But what we have to look at is whether or not, in our sphere of knowledge right now, the benefits outweigh the risks.

I cannot prove to anyone that there is going to be no harm from genetic modification ever. Because you can't possibly take into account everything that can happen, and science can never prove a negative. That is a naïve expectation that members of the public have.

Let me give you an illustration of that. You know every Christmastime we have evidence that reindeer can fly. You see it on TV programs, you see it in movies, you see it on cards. Well, is it possible? I don't think so, but could I prove it. Well, I could take a reindeer and take him up to the top of the Peace Tower and nudge him off. Let's face it, if that reindeer ever in his life were motivated to fly, that's the moment. What would happen? I suspect we would have a mess at the bottom. I could repeat it with another reindeer and another. What will I have proven? Only that those reindeer on that given day, could not or did not choose to fly. I cannot prove that reindeer cannot fly—that there are not eight reindeer somewhere in the world, given the right conditions, the right stimulation, that cannot fly.

Similarly, we can never say that there will be no problem with genetic modifications. So far the problems that have cropped up have not been significant. The benefits outweigh the risks. The benefits may take some time to be manifested that is true, because the stage we are at with genetic modification, I think, is the stage of the Wright Brothers' first flight. I think



if you were present there, you would not have been very impressed. Because you would have seen this primitive contraption kind of bounce around for maybe 100 meters. Not very effective. But anyone there with some imagination would have realized that okay today it flies 100 meters, tomorrow it's probably going to be 200, and by next year a mile and within five years from city to city. That's where we stand. The principle is demonstrated. I think that we are going to see the benefits in the long run. So I'm not an enemy of Tony the Tiger of Frosted Flakes.

I think that exploring genetic modification is a good thing and there are going to be all kinds of benefits. I think the riskiest thing in life is not taking any risks at all, because then you never get anywhere.



Indeed we know that there are 2 billion people in the world who suffer from iron deficiency anemia because they subsist on rice, which has very low iron content. It is possible to genetically modify it to increase the iron content. We know that there are about 250 million people with significant visual impairments developed every year because of a lack of Vitamin A. That's because they subsist on rice which has very little beta carotene, which is the body's precursor to vitamin A. Golden rice can be engineered to have more beta carotene. It is not going to happen tomorrow, or next week, or in two weeks, but the principle has been demonstrated. Not only do I think we will be able to engineer things like broccoli to have more sulphoraphane, which is an anti-cancer compound, I think we'll be able to engineer crops to grow in soil that is very salty, which is a big problem around the world. So we have to have an open mind and realize that there are no guarantees but that the benefits are going to be very real.

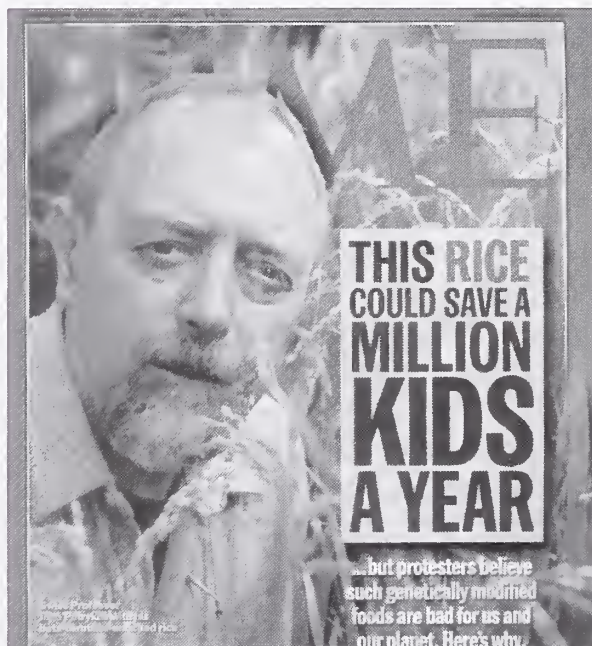
These are the kind of issues that we have to deal with all the time. But there are others, too, which are simpler and perhaps more curious, very often food related because everyone is interested in food.

I had a lady who called me up and said, "I have a carrot problem." So what's your problem? "I slice up

my carrots, I put them on a plate and put them in the microwave oven to cook them." Well, I didn't say anything about this particular technique of cooking carrots. But okay. So what's the problem? "They explode." Well, of course, this gets my attention. Over the years I have learned that you don't dismiss anything out of hand. You know, that's one of the worst things that you can do in science. You always investigate.

So I say, tell me exactly what you did and what you saw. "Well, I put the carrots on the plate exactly as I am showing you here" and exactly as you will do when you go home tonight. And she says, "I put them in the microwave and they exploded." So I said, describe the explosion. "Flames. Fire." So I say, Okay, and I've got to try this. So I go home, set it up just like that. Turn on the power. Sure enough, maybe not exactly an explosion, but wisps of flames, really interesting.

What's going on? Well, it turns out that the microwave set up mini electric currents inside the pieces of carrots. Sometimes a spark will jump the gap between the two carrots. As you can see where the carrots have become charred. But the carrot oils, of course, are also volatilized by the heat. And the carrot oils are highly flammable. So the spark will set these oils on fire and you get these little whiffs of flame. It's really interesting, you'll enjoy it.





Let me tell you that carrots are not the best. Green pepper is very good and orange peel is outstanding. You may have to play around with the distance, but it will happen.

Now I talked about this on the radio one day. I described it very much as I have described it to you here today and it turned out to have an interesting consequence, because I had a call from the manufacturer of Mrs. White's pickles. Now you probably have not heard of this brand pickle, but it is an outstanding brand and if you ever go to Montreal, make sure that you pick up Mrs. White's dill pickles.

But they had had a complaint from a customer who told them that while she was heating up her dill pickle in the microwave oven—and there are some issues that we just will not explore. She complained that they started to spark. Now the only time that she had ever seen sparking in the microwave oven, of course, was when she had put some metal in there. So she was convinced that the pickles were contaminated by bits of metal and she was threatening to sue. Well, one of the Mrs. White's pickle people had heard my explanation on the radio and wondered if this carrot effect would also apply to pickles. So of course I did the pickle experiment and it turns out that it does apply. Pickles can also spark in the microwave oven.

And as soon as we established that, they were able to allay the fears of this lady and I now have a lifetime supply of Mrs. White's pickles. And another interesting mystery has been solved.

But there are some that are even more interesting than that. Believe it or not I have had to answer questions like this. How do you open a cremation urn that has been epoxied shut? Why? Well, it turned out that they read the will a little bit too late. And the urn already had been glued shut, when they discovered that the victim wanted to have her ashes strewn over an area of the forest or something. So they couldn't get the urn open. So we had to do some experiments. So eventually it turned out that acrylonitrile was the right solvent. So if you ever have to confront this problem, you'll know that it is acrylonitrile that can open the epoxy glue on the urn.

One day I had to make a house call on a Barbie doll. Why? Barbie doll collecting is a whole world. They have conventions. They trade them. They sell them. It's absolutely fascinating. I went to one of these conventions with 5,000 Barbie doll collectors there. And they have hundreds of booths where they sell the accoutrements. They sell Barbie houses. They sell Barbie dolls. There are women dressed up like Barbie. It is absolutely fascinating. And some of the oldest Barbie dolls, of course, have huge value.

Well, this lady calls me up in panic, saying that she has purchased a \$5,000 Barbie doll and it wasn't perfect. There was little bit of her lip that had a dent in it where the paint had come off. And she had tried to fix it. And she had tried to fix it by taking a felt tip marker, a red one, to fill in the spot. She didn't reckon the fact that the ink would run. And it ran into the doll. So she wanted to know what she could do. So I had to make a house call.

I went with my solvents and my Q-tips and I investigated. Now when I first saw this doll, it really



was tragic. It was too horrible for me to show you what she really looked like after what was done. It was so terrible that even Ken was horrified.

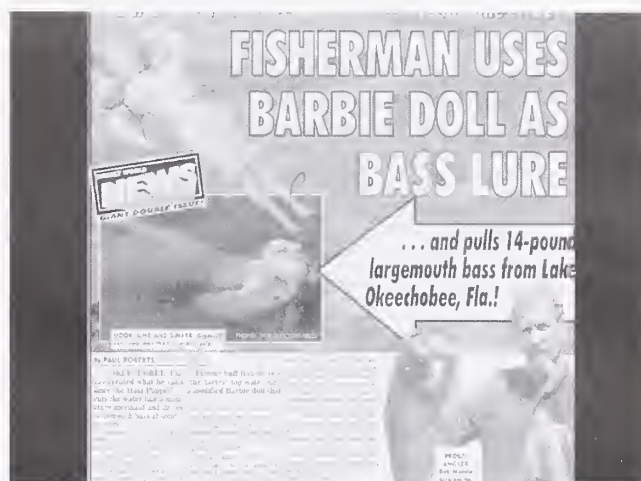
So I tried all my solvents but this time I could not solve the problem because the dye had permeated the plastic. The plastic was very porous to this particular dye. Eventually with a little bit of peroxide, we were able to lighten the color but that was it. And the doll obviously lost a great deal of its value and she was pretty devastated by this. But there is a moral here.



And that is, if you buy a \$5,000 Barbie doll, do not attempt to repair it with a 29 cent felt-tip-pen without testing whether or not it will run. What eventually happened to the particular Barbie doll I don't know, but if this lady were a regular reader of the tabloids, she may have used it for a different purpose because it turns out that Barbie dolls—at least according to this gentleman—are very good at bass luring. I don't know. I've never seen any scientific tests to attest to that.

A lot of the questions that we get asked in my office are by frightened people who are worried about toxins in their lives. Worried about keeping their health. All understandable, but very often confused. They think that there are simple answers to complex problems.

I will give you some examples. You know that one of the real worrisome issues these days is cholesterol.



Cholesterol has virtually become a four-letter word. Even those people who have no understanding of what cholesterol is want to eliminate it from their life. So you can understand why it was some few years ago when some scientific research showed that oat bran can reduce cholesterol, that this caught the public's imagination. Everyone wants to lower blood cholesterol because its is associated with heart disease.

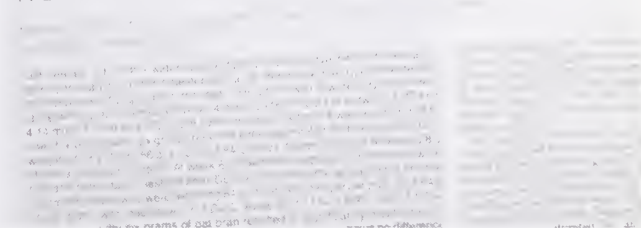
So stores were stripped bare of oat products. It was quite an interesting period.

Now before then oat products and oat bran particularly were very cheap. This is the outer covering of the oat and it was used only as animal food. So all of a sudden when it was discovered that oat bran could lower cholesterol, it was taken out of the mouths of horses and it was put on our breakfast plates. So what did that leave for the horses? Well, you guessed it. They were eating our foods, we were eating their food. It didn't matter what it was. It could have been dirty potato chips, if it said it contained oat bran, we wanted it. People thought that all their dietary sins would be forgiven if only somehow they could get oat bran into their diets.

Original Contributions

The Hypocholesterolemic Effects of β -Glucan in Oatmeal and Oat Bran

A Dose-Controlled Study



It was a very interesting period. It became a fantastically popular product—oats. Now up to that time it hadn't been that popular, except in Scotland, where Dr. Samuel Johnson, one of the authors of an English dictionary, told of how the Scots live on food which in England is given to horses. That was a definition used in a dictionary and as you can imagine it upset the Scots. The Scots, of course, had always been great proponents of oats. We know that porridge and haggis are made of oats. There is also a concoction that some of you may have heard of called athole brose, which is an alcoholic beverage made from oats. So the Scots were very familiar with these and they were really disturbed when Johnson said that this was only horse food and they had revenge. He was invited to give a public lecture in Scotland after which he was treated to some dinner, for which they gave him porridge. So the hostess asked him, "How did you like the porridge, Mr. Johnson?"

And he replied, "Very good for hogs, I do believe."

And she very cleverly retorted, "Well then, pray let me help you to a little more."

So the Scots have always been found of oats, but this has not been the case in North America until this interesting little episode. And that really popularized oats, particularly Quaker Oats. Everyone wanted to eat it because all of sudden it became a health food. It is indeed healthy, although there are no single foods that can be classified as angels and others denigrated as devils. We have to look at the overall diet. But if you put oats into your diet and in particular steel cut oats, I think that those are very tasty, you can indeed lower your cholesterol.

However, you have to look at numbers. In science we want to be quantitative, not only qualitative. When someone who is scientifically minded is told

that you can lower your cholesterol by eating oats there are specific questions that immediately pop into mind. 1) How much do you have to eat? and 2) How much can you lower your cholesterol? We want numerical answers. And the answers here are not that attractive.

You have to eat a lot of oats in order to have an impact on your cholesterol level. How much? Well, the particular kind of fiber, known as soluble fiber, that lowers cholesterol is beta glucan.

You eat about a cup of oat bran. It isn't always easy to do that because oat bran is not one of God's gifts to the palette. Oatmeal is more tasty and you can do that. Porridge is, of course, just another form of oatmeal. One and a half cups a day, cooked oatmeal we're talking about, can have a very significant lowering of cholesterol level, plus it also gives you some insoluble fiber which is great for the intestine and generally it will also help dieters because it will fill you up and it will make you eat less of other stuff. So I am a great proponent of oats, although they are not miracles.



There is no single food that is a miracle. Cheerios has recently discovered that the O in Cheerios stands for oat bran. Prior to all of this stuff, they probably didn't even realize that they were making their product out of oats. But now it has become a health food. But you also have to eat a lot of Cheerios in order to have 3 grams of beta glucan. As you can see about five servings. Although I'm sure that General Mills, the maker of Cheerios, is working on making a bigger Cheerio so that we don't have to eat quite as many in order to get the beta glucan.

You know today we are accustomed to talking about foods in terms of are they were good for us or not, is it healthy or not. But you know that is a rela-

3 GRAMS OF BETA GLUCAN	
OAT BRAN HOT CEREAL	1 CUP
OAT BRAN MUFFINS	3-5 MUFFINS
OATMEAL	1.5 CUPS
CHEERIOS	5 SERVINGS

tively new concept. Because today we have the luxury of talking about these things, especially in North America, because we don't have to worry about not having enough food, at least most of us don't. We don't appreciate the fact that every 3.7 seconds someone in the world dies, purely from not having enough food. So we have the luxury of worrying about whether our food is genetically modified or whether or not there are specific additives in our food. Most of the world is quite happy just to have food to eat.

So what about this business of the health connection that we worry about—the notion that you are what you eat? Where does this trace back to? Well, actually the first person to start talking about this was Hippocrates a couple of thousand years ago when he said, “Let thy food be thy medicine.” This was pretty good advice. Although he was not very clear about what you should eat. He didn't know that. He knew that there was a relationship between food and health. Of course, Hippocrates also thought that rubbing pigeon dung on a bald head would grow hair. So he was not the ultimate fount of good information.



It was this gentleman, however, who first gave us what was really quite solid advice about what we should eat and how it connects with health. This was Sylvester Graham. Graham was a Presbyterian minister, the son of a Presbyterian minister, in the 1800s in New England. And in those days ministers made a living by going around from congregation to congregation giving sermons and then putting out the proverbial hat and if people liked what they heard, they would support the preacher.

He began by preaching abstinence from alcohol. As you can imagine, this did not go down well in New England in those days, when the traditional breakfast was bacon washed down with whiskey. So people didn't want to hear that. So he had branched out into another area. So he decided that he would become a nutritional expert. Of course, he never

studied any nutrition, but he became a nutritional expert and he had a nutritional scheme. He said that there were some things that we should just not do in life, and for that he became known as Dr. No—the original Dr. No. Because he said, no meat. Why no meat? He said that it would inflame the passion. He suggested that it would make people engage in activities that he thought should be reserved for procreation only. Because these activities robbed the body of energy so that you didn't have enough energy left to maintain health or to cure yourself from disease if you got ill. He also suggested no spices, no caffeine, no alcohol, and no doctors. Which to be honest with you in the 1800s was not a bad idea. Because in those days what did doctors do? They purged patients. They bled patients. If you got better, it was usually in spite of the doctor not because of him. So that was not bad advice.

But his most venomous attacks were against meat. Because this was sexually inflammatory, he said, and it would cause people to do horrific things. What kind of horrific things? Well, for example, an activity that was classically discussed in the Seinfeld episode known as the Contest, where this activity was never talked about by name, but everyone knew exactly what was being referred to. And this is also what Graham suggested. He said that people who ate meat were led astray, destined to take matters into their own hands, and this would rob their body of energy, and that's why they were constantly sick. So he said, “Leave meat alone, go on a whole grain, vegetable diet and you will be better.” That was good advice. In fact, it was the same kind of advice we give today, but not for the same reason. He was quite wrong about meat inflaming the passion, but he was correct about the advice that was given.

So if you want to eat, what would you eat? Well, you would eat graham crackers—the world's first anti-sex food, although, of course, it is no longer being marketed in that particular fashion. But that was the origin. And people who started to eat more fruits and vegetable and more whole grains, probably were better off because the traditional diet in those days was really atrocious.

Today we have many nutritional gurus who have followed in the footsteps of Sylvester Graham, some with equally outlandish ideas. When you walk into

any book store today and you begin to wonder why it is that we train physicians and nutritionist when we have all of this advice that is readily available. Any disease that is known to mankind can be cured just by having the right diet or by staying away from certain foods.

Well, I like to pick on some of these books. And this is one that I particularly enjoy taking a poke at. This is really an anti-science book. Now before I go on and tell you all of the terrible things that this book does and has in it, I should suggest that the diet that the authors recommend is not a bad diet. They end up recommending mostly a vegetarian, whole grain diet, so I don't have any complaints about that. They also end up recommending a system of food combining, such as not eating proteins with carbohydrates and eating anything but fruits before noon, they tell you, don't worry about the diarrhea. Anyway, the diet is not bad, but all of the nonsense behind it and explanations, are terrible. It pollutes the mind and creates an anti-science environment.

Let me give you a classic paragraph from this book. Hold your chairs. "Within atoms and molecules reside the vital elements we know of as enzymes. Enzymes are not things or substances. They are the life principles in the atoms and molecules of every living cell."

I first saw this handwritten. It was brought to me by a student. I had not read the book at the time. She wanted to know what this was about. Gee, you know this must be some kind of joke. Someone must have sat down and said to themselves, "What is the greatest amount of silliness that can be put into the fewest words?" I think this is a candidate for that. Obviously, enzymes are things, they are real, you can put them in a bottle. You can put them on a shelf. These deluded people seem to have the idea that enzymes are some ethereal substances, perhaps akin to the human soul, which we may or may not have. I don't know. Some of us may and others not. But, in any case, you cannot put it into a bottle.

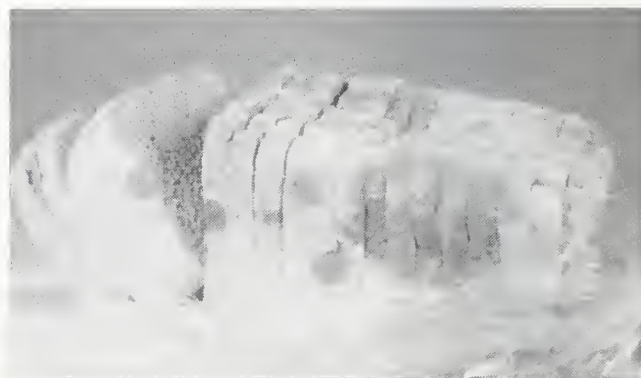
What they suggest is that when you process food, you kill the food because you destroy its enzymes. Now enzymes, of course, have real biological value. We couldn't live without enzymes, but we produce all of the enzymes we need intracellularly. We do not need them from an outside source, and we cannot use

them from an outside source because they are metabolites like any other protein. But this is the kind of nonsense that they disseminate.

They also tell us that you don't want a microwave oven in your kitchen because it is like living next to a nuclear reactor. Well, I could even argue that living next to a nuclear reactor is not a bad place to live because there will be very few traffic accidents there. But never mind that. The suggestion that microwaves somehow are akin to nuclear radiation is ridiculous and it just scares people.

They delve into every area of our life, including our love life. Believe it or not the authors tell us that you must not have female orgasm during pregnancy because it cuts off the oxygen to the fetus and results in inferior brain development. Now I don't have any idea where they would pick up something like that. Even if you had such a hypothesis, how would you go about testing this?

They tell us that the greatest threat to health is processed foods, such as sliced bread. Now I'm not going to tell you that sliced white bread is a great source of nutrition. Of course, it's not. And of course, we should be eating whole grain breads as much as possible. I will, however, tell you that people have survived eating white bread. It is not a toxin as they imply. They tell us that processed foods such as this are a great threat to health because chemicals are used to process them. Here again, chemicals are synonymous with poison. Yes, processed foods do use chemicals. Why? Because we know that if you don't add a preservative to white bread like this, within a couple of days, this is what happens. And market studies have shown that people do not buy this kind of bread.



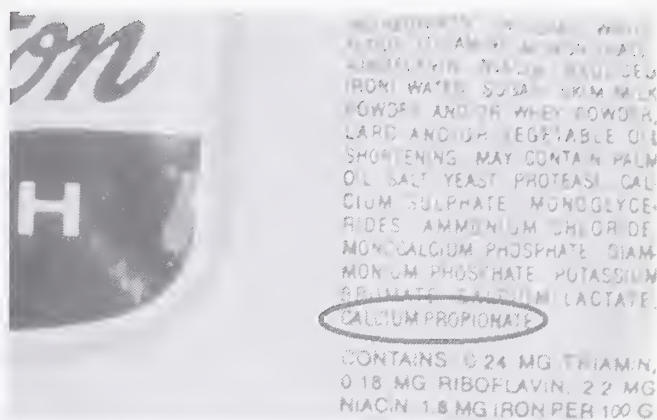
So because of that we add a preservative. The preservative that is used is calcium propionate. A very effective preservative because it is a good mold inhibitor, but it allows yeast to thrive, which is exactly what you want in bread.

But then they get worried because there is a chemical in their bread. Well, first of all I think it is important to point out that bakers and other food processors cannot just randomly put additives into foods. It doesn't work like that. You have to apply to be allowed to put certain additives in and you have to satisfy the government and it takes lots of studies in order to do that. There are all kinds of regulatory hoops and hurdles. So by the time an additive is approved, there is a lot of information to suggest the benefits outweigh the risks.

In the case of calcium propionate there really is no problem, because we have lots of it in our bodies anyway. It is a byproduct of metabolism. Whenever we take in fat we produce propionic acid and propionate. In fact, we sweat preservatives. If you analyze your underarm sweat, you will find calcium propionate in there.

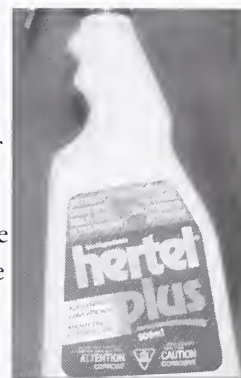
Which is interesting because it explains a feature of French life. If any of you have ever been to France, and purchased a baguette, you know that they are delicious. But you have to eat them within about 19 seconds of buying them because they don't have any preservatives, so they will go moldy and they will go hard.

You know the Frenchman's traditional way of carrying the baguette home, which is the ultimate preservative process and it's all natural of course.



In talking about these things, how can we not talk about interesting things like cleanliness and cleaning.

I had a lady call me up. She wanted to know about this particular cleaning agent, which happens to be a good one, Hertel Plus. She has been reading the liquid ingredients on there and finds sodium tripolyphosphate. She calls me up and wants to know if this is a chemical.



Well, right away I know where this conversation is going because what she is really asking is is this dangerous? Is this poisonous? Is this toxic? Because in her mind, of course, that's what a chemical is.

So, of course, I go through my usual spiel, telling her that everything in the world is made of chemicals.

If you're buying something without any chemicals, then you are not getting a very good deal, because you are buying a vacuum. And I think I was able to explain to her that the phosphate is in there to combine with minerals in the water, which would interfere with the activity of the detergent. And she bought it because after all if you expect to see chemicals somewhere, it is in cleaning agents. That's okay. That's where they belong.

But two weeks later she calls me again, panic in her voice. She has again found sodium tripolyphosphate, but this time on a different label. This time it was on a food label and it happened to be Kraft dinner. So she calls up and she says, "Look, I feed my son a Kraft dinner every single day." Apparently this was something that was of no concern to her. But what was of concern was that it contained

tripolyphosphate and she wanted to know why a cleaning agent was in the Kraft dinner. She knew that eating this was messy business and she wondered if the company has developed a secret process to clean her son from the inside out.

Of course, I explained to her that this was not the situation. The phosphate was put in there because it enhances water absorption by the macaroni. So she can give her son the macaroni, which apparently was the only

thing she was ever feeding him, very rapidly. I'm not sure that she was satisfied with this. Cleaning agents are one thing. There the phosphate agents are fine, but you don't want them in your food. Even though I explained to her that phosphates occur in nature, that every time you take a bite of meat you get far more phosphates naturally than you would get in the macaroni.

Where do they get such ideas? Well, from reading books like this book about food additives. Imagine if my phosphate-fearing friend looked it up in this book. What would she find? Obtained from phosphate rock. Highly alkaline. Shampoos. Cuticle softeners. Bubble baths. All of that makes sense. Then to find that it is also used in incendiary bombs and tracer bullets. Now not only would she worry about her son being cleaned from the inside out. Now she begins to worry about him exploding and disappearing, although probably not without a trace.

The author has made a fundamental chemical error. She has confused phosphorus with phosphates. Phosphorus indeed was used in incendiary bullets.

Phosphorus is the element. When you combine it with oxygen to form phosphate, it has completely different chemical properties.

This is tantamount to saying that water is a dangerous substance because it has hydrogen. And you



know what hydrogen can do. You remember the Hindenburg. You remember the Challenger. Hydrogen is very explosive. Therefore, you have to worry about water. Of course, when hydrogen combines with oxygen, you get something that is quite different in physical properties. Such is the case here as well. But it is very difficult to get these ideas across to people who have literally no scientific background whatsoever. These books tend to be sensational and sensational ideas sell.

People want to know what to worry about. Of course, it is a natural thing to worry. And they cater to that. They give them things to worry about that needn't be worried about. One of the most important things in life, I think, is knowing what to worry about. You don't want to waste your worries. Worrying is very stressful. There are enough things to worry about beside phosphate in macaroni.

They also get these ideas from "they." The all-inclusive, wise "they" who know everything. They say that. Well this "they say" can be a problematic business.

I'll give you an example. Remember the old days of playing telephone when you were kids. You would whisper something into someone's ear and they would whisper it into the next person's ear, etc. And by the time it has gone through a channel of whispers, the information would come out very different.

I find this all the time. I will do something on radio or TV and I will hear what I said or what I did, and it will be quite different from what actually happened because people are not very good observers. You know that if you have 10 witnesses to a traffic accident, then you'll get eight different stories. Right?

People are not very good observers and they do jump to the wrong conclusions.

I'll give you a classic example. One day I was talking about a particular kind of color—cochineal red, which is very often used to color cherries like Marichino cherries. It is also used to color cherry ice cream and strawberry ice cream. It is a fascinating dye, which comes from an insect source. These small insects are raised on cacti in Mexico, the southern U.S., and the Canary Islands. And the female of the species produces a red juice, which can be processed into a very effective dye for coloring ice cream. These insects are very small—smaller than a cockroach. This is a dye that has been used for centuries and is one of the best time-tested products.

I told this story on the radio very much like I told it to you here today. What happens? A couple of days later I get a letter from a lady who says that she has told this story to her friend, who refused to believe it. And she was now asking me to confirm in writing that there are cockroaches in chocolate ice cream.

Well, you can see what happened. She heard the word ice cream. She heard the word cockroach, which was only used to describe the size of the insect. Maybe not the most appropriate analogy. I had never mentioned chocolate, but that must have been her favorite ice cream. I had talked about strawberry and cherry. She had picked up a few smidgens of truth that metamorphosed in her mind into something that was completely different. And probably caused anxiety in her friend, who is probably a chocolate ice cream lover and now thought that chocolate ice cream was colored with cockroach juice.

So you can see how important it is to try to communicate effectively and to get the information across.

Incidentally, there is nothing wrong with coloring with insect extract. I mean that's just a personal, social upbringing. Why is it that someone's mouth waters at the thought of eating the rear end of a cow, which is what steak is, and they are horrified by the prospect of a little bug juice in their strawberry ice cream? So there's really nothing wrong with that but I'm sure that there is a lot of needless anxiety created here.



So what we need to do is powerful education. From early on in life we need to get kids thinking scientifically. We need to promote scientific education at all levels and to foster critical thinking. But it is not an easy challenge. Especially because people are not good observers and are not very adept at coming to the right conclusions based upon the observation.

And we are challenged by one other problem in our attempt to communicate science. And that is that we can never have conclusive answers. We can never say that something cannot be, that it is totally nonsensical. There is always a maybe. That's why so many scientific publications are infused with perhaps and maybe and if, etc. Because it is rare that you can say something absolutely conclusively. And we all have to keep in mind that as scientists we are certainly not infallible. We have to keep an open mind. Obviously, not so open that our brain falls out. But an open mind, because stuff happens that is unexpected and we have to be ready for it.

And I'll give you my final example about that. Remember a couple of years ago, when Coca Cola came out with New Coke. This was because they had been engaged in a long battle with Pepsi. And Pepsi had set up these booths in shopping centers where they were doing the Pepsi Challenge. They were giving people Pepsi and Coke and asking them, which was better. Much to Coke's dislike, people liked Pepsi too often. So they decided that they needed a marketing gimmick of their own. And they approached their advertising agency and the agency told them, "Look, Americans like new and improved, so come up with New Coke."



Boy, was that bad advice. Americans may like new and improved but not in every facet of life. There are some things you don't play around with, motherhood, apple pie, baseball, and Coca Cola. They changed the formulation, slightly. I mean only so that they could say that there was a change—nothing of any importance.

But, of course, there was a rebellion among the masses, who didn't want Coca Cola played around with. And there was tremendous concern. They started Old Coke Drinkers clubs, they hoarded the product, etc. Eventually Coke relented and they reintroduced Coca Cola Classic and now New Coke has been phased out. And now we have the old Coke, which has become the new Coke, etc.

But about 15 months after the introduction of the New Coke, scientists began to hear some reports from certain areas in Africa about an increase in the birth rate. And no one could understand this because it was in the little villages where Coca Cola consumption was said to be very high. And a few researchers even suggested that there had to be a connection. That somehow the increase in birth rate was too tied in with the introduction of New Coke. Of course, most scientists said this was absurd. There can't possibly be any such connection. Then two Harvard researchers decided to investigate. They found that indeed there was a connection. It seems the ladies in these villages were not using Coca Cola as a delicious, refreshing beverage. They were using it as a contraceptive. Well, how does one do that? I'll leave that to your imagination. I'll just tell you that you don't drink it. You make use of its spermicidal properties.

Now, of course, as the researchers heard this, they said maybe, but is it testable? So they went into the laboratory and got some sperm. And you know these

little guys like to swim. So they put them in a petri dish. And they decided to measure what is called the sperm motility. How quickly they swim. So they measured it in Coca Classic and found the sperm motility. Then they took New Coke, measured it and what did they find? Sperm motility, five times greater. These little guys were five times more active in New Coke than Old Coke and there was the answer. New Coke was not as effective a spermicide as Old Coke had been. Now just why that is the case nobody knows. The Coca Cola company did call a press conference, but the only comment they had was that Coke markets itself as a delicious, refreshing beverage.

And then you know how researchers are. They like to push the envelope. So you tested Old Coke and New Coke, so you better test other soft drinks too. So they decided to test Diet Coke and discovered something staggering. Sperm motility was zero. Which, of course, leads us to the final scientific conclusion, based upon the observations, that as far as chemical contraception goes, Diet Coke is it. Right? Well that's it for me too.

Coke Brand	Sperm Motility
Old (Classic)	8.5
New Coke	41.6
Diet Coke	0.0

Except for one little finale to this whole enterprise. Which comes for two reasons: My publisher insists that I always mention that there are books to be purchased, and the other is that because there is a story with that too that is very illustrative of our attempts at communicating science and some of the pitfalls. Two years ago when I was approached to put together a book, I said, yes, I would be happy to do that but I want it to be called, *The Right Chemistry*. Because I was so tired of all the perjoratives with chemicals, you know dangerous chemical, toxic chemical. I wanted *The Right Chemistry*. And the publisher thought, "Yeah, that's a pretty good idea."

And I put together the book, and they thought it

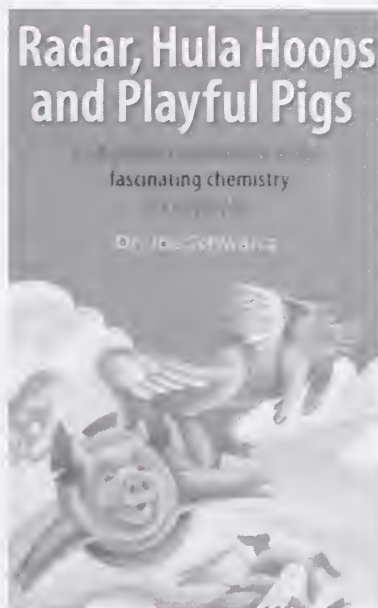
was interesting. And everything was just about set until I get a call from him saying that he had been showing this to his sales people in the U.S. and while they liked the book and they liked all the stories in there about the discovery of gunpowder and why Rasputin wasn't poisoned by cyanide and how to remove skunk smell and the link between vitamin E and heart disease and how selenium may prevent certain cancers and all that, and the ups and downs of underwear, but you can't call it, *The Right Chemistry*, he told me. I said,

"Why not?" "Because it's a scary word.

People are not interested in chemistry. It frightens them. They think about formulas. They think about equations. Only the nerds are going to buy it, and they don't spend money."

So what do you want? You have to change the title. You have to have something a bit more captivating. Do you have any suggestions? This is when he brought up the idea that one of the chapters in the book, "Radar, Hula Hoops and Pig Balls," at the time. And it was a chapter about polyethylene, which was used as sheathing material around radar cables during the second World War, and helped win the war. After the war it was used in hula hoops, which was a financial windfall for the inventor. And then a clever farmer realized that his pigs were biting each other when they were in close confinement—on the ear and on the tail—that required antibiotics which is expensive. They were doing this because they were bored, and they could be entertained with polyethylene balls, which were pig balls, and then they would leave each other alone. These were the pig balls. That was the title of the chapter. That's what they wanted to call the book.

I said, well no. I'll go for the radar, I'll go for the hula hoops, but I'm no pig ball man. And I suggested, therefore, playful pigs. Which also meant that the



cover had to be changed because the test tubes and other things that were on the cover were no longer applicable. So they hired a graphic artist who came up with this cover design, which has flying pigs—which is a problem. Flying pigs and science don't go together that well. But it was too late. And I kind of liked the pigs, they were cute. But the major problem was that the story has nothing about flying pigs. The pigs were walking pigs in the story. So I had to go back and rewrite that piece of the story so that now there are legitimate flying pigs in there, scientifically flying pigs.

Anyway, I did this and the book sold well in Canada. I thought that by the time it came to the next one, I would be allowed to call it *The Right Chemistry*. No, the publisher said, people are scared of chemistry. You have to come up with something else. So I did. I have had a long infatuation with Barbara Eden, who used to play in *I Dream of Jeannie*, in the old TV show. That was my favorite show when I was a kid. Even then I remember wondering about how she came out of the bottle with this puff of smoke. I discovered when I was in graduate school that it was a chemical reaction that they used. Hydrogen peroxide, they found, under the influence of MnO_2 , manganese dioxide, mixed with water, is exothermic and you get the steam. All you have to do is mix the two chemicals. And that always intrigued me.

And then two years ago, I was out in Vancouver on behalf of the Discovery Channel doing a trade show in their booth. As luck would have it, next to us was the Arts & Entertainment booth, A&E. And they had just bought the rights to the old *I Dream of Jeannie* TV show. And who was there to promote this, Barbara Eden. So as you can imagine, I high-tailed it over there. I got into a conversation with her. Did she remember how she got out of the bottle? She told me she didn't even remember how she got in it.

And I described to her the chemistry. I even showed her the chemical reaction. I thought, "Gee, if she thinks this is neat, it really is. I can use this reaction to be the focus of the next book." And it turned out to be the case, and it became the *Genie in the Bottle*. Because it did allow me to give that particular account and also because I like the idea of the *Genie in the Bottle* as a metaphor for science. Because I think science can do absolutely marvelous things if it

is handled properly. It is just like a genie in the bottle. But you have to be careful about letting the genie out, because once it's out you can't put it back into the bottle.

So I like that idea about the metaphor—about the care we have to take with science—and, of course, I also like the story about Barbara Eden. And now I thought that maybe the next book, I'm going to be allowed to call it *The Right*

Chemistry, but that's not going to happen either. It is going to be called, *That's the Way the Cookie Crumbles*. And maybe by the fourth

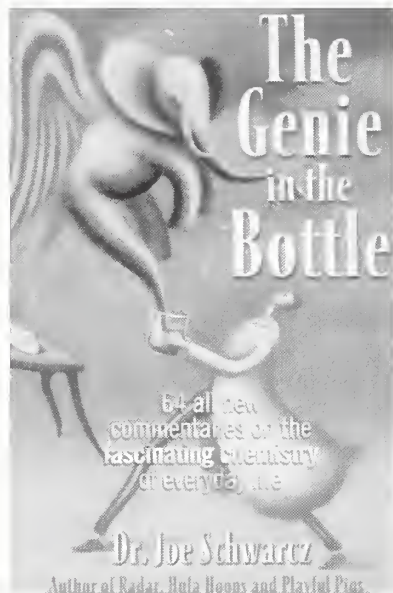
one I will have done enough groundwork to do it. But probably not. Because I think that the publisher is right. And that's the bottom line of this whole story. If it were called *The Right Chemistry*, it probably wouldn't interest people that much and it wouldn't capture the imagination. Because they don't think of chemistry as a positive thing in life, as potentially interesting. So sometimes you do have to sugarcoat it a little bit in order to get people to taste it. And once they taste it, I think that they will like it. So although at first I wasn't particularly fond of catering to public misconceptions, I think that there is a certain extent to which you have to do that, if that's what it takes to capture the attention.

So I hope that I have been able to get across some ideas about what it takes to communicate science to the public, and some of the misconceptions out there. And why I think that it is such an important job. Because when people are ignorant of science they will be more anxious than they should be about things that they do not need to be anxious about. They will ignore other things that are worth worrying about and they will very often fall into the clutches of charlatans. Because when science doesn't have the answer,

the quacks will rush in to fill that void unless we arm the public with enough weaponry to make sure that that doesn't happen.

And we can do that by properly spreading scientific information, making sure people understand that chemists are not different from other people. But we do possess the vocabulary and the equipment to make life not only more interesting but more understandable for everyone. Thank you.

Note: Due to technical difficulties, Schwarcz's talk to the Best Practices meetings was not recorded. The transcript above was created from a videotape of a very similar talk given by Schwarcz at Carleton University in Ottawa, Ontario, Canada in 2002. Thanks to Carleton University for their assistance.



Putting Communications Research and Evaluation into Practice

Susanna Hornig Priest, Associate Professor, Dept. of Journalism, Texas A&M University

Priest: I'm going to talk today about the results from an analysis I did of a survey that we did at Texas A&M in April and May of the year 2000 on public opinion about biotechnology. This was actually a part of a major effort involving 14 or 15 European Countries—I've actually lost track—as well as Canada and, most recently, Japan to study the relationship between public opinion and media coverage, particularly newspaper coverage in all of those countries. As part of my work for this group, I decided to take the U.S. data set and use biotechnology as a case to talk about some of these issues of public understanding, science journalism, science communication's role in agenda setting, framing, and cultivation. These are all processes that inform public attitudes, public opinions, and public perceptions of science.

I think most of us have heard of biotechnology and genetic engineering by now, but some of us have followed the public opinion literature more closely than others. I actually have a subtitle here to lead into the discussion of opinion: "Four Myths, a Hypothesis, and a Partial Solution and a Caution."

One of the four myths is that biotechnology in the United States is not controversial in comparison to what's gone on in the UK and Europe. This is actually a greatly overstated assumption. Genetic engineering, at least by that name, is enormously controversial in the United States. And the controversy has been increasing for a long time. As a basis for comparison, consider public responses to several other technologies that were included in our study. For space exploration, for example, only 7.7 of the people we surveyed thought that space exploration would make the quality of life worse over the next 20 years. We also asked this question about the Internet. And somewhat to my surprise, 15.8 percent of the population thinks the Internet will make the quality of life worse. I've heard several explanations proposed, ranging from Internet pornography to withdrawal from social interaction.

About a third (32.4 percent) of the U.S. population thinks that nuclear energy will make things worse over the next 20 years. For genetic engineering nearly the same percentage of people (30.1 percent) hold this opinion—and by the way they are not necessarily the same people. If you think that nuclear energy is likely to make the quality of life worse, you are a little more likely to think that genetic engineering is going to make the quality of life worse, but by and large those are not the same group. The comparison, though, that I want to make is this: We'd all acknowledge that nuclear energy is controversial in this country. We may think that people who are opposed to it or people who are in favor of it are "out to lunch," depending on our own personal opinions. But we don't argue very much that it is controversial. This is pretty much accepted.

But genetic engineering is different. Until quite recently there was a perception that people weren't concerned about it. They are. That perception may itself be a media effect. One of the things that the media do is rely on statements from people who are promoting one agenda or another, including, in this case, the promoters of biotechnology—both scientists and people in the corporate world. By and large these people are positive. Our mainstream media are very heavily subsidized by those kinds of information sources, and they tended to ignore the controversy that exists in the United States in greater proportions than in some European countries.

My second myth is that opposition to science and technology results from ignorance. I think a lot of people in this room, assuming that more of you are scientists than are journalists, probably begin with the assumption that the problem is that people don't understand genetics. They don't understand biotechnology. Our survey used six different biotechnology applications, some from medicine, some from agriculture, and asked people as one of many, many questions whether—bottom line—they would encourage

Encouragement and Knowledge by Education Level

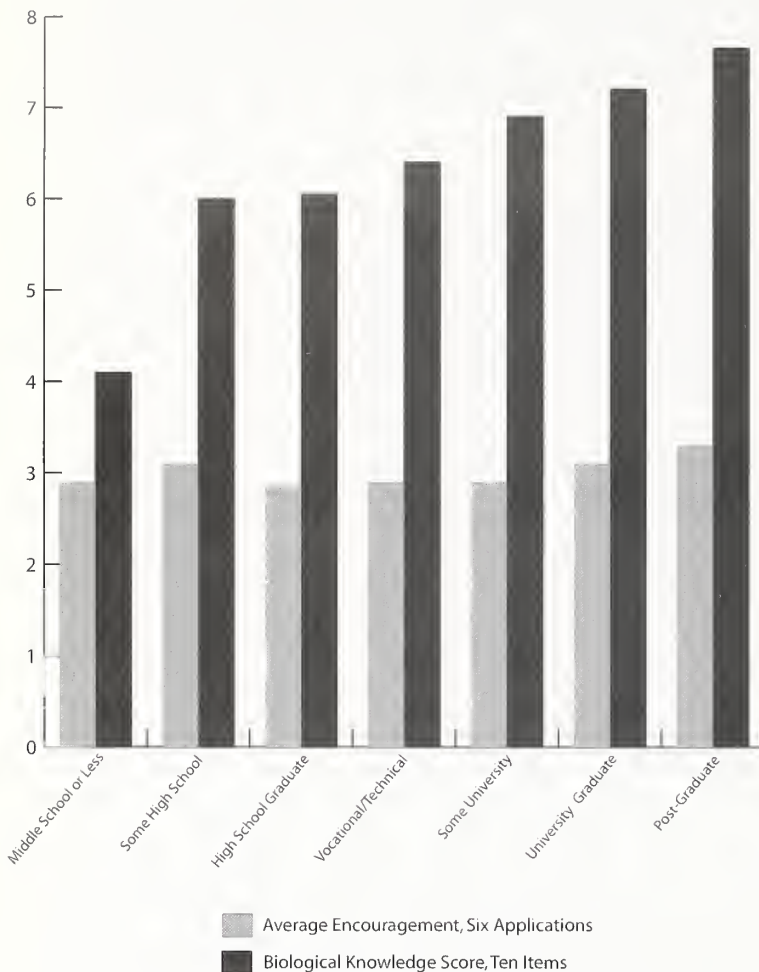


Figure 1

these technologies or not. I don't have time to go into quite all the variations between the different forms of biotechnology in terms of response. Basically, however, there is very little relationship among education, knowledge, and encouragement of these applications.

As people's education goes up, not surprisingly, people's ability to score well on a short test of biological or genetic knowledge goes up. [See Figure 1.] These questions were borrowed from my Canadian and European colleagues and included ones like: True or false, only genetically engineered tomatoes have genes. The more education you have, the better your ability to respond to these types of questions in ways we think are correct. But overall encouragement for biotechnology doesn't lie with education particularly. And, in fact, it is only weakly related. The overall correlation between that biological knowledge score and

encouragement of biotechnology totaled over six applications is a fairly modest 0.25. There are a lot of other things going on.

One of the other things going on is that for many people, educated and less educated, this is a moral argument. The bar on the left [see Figure 2] is average moral acceptability. Is this application morally acceptable? This varies across the six applications we tested, but if you put them in order by lower to higher moral acceptability, you get the same pattern as for the darker bar, which is back to that level of encouragement variable. As moral acceptability rises, the level of encouragement rises.

By the way, that third bar is people who remembered taking six science courses in college. Basically, you can see that they aren't that far from the general population in terms of their support or encouragement for these technologies or the degree to which that seems to be related to moral acceptability. So it's not really a question of knowledge.

I think another myth that I haven't heard expressed so often but that is kind of implicit in this discussion of morality is that maybe this has something to do with religion. One of our questions asked people how religious they are. We have a whole range from actually anti-religious to extremely religious. There is some relationship between this and biotechnology knowledge. People who are extremely religious tend to have a little bit lower scores on that knowledge test. Maybe a weak relationship between encouragement and religiousness, but clearly it is not entirely a linear relationship. Maybe it is the people at both extremes, but the overall correlation between the degree of religiousness and biotechnology is even lower than for knowledge, a very modest 0.16, and that, in fact, excludes the 1 percent of our sample who stated that they were anti-religious as opposed to not religious. Because it is such a small group, I threw them out; otherwise the figure would be even lower.

So it's a moral issue we are looking at, but it is not an issue of religion per se. Concerns are not confined particularly to religious extremes, although there is some relationship there. Encouragement is just not that closely associated with religiousness. By the way, it doesn't seem to be associated with political affiliation in this country, either. We looked at that. We

couldn't find any pattern really worth talking about at all.

Does it have to do with some of the other things media might do? If science literacy in the narrow sense of better abilities to score well on tests is not really the issue, then maybe we ought not to be thinking of science journalism's role or science communication's role as simply increasing factual knowledge. If we want a public that is more comfortable with science, we're going to have to look in other places. So what are some of the other effects of media on perceptions? You been introduced to the notion of agenda setting. What are people paying attention to? How novel and strange is an idea? Maybe one of the things that media accounts might do is just get people more familiar with the topic. Maybe they make them feel better informed, more on top of things, regardless of whether they're actually scoring better on objective tests of knowledge.

There is a little bit of relationship here, apparently, but not very much between biological knowledge and some other factors. How frequently do you talk to others about biotechnology? So how much is this a general topic of discussion around your house? The more frequently you discuss these issues, the more knowledgeable you are. I didn't run significance tests; it probably would have been statistically significant because it's a big sample. But there isn't a big difference between people who don't talk too much and people who talk a lot about biotechnology issues in terms of encouragement. Nevertheless, there is some relationship that's apparent there.

What about recency of exposure? I thought maybe at least the media, by telling people about these issues, by getting them familiar with these issues over a period of time, might have an effect on public attitudes. So I put a question in there about how long ago somebody remembers hearing about biotechnology, so we could judge the time that's elapsed since they first remember hearing about it. Again, their knowledge goes up

if more time had elapsed, maybe because they themselves are connected to the scientific community or because they read different kinds of publications, but the level of encouragement stays about the same. If there is a relationship there, it is not a very strong one at all.

What about how well informed people think they are? Clearly if people think they are better informed—and this is encouraging—they do, in fact, score better on that true and false test of knowledge. The ones that think of themselves as more informed, generally speaking, also have a little bit more encouragement. But again, this is not a strong relationship.

**Average Moral Acceptability (All Respondents),
Average Degree of Encouragement (All Respondents),
and Average Level of Encouragement
(Respondents with Six College Science Courses)**

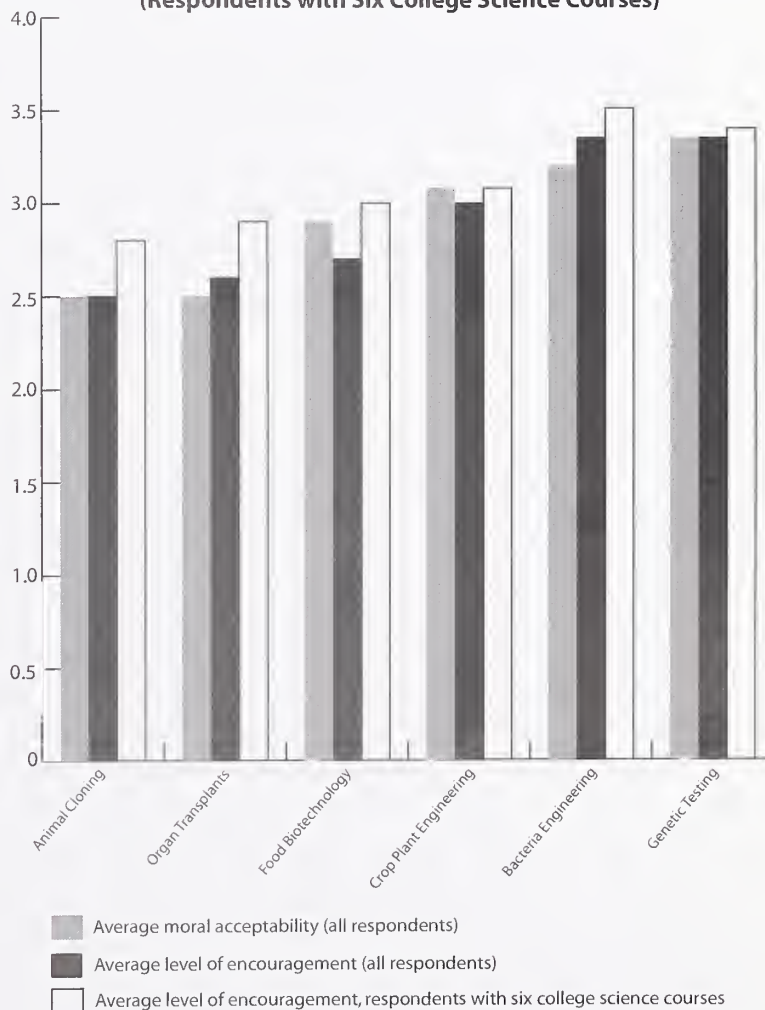


Figure 2

So I guess my fourth myth is that as levels of awareness and information rise so will public support—regardless of factual knowledge. There is some weak support for that but basically, there are more questions than answers suggested by our data.

We tried to sort this out a little bit more clearly. It is great fun to be playing with such a huge data set and I haven't even started to look at the other countries yet. It is kind of a terrifying thought. But you end up in a situation like this, with a lot of data, and would want to reduce it to something that people can get a better handle on.

This is one of the ways to do it—basically a series of regression analyses, resulting in what we call path analysis. [See Figure 3.] This is simply a way of representing complex relationships between whole bunches of variables. The ones on the left, we are calling independent variables. There are relationships between age, gender, education, income, and number of college science courses and this encouragement score. And then, in between, as kind of mediating variables, we put those elements that we thought were most likely, based on this preliminary analysis that I just showed you, to be responsible for whether or not people encourage biotechnology, feel positively about

it, including the ones I talked about and a couple of others.

We developed a food concern index based on people's answers to a series of food safety questions. Were they concerned about nutritional quality of food, were they concerned about contamination, pesticides, and a series of other things? One thing the media might do that we might be concerned about is that maybe they give too much risk information out, over-sensitizing people to risks so they are afraid of the next controversy that comes along to a greater degree. Well, it does turn out that people who are generally concerned about the safety of the food supply are a little bit less likely to encourage biotechnology, but it is again only a weak relationship.

There's our knowledge score. [See Figure 3.] Yes, if you know more about these technologies or genetics or biology in general, you're going to be a little more encouraging. But again it's not a very strong relationship. That awareness index is the three kinds of mushy variables I just got done talking about: how frequently you talk, whether you consider yourself informed, and how long ago you heard about biotechnology. We collapsed these into a sort of awareness index. That's a very weak relationship. (I

might get a better picture, if I sort of took that apart again, since those variables behave a little bit differently. We had thought of them as being kind of intertwined when we first came up with them.)

The biggest relationship here is the one between trust in biotechnology providers and the encouragement score by far. I don't have quite enough time to go into that in great detail. But we did ask people in this survey whether they felt that a whole series of entities related to biotechnology were doing a good job for society. And some of them were more popular than others, and some of them were more closely related to encouragement than others.

You'll be happy to know the results, I think. People think scientists are doing a good job. Scientists are the clear winners. Farmers are doing a good job, another clear winner. Industry is doing a pretty good job,

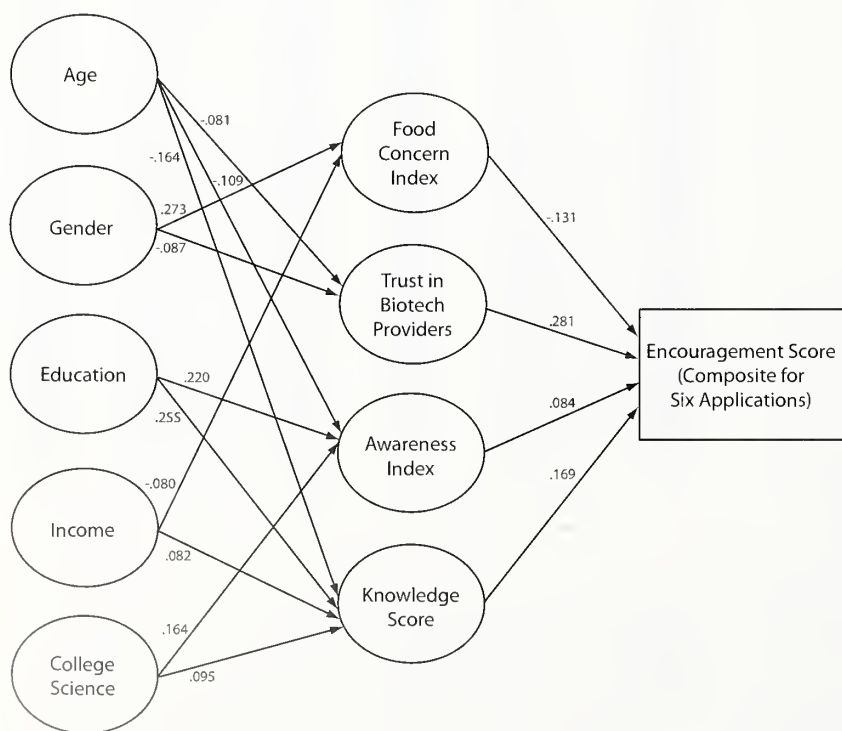


Figure 3

maybe not as strong—this is somewhat to my surprise actually. I've been concerned about the over-promotion of biotechnology. It might, in fact, have produced a sort of backlash. But, so far, people are pretty confident that industry is doing a good job. Number four is consumer organizations.

Who are the losers? Actually, there are three losers. Want to guess what they are? Media is one, although it's about tied with some others. We [media] are not a big loser, but we're not in the same category as science or farmers. Government is the strongest loser. Is government doing a good job regulating these technologies? There is a lot of concern about that. The third loser, for reasons I can't explain, is churches. People don't think churches are doing a good job. Maybe they are looking to religious leaders to give them guidance because of their moral concerns and they are not getting it. I don't know. We need to do some interviews to find out.

Let's go back to the picture. [Figure 3.] Essentially, after a great deal of manipulation that I don't have time to go into, the bottom line is that trust in institutions seems to be a lot more important than knowledge, than risk, even than awareness.

But remember, I said there were four myths, a partial solution, and a caution. The caution is that I don't think that trust can be sold like soap. I'm afraid that when I take this message out that people will think that what we have to do is figure out some way to sell trust in science. You know, we've been doing pretty good so far, how do we do this even better?

The caution is that I think trust is easily lost and not very easily gained. But maybe those of us involved in science communication and science education over the years, who've done a better job than we thought, ought to be very cautious about trying to package this and sell it. Rather I would encourage people to think about trust in terms of dialogue with the public on these issues so that we continue to promote these other things—education, knowledge, information—not just for their own sake but because they themselves and that dialogue itself is probably a really important way to build trust.

Note: Due to technical difficulties certain talks at the Best Practices meeting were not recorded. The transcript above is from a substantially similar talk given at the annual meeting of American Association for the Advancement of Science, 15-20 February, 2001, San Francisco, CA. Reprinted with permission.

The Evolution of Research and Evaluation in Public Relations

James Grunig, Professor, University of Maryland, Department of Communication

Due to technical difficulties with the videotaping of the meeting we do not have a transcript available for this talk.

The Evolution of Research and Evaluation in Public Relations

James E. Grunig

Department of
Communication

University of Maryland

Landmarks in Public Relations Metrics

- 1977: AT&T measurement project culminates in first-ever conference on PR measurement at the University of Maryland.
- 1992: First book from IABC Excellence project published. Explains the value of public relations to an organization.

Landmarks in Public Relations Metrics

- 1996: Summit meeting on PR effectiveness held in New York, sponsored by IPR, *Inside PR*, and Ketchum Public Relations.
- 1999: IPR forms Commission on PR Measurement and Evaluation.
- 2000: DOE holds conference in Batavia, IL, to develop metrics for its laboratories, resulting in white paper by J. & L. Grunig.

Levels of Analysis for Evaluation

- Program level
- Functional level
- Organizational level
- Societal level

Program Level

Individual communication programs such as media relations, community relations, or customer relations are successful when they affect the awareness, cognitions, attitudes, and behaviors of both publics and members of the organization.

Communication Objectives

One-Way

- Communication
- Message retention
- Cognition
- Attitude
- Behavior

Two-Way

- Disclosure
- Accuracy
- Understanding
- Agreement
- Symbiotic behavior

Research Methods for Evaluation

- Quantitative
 - Surveys
 - Experiments
- Qualitative
 - Observations
 - Interviews
 - Focus Groups

Organizational Level

Public relations contributes to organizational effectiveness when it helps reconcile the organization's goals with the expectations of its strategic publics. This contribution has monetary value to the organization. Public relations contributes to effectiveness by building quality, long-term relationships with strategic publics.

Functional Level

The public relations function as a whole can be audited by comparing the structure and processes of the department or departments that implement the function with the best practices of the public relations function in other organizations or with theoretical principles derived from scholarly research. Evaluation at this level can be called theoretical or practical benchmarking.

Generic Principles of Excellent Public Relations Practice

- Public relations is a unique management function that helps an organization interact with the social, political, and institutional components of its environment.
- The value of public relations can be determined by measuring the quality of the relationships the organization establishes with its institutional environment.

Generic Principles

- Public relations serves a strategic managerial role as well as a technical role.
- Public relations departments strategically plan, administer, and evaluate public relations programs.
- Public relations helps to shape the underlying conditions of organizational excellence.

Generic Principles

- Communication activities are integrated through the public relations department or a senior communication executive.
- Public relations is empowered by the dominant coalition of the organization.
- Public relations is not subordinated to marketing or other management functions.

Generic Principles

- Public relations is two-way and symmetrical.
- Public relations executives are ethics counselors and internal advocates of social responsibility.
- Public relations departments have a professional base of knowledge.

Relationships Can Be Measured to Evaluate Public Relations

The newest trend
in public relations research

Relationships Produce Reputation

- “To acquire a reputation that is positive, enduring, and resilient requires managers to invest heavily in building and maintaining good relationships with their company’s constituents.” (Fombrun, 1996, p. 57)
- “PR is responsible for building relationships with key stakeholders in a manner that cultivates positive reputations.” (Jeffries-Fox Associates, June 16, 2000)

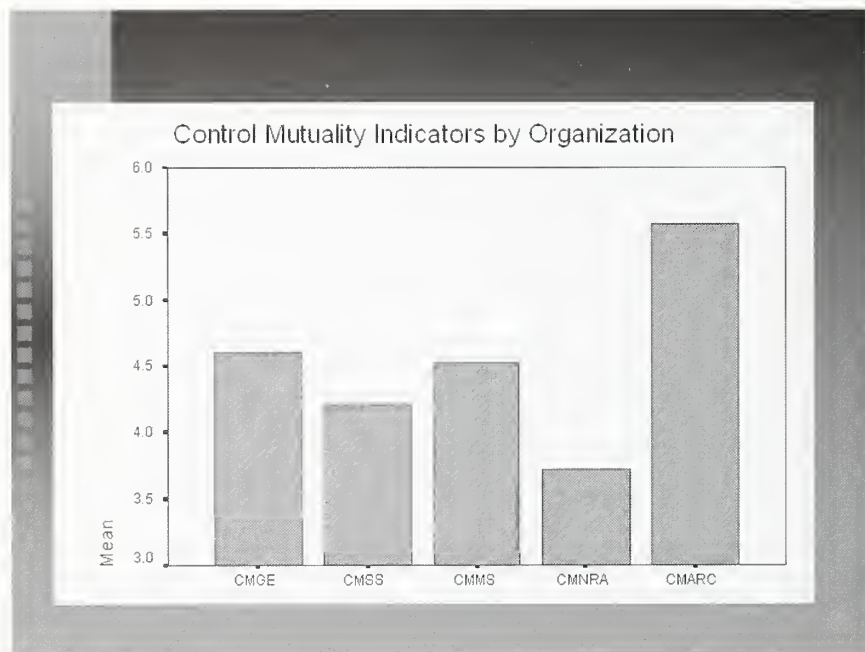
Types of Relationships

■ Exchange

One party gives benefits to the other only because the other has provided benefits in the past or is expected to do so in the future.

■ Communal

Both parties provide benefits to the other because they are concerned for the welfare of the other—even when they get nothing in return.



The Future of Broadcast Journalism

Peggy Girshman, Assistant Managing Editor, National Public Radio News

Girshman: Hi. It's great to be here. When I first graduated from college in 1975, I considered myself extremely unfortunate that I had missed the "Golden Age" of broadcast journalism. I had missed Edward R. Murrow, I had missed World War II, I had missed Watergate, I had missed the downing of a president, I had missed everything. And all I ever thought about is how terrible it was, and how bad the local news was, and how everything had deteriorated so much.

Now, of course, I feel the same way: that the early part of my career was just golden, and now, if you look at local news, you see nothing but dreck, and if you look at even network news, you see nothing but dreck intercut with commercials, and now there are even more commercials than there were before, cutting into material that you sometimes can't distinguish from a commercial. I think both perceptions are wrong. But if you want to keep with the one that we're in a toilet right now, you could look at this past week. It's been a very interesting week. If you've followed the *Nightline* debate at all, is it ok to replace probably the finest program on television, news-wise that is, with David Letterman, when David Letterman's already somewhere else? And should you take the seasoned-veteran journalists, Cokie Roberts and Sam Donaldson, off the air and put in people who have mostly done stand-up or political consulting, and that would be George Stephanopoulos and Claire Shipman.

On the other hand, I'm a glass half-full person. I see what's happening now and I say, "It's been a really interesting six months." We had the biggest story ever [September 11 terrorist attacks], of what I think will be my long career, and I thought at the time, "We will have this story every day for years. Years." And so far, it's been months and it's still there, and you'll hear a lot about it next week because next week is the six-month anniversary. That, like many other big stories, like the Gulf War, like the impeachment, has had a positive effect on people getting their news, getting any kind of news, whether it's newspaper reading or whether it's radio listening or TV watching. So I would say that

that's good. I'm a journalist and I think people paying attention to what journalists say is a good thing. You might not.

This was the first time in our history where, truly, things weren't being filtered through a reporter's eyes, except for things like hearings. We all saw the same thing at the same time. Many people saw it with other people next to them; they could share it, they could talk about it. Nothing filtered it, nothing explained it; it was inexplicable, and that, to me, was a real interesting marker in television journalism, because it set a new standard for how you wanted to get [news]. This is a huge thing. You can't imagine something this big happening, so now, all of a sudden, without a picture on anything, it suddenly doesn't work as well. I mean, it's more exciting to see a live picture on CNN from Afghanistan than to read a great analysis of what's going on there, even though that live picture of what's going on in Afghanistan is a mile away, a plume of smoke. What does that tell you? I don't know.

But people have kept watching. At NPR, audiences for some of our stations went up 25 percent, and they've stayed there. It's been a boon for us, and so I think that when we're reviewing the past and the present day, before we go into the future, we need to see that as sort of a watershed event. Not that it's changed our country necessarily forever, but I think it's changed a little bit about journalism forever.

I wanted to tell you a little bit about what's going on today. Continuing a trend that's been going on for more than 15 or 20 years, most people get their news from television. In a recent survey, 80 percent watched local TV news in the last week, 68 percent read a daily newspaper in the last week, 64 percent watched network news or national news of some sort, that includes cable; 62 percent got their news from radio, which could include public or commercial radio, and 34 percent got news from the Internet. These data are a year-and-a-half old, so that's probably low now. There's a local-national TV complement in that a lot of people

who watch local news watch their national news as well, because local news is on at around the same time.

In many cities, there's now all-news cable locally. As a matter of fact, here in Washington, the ABC affiliate that does local news is just merging its newsroom with Channel 8, which is an all-news local cable station. And that's very interesting, because they were viewed as competition before. So, journalists will lose their jobs out of this probably, and they will also lose two independent views of the news. They will combine into one newsroom that is collecting all the news.

But across the board, regular use of regular media has gone down. Newspaper and television news viewing has gone down even though there are many more options now than there used to be. It's not just the per-unit share. Fewer people are paying attention to broadcast news than before. Fewer people are reading newspapers and magazines than before. Why is that? Well, we added a new option, which is the Internet. And you can look at the Internet as sort of a new medium. Or are they using the old media to make news? Sure they are. They're writing words. They're putting up pictures like you'd see in a newspaper. Frequently, they ARE the newspaper pictures. They're putting up audio. In the case of our Web site, we put up audio directly from our newscast. As a matter of fact, you can click on NPR.org (please note the plug) and get the latest newscast within the hour. MSNBC lives and dies by video and audio from its channel and from NBC News. So, MSNBC.com, which is always in the top two or three news sites on the Web, uses pictures and audio from its broadcast partner; same thing with CNN, another very popular news site. So, do I include them when I think about the future of broadcast journalism? I do. How else did they get it?

Another trend that's continuing fairly strongly, although it's gone down a little, is people watching a TV news magazine sometime in the last week. There are lots of them on still. Some of them have gone; *Dateline*, a show I worked on, went from five nights a week to three, to two, and, during the Olympics, to zero. About half the country, at least, watches a news magazine every week. And you can quibble about

whether that's news or not. It's certainly information. It's non-fiction. If it's a court case that you never would have heard of, is that news? I don't know. It depends on your perspective. It's not about, "Here's what happened today in Afghanistan," but it certainly is communicating information news-wise.

The most interesting thing, or the most sad thing to people like me, is not even a trend, it's a fact. Old people like news; young people don't. And that's been true forever, but as the population ages, our demographics go down. Demographics are a very important thing. So, for example, in the most recent survey of 18 to 34 year olds, only 28 percent of them read a newspaper every day. Sixty-six percent of the over-65 group does. So, it's more than double. Across the board, local TV news, same thing. The thing that young people do the least is read newspapers. And by "young" I'm talking 34. That's not that young. And the worry at the network and local levels is what will happen when your demographic gets too old.

60 Minutes routinely ranks in the top 10 or 20 programs of the week. But when you look at the demographics—if you look at the most popular age for advertisers, 18 to 49—(that's a huge range) *60 Minutes* ranks low in popularity, in the 60s or 70s. It's like number 68 for the week for those younger people, but number 9 if you count everybody else. I'm close to that 49 age cut off, so I don't want to be counted out in two years. But it sort of freaks people out and this explains why *Nightline* is being dropped, or probably being dropped, because while they have enough people watching the show, they're too old, and they can't charge as much for an advertisement. You can charge \$50,000 maybe or \$35,000 maybe for a *Nightline* 30-second advertisement. They can get \$500,000 for that during *Friends*. *Friends* is younger demographically. And it sounds ridiculous for a journalist to worry about what are the chances of getting breast cancer if you're 49 and how do I write this right, to think about ratings and news and ratings and numbers and ratings and demographics, but we all are forced to do that because it has affected our lives.

I know I'm supposed to be talking about broadcast journalism, but look at the front page of your newspaper. They started putting Life Features on the front

page. That was to try to appeal to other people. *The Washington Post* has a kids page on the back of the comics section—which is great, I’m not complaining about it at all—I’m just saying they’re trying to get younger and younger audiences, and they’re falling farther and farther behind.

Now, when you think about broadcast journalism, you might be thinking cable, even though, technically, cable isn’t broadcasting, but for this purpose we’re going to talk about it a little. I mean, 20 years ago, we had one cable outlet. I thought it would tank. I had an opportunity to go work there and I said, “They’ll never make it.” I’m laughing now, but I took the job at the other one, and it failed in six months. But there was a huge jump when FOX went on the air with people watching FOX. MSNBC has a smaller audience, so we have three, 24-hour-a-day cable news operations. You can get news any time. But beyond the jump of initial new watchers, cable news has remained relatively flat. When people come in, they come in during crises, and then they go away. They stuck around for us. They stuck around for newspapers more, and they’re sticking around for some regular news, but they haven’t stuck around as much for cable.

The main draw of cable seems to be yacking. That’s what they put on, lots of people yacking, and if you watch one channel, you might think it has more opinion than another channel, but 30 percent of people watch cable news sometime during the day. That includes CNBC, so even if you’re tuning in to watch your stock floating by, that’s considered watching news. That’s growing slightly, although people actually watch less CNBC now that everything’s printed in red instead of in green. It’s one thing to watch your stock keep going up, up, up, and then you want to check it three times a day or ten times a day, even. But guess what: You tend to check it less when it’s going down.

So, the main goal in programming, whether you’re making the show *Friends* or whether you’re making *Nightline*, no matter who you are, is, how do you get the maximum number of people to watch and the youngest people to watch, and how do you keep it moving all the time, because everybody’s got a remote. The second they’re bored with television, they

flip the channel. The second. Can you imagine anything you’re writing having to meet that standard? I’m sorry, this sentence is dull, I’m stopping halfway through. I don’t think so, you know. They can pick it up and put it down, and once you lose them, they tend to be gone. So there’s tremendous pressure, less so in public broadcasting I’m happy to say, to keep it lively all the time. This explains what happened with local news going to 30 seconds, 40 seconds, 45 seconds; the longest story you’ll see on local news, their in-depth series, is two and a half minutes. Two and a half minutes for NPR? That’s like a joke, you know, if we can’t say it in five, more than five minutes, it’s not worth saying. And they have pictures, so they’re actually transmitting more information.

So, there’s tremendous pressure, especially now that there’s hundreds of cable channels, and people who get cable TV in their home are watching broadcast TV that way, so your local NBC affiliate is competing with HBO, and sometimes if you have digital cable, competing with 15 channels of HBO, or 15 channels of the Discovery Channel, where they really care about who’s holding the clicker. For example, I don’t know whether you call what Discovery Channel does, or lots of science documentaries, “news.” When MTV puts on news, do we call that “news?” Yeah, I think so. Is the Discovery Channel news? Well, it sort of looks like news sometimes. It’s topical stuff.

They have a shelf life on their shows of three years. That’s not news by my definition, but they’re very worried about men. The cable channels are more worried about men than the broadcast channels are, because men hold the remote. This sounds sexist, but women are more loyal. They turn on a channel and they’re willing to sit there and watch through the commercial and watch for their favorite people. They bond with people. With men, if it’s not blowing up, they might change the channel. This explains the high rate of crime news. Despite the dropping rate in crime, there is still the same amount of crime news on local television: body bags, car crashes, whatever. Because the perception is, “I can do this in 30 seconds, then I’m moving on to the next really cool picture.” And there’s nothing wrong with that in one way, that is something that’s going on in the world. Bill Skane, former CBS producer, is laughing at me, because he knows. It’s hard!

How do you program? Women care about medical news more than men do, and women watch network television, so you want to have more medical news. If you watch a morning program, *The Today Show* or *Good Morning America*, you'll see lots of medical segments. You will not see a physics segment, ever, because it's the women who are home getting the kids ready and who have the TV on in the kitchen. That's the perception and, believe me, if that's the perception, they have 12 studies to back it up. They don't do anything by accident. They don't try anything by accident. Everything is researched, and you know exactly who's sitting out there, and you know exactly how old they are, what sex they are, what color they are, what they're going to buy, and what they're likely to buy, what your advertisers might want from them. So, everything in between the commercials is designed to appeal to the people who we want to have watch the commercials.

This sounds very cynical. I'm sorry. But what have we gotten over the years with this? We've gotten shorter and shorter segments, for the most part. We've gotten medical stuff, weather. Just think about this: Weather's on every single night for three minutes. That's more than we spend on any story in the rest of the newscast. So, as a result, by the way, the public understands jet streams, the direction of weather, what fronts are, what barometric pressure is, I mean, this is our best way to teach science, actually.

I did want to talk a little bit about what I see for the future, and also what I see for science news and science content in newscasts. What I see for the future is much, much, much more blending of these things, so that it won't matter whether you say you watch TV or listen to broadcasts or went on the Internet, because you're probably hearing or seeing the same thing. There's lots of co-branding arrangements right now, and NPR, for example, is pairing with the Bill Moyers show, which airs on Friday nights, called *Now with Bill Moyers*, so that's a PBS and NPR collaboration. But now, all of a sudden, you'll see one of our reporters on a PBS broadcast doing the same story that he might be doing for us. So, people are sharing material more than ever before. You'll see lots of collaborations.

The reason you see all these pictures on CNN is they have television partners all over the world, including in every little local city. As a matter of fact—this

happened in the Columbine High School shooting—the CBS affiliate in Denver had some exclusive pictures. They were a CNN partner. They fed it up to CNN, so the NBC affiliate could pull it down somewhere else. So, there's lots of sharing of material, and you're going to see much more of that because there are billions of Web sites, arguably hundreds of big news Web sites, and hundreds of TV channels, and clear channel radios and satellite radio.

When there's hundreds and hundreds of options of all forms of media, then all of the sudden the cost goes out of whack. The thing you used to be able to spend a million dollars on suddenly you can't, because you have such a narrow audience. It's all narrow, like little magazines. And so, people tend to share more, thinking, "O.K. I can run this piece that I pulled off of our partner, the Discovery Channel, on *Dateline*. *Dateline* and Discovery have a partnership. Discovery wants it because it promotes their show. NBC wants it because it's material that they can get cheaper than they would elsewhere. So you'll see more and more of that. In a way, you could see more redundancy, but in a way, you have so many more choices. In the future, this means that people who are creating the content have to worry about diminishing audiences, less money to gather news, and less money to produce it.

Most of the networks have closed down their foreign bureaus, partly as a result of the "clicking" problem, because people don't like foreign news as much as they like domestic news. And most networks are still condensing what they're doing, even though as they've added news magazines, as they've added cable affiliations, they're not growing. They're shrinking, and that's because of the demographics and the splintering of the audience.

And so far, nobody that I know of has made money off the Internet although my friend at MSNBC says they're working hard at it. They were pretty close to breaking even until September 11th. I mean, we've all put a lot of burden on September 11th, which is probably unfair.

I wanted to talk a little bit about science news. In terms of general news, there's just going to be more and more of it out there. It'll be more homogenous, but there will be more different sites to find it on. In terms of science news, I have a bleaker picture. As this news

hole has expanded and splintered, we have fewer and fewer science news specialists working for major news organizations. And that applies to newspapers, as well, which have reduced their science pages or their science staff, sometimes to zero or sometimes to one poor schmo who has to be able to answer the question about the new Alzheimer's vaccine at the same time he's answering the question about table-top fusion, which was just the other day. Nobody knows all that, so we've lost some specialists, and even then, we never really had that many. We had a few at the broadcast networks—one, in many cases, one producer, one reporter.

At NPR, we have a huge science staff that's probably the biggest science staff of any national news organization—of any news organization for the public. We have about 20 people between editors and reporters. And we've kept that going. The *New York Times* has stayed pretty stable, but I'd say everybody else has reduced science coverage. And if you think about how CNN has to operate or any of the cable operations operate, they live by yacking. So who do you yack to? If you don't have anybody inside sort of giving you somebody good to talk to, then it's harder to book guests. And a lot of these people didn't like science growing up. They don't know much about it. The last science class they took was in the 7th grade; come to think of it, the last science class I took was in the 10th grade. So, there's nobody there to help translate it even internally to editors or to producers. I worry a little about this.

There has been blossoming of cable channels that deal with science and technology and health; there's just been a huge boom. I mean, there's Regular Discovery, there's The Learning Channel, which does a lot of this. There's Discovery Health, there's Discovery Science, there's Discovery Technology. Not a lot of people get them yet, but they're there. But the question is, are people watching them? Are these things accurate? Most of the people who work at these channels don't have a science background. Most of the channels have one of two people there who have a science background. So even there, where you think you're getting specialized information, you're getting people who care a lot about television but also think that you can keep something on the shelf about medicine that lasts three to four years, which is not

possible in our current climate of discovery and innovation.

And there is certainly nobody on the local news level except for somebody who tends to get designated as the health reporter that week or that year. Somebody who comes in with nothing who does manage to try really hard, makes good relationships with the hospitals in the area, but can't independently evaluate the study, doesn't know what a "P value" is—I had to use my statistical terminology, thank you—and doesn't have a clue who to call to get some sort of critical opinion. So, what you would tend to do—this is very typical for television news—is, if there's a story in today's *Journal of the American Medical Association*, you take a look at it, and you call the local hospital, even though they didn't do the research (you never talk to the researcher). They explain it after they look at it, you do two sound bytes and a little bit of cover in between. You look for a patient who has this problem. Here's Fred with prostate cancer. Here's Fred eating breakfast with his wife. You always have to start with an anecdote, and then we go to the doctor at the hospital, you know, what this new study means and maybe someday, Fred will be cured with this treatment, and we end with Fred saying, "I just hope they work it out."

And that's the best it gets, right now. And I don't see that trend changing or reversing itself, because local news is collapsing its newsrooms. Network news is collapsing its newsrooms. We're not talking about more specialization here, we're talking about more need, but less specialization. I hate to sound so glum, because I want to say that I think that public radio is doing very well. We have an interested, fascinated audience. We can put on all kinds of intellectual ideas, and people will watch it and listen. *Nightline* just did five half-hours on the Congo and what's happening there, so there's moments of brightness everywhere, and people seem to be interested. They're still watching.

Are these young people that I talk about—the 28 percent of the now 18 to 34 age group that read a daily newspaper—are more of them going to grow up to be newspaper readers? Are they going to turn into the older generation, or is there a permanent change? I don't know. It's always been that way. People have always read more and paid more attention as they got

older, except for a little blip during the 60s and early 70s, the golden age. And we'll see what happens, whether young people grow up to be news consumers or not. I think that they will, but not to the same numbers. We'll see, maybe eventually, a gradual deterioration, but I hope not.

Live from the Field: Observing Science in its Natural Habitat

Hannah Holmes, freelance writer; reporter and columnist, Discovery Online; and author, *The Secret Life of Dust: From the Cosmos to the Kitchen Counter*

Holmes: Thanks for having me, it's fun to be here. Thanks for the soapbox. It is my favorite one. I think science writing really labors under a burden: The public thinks they don't like science stories. But I think they just don't get a lot of perks and thrills and frills in the average science story. And going into the field is a really great way to put in a lot of bells and whistles that will drive a story and keep the momentum going, even if the facts are a bit dull.

And when I say that I mean, if you don't mind dismemberment and dysentery—because there are some hardships that go along with it. So far they seem to balance out.

I want to talk about some elements that go into most science stories, and how going into the field can pump those up and put some life into a science report. How it can turn a report into a story. I think for me the goal is to make a science report into a narrative that has some momentum of its own, and a story line, and characters. So let me just talk about some of the basics that go into a story, and how going out there can help to build those.

One is plot. Science lends itself so well to a mystery story. It always starts with a question. There are always little revelations along the way. At the end there may be an answer, there may not. There may be new questions—it doesn't matter, if you have the momentum of a discovery process.

Let me just give you an example of how that played out with my first assignment, with Discovery. The editors there had read a news report about a woman who found phytoliths—these are little tiny rocks that form in the skins of plants. She had taken these out of a mud core from an ancient lake. And by studying which phytoliths were in which layers, she could conclude that people were practicing slash-and-burn agriculture in Central America 7,000 years ago. Well, that was the news report. Discovery sent me to Panama to turn it into a story. And I collected scenes

that I could string together to bring this series of facts to life.

So I met Dolores. She's not just some lady. She's like a tractor. There's not an ounce of nonsense in this woman. She threw me in her car and drove out into the Panama countryside. And it was beautiful and there were orange flower petals all over the road, and it was just lovely. We got to a big flat valley, a beautiful valley. There were cows out there in the valley. And it turns out this is actually an old lake bed. This is where she got her mud. There is another scene that I can use.

She took me to her mud room, which is a giant refrigerator full of mud. And she took a core out of there and brought it to her lab bench. I could smell the mud. I could see the texture of the mud. I could bond with the mud. There's another scene. These are some more sensory elements that people can start to hook into to envision this stuff.

And then she brought out pictures of the phytoliths, and they are not just dumb little rocks—they're beautiful little clear silicate things. Every plant makes a very specific shape. So some are golf balls. Some are little lasagna noodles. Some are little cones. They're really neat. Some of them were black. They were black because people had set fire to these plants. And it started to come to life for me.

For the last piece of that story I went to Barro Colorado Island where there is a rainforest reserve. I just wanted to see what it's like to be in a real rainforest.

So stringing those things together helped to bring a news report more to life. That was the early days of Discovery and they didn't string them together. They wanted the reader to be able to chart her own course. So you could start anywhere and it was very disastrous. But it was a start. I did my part.

Another element of a science story is usually a star or a cast of characters—some researcher or a group. And I don't know about you, but my experience with interviewing scientists in their offices is not always that exciting. And it's understandable. They tend to be nervous. They are worried that you are just not going to get it. And it's a real risk, I think, a lot of the time. So they're tense. And they're not accustomed to being the center of attention. The dynamic is just not very good.

But if you get that person out into the field, especially if you get them out with their buddies, it is a completely different situation. The group dynamic causes everyone's energy to go up. People interact with each other in real ways that bring out their real personalities. And you see them for the interesting—kooky, odd, weird, whatever—people that they are.

For an example, I'll go to Monserrat from Panama. This situation actually presented both sides of the coin. The Monseratt Volcano Observatory was a very transitory place. Both students and sort of "boss types" would rotate through on pretty short rotations. Two weeks. Maybe two months. So it was never quite clear who was who—who's the boss, who are the small people. There was a lot of tension and a lot of unhappiness. So I would go into the observatory every day—I was there for a three-week project reporting every day to Discovery. I would go in in the morning, and everyone would just be in their corner doing their thing—nobody looking at anybody else, nobody talking, certainly. And no one talked to me. No one wanted to be overheard because there was so much tension.

But at some point in the day, people would get in a vehicle and go do some field work. And I would get in the vehicle with them and shut the door and these personalities would just explode in the car. They would be joking with each other, making fun of each other, trying to make me laugh. They would be spontaneously commenting on how the mountain looks today or how it smells, or what they noticed yesterday. It was a completely different side of them and it was a lot more fun.

So one day we went out to get ash samples. And volcanic ash—again, my first impression is not wild excitement. It's little, its gray, it's supremely annoying

to work with. But volcanic ash in the hands of this student, Haley, was quite another matter. This girl was screaming at cows because they had knocked over her ash trays. Her ash trays happen to be bureau drawers that she stole from a dilapidated hotel which got ashed over. And then she is yelling at her advisor because he is not being careful brushing the ash out of the tray into little Ziploc bags. And these will be sent to the United Kingdom to be analyzed for their deadly cristobalite content. And suddenly, ash is a lot more interesting.

Another day I got in a truck with some students, with an advisor they really liked. And we went to take the temperature of some pyroclastic ash that had settled over some towns. We're sticking a probe 20 centimeters into some ash and we're waiting the prescribed 84 seconds and we're writing down the number. But these folks get along really well. They're having a good time. They're all asking the advisor questions. And he's just feeding them information, feeding me information, it's very natural. And at some point he started digging up trees out of the ash. This is like a 20-foot deep section of ash. So he was digging out these blackened trees, and I'm thinking he's going to analyze these for how hot it was when the ash hit the trees and he is going to get something really interesting here. Turns out they were having a barbecue, and this was free-range charcoal.

The same group walked up the hill and they found a little hole in the ash. One of the students said they had talked to a friend who is a biologist, and the biologist said that iguanas like to lay their eggs in warm places. And they'll dig down to the right temperature in the ash and put their eggs in there.

And the point is that these aren't one-dimensional, shy people with one interest. They are multi-dimensional. They have a lot of interests. They're creative. They're fun. They're people you want to hang around with. And that is the kind of mood that I want to pass on to the reader.

Sometimes you do have office-bound researchers who don't do wonderful things in the field. But some of these techniques can still apply. It is a darn sight better to go see someone in their office than to talk to them on the phone, because any little detail you can

pass along helps the readers to build their own image of the person, and to invest in the story.

I'll give you an example from the dust book. I needed a space dust scientist. I had two guys to choose from. One guy was at Caltech. He was doing interesting research. He was using kiddie pools to catch space dust. He's obviously got some interesting stuff going on. But I talked to him on the phone and he was unbelievably shy. He could hardly talk. He was a yes-or-no kind of guy. Ventured nothing. So I tried the next guy, a researcher at the University of Washington. Shy! But a little more forthcoming. I went to Seattle for other reasons, so I went and talked to him. And the guy's wearing a bright green shirt. And I'm thinking, well, that's a little different—that's something that maybe the reader can start to build on. And he's got some cute mannerisms. Yes, he's shy, but also he's quirky and he's funny. He's got a poster on his wall of an astronaut standing on the moon in a space suit taking a pee.

So even if they're not doing something wild in the field, there are still details you can pick up about them that help the reader to understand that they really are just "folks." Now, all of this stuff is really window dressing, and little hooks, and little perks to get people to the lesson. Ultimately, I want to sneak some science in here without making it painful. I want it to be so subtle that it is under the radar, and people don't go, "Ewwww, a science story."

And this where going to the field is really invaluable—for a few reasons. One is accuracy. For me to put my eyes on the subject and watch something unfold is worth so many millions of words. There is just no comparison.

One very simple illustration of this: Before I went on a fossil expedition, if I had written about a fossil discovery, I would have been at risk of summarizing along these lines. You go to the field. You dig up a fossil. You get something that has all its ribs attached, its legs attached, it's got all its vertebrae in a line, and you pull that out of the rocks and you take it home. That would have been my working assumption. Having seen how it really happens, now I know that you really just dig up a piece of rock about this big. Maybe there's a little bit of a head over here. Maybe there's a little bit of a tail over here. And you hope

the rest is in there. And some time months or years from now, you'll actually see the rest of the fossil. So without witnessing the process, I would have had no idea.

Another real benefit is access. It's one thing to talk to somebody on the phone and to have them say, "If you've got any more questions, give me a call. Don't hesitate to call." Or, "Come by if you have more questions." Well, that's okay. But if you are on expedition with them, you're living with them and they can't get away. You throw a rock and you hit someone who is really interesting.

I was on a Woods Hole expedition with the Alvin submarine—and talk about a contained group. There was nowhere these scientists could go. And every afternoon the Alvin would come back up on the deck and all these scientists would gather around. And the geo guys would take their rocks and go to the rock lab. And the gas folks would take their gases and go to the gas lab. And the bio people would take their slimy things and go to the bio lab. And whatever you were interested in, you'd just go along.

All the grad students and all the other scientists would gather, because a lot of that stuff is pretty new and pretty exciting. And it was a very spontaneous, natural, energetic exploration of a discovery—in some cases, stuff these people had never seen before in person. We picked up a spaghetti worm one day from the bottom of the ocean. I've certainly never seen one. But I was not the only person asking questions. No one had seen this. So everyone was talking about it. That kind of access is just priceless in terms of bringing the story to life.

For me personally, the ability to draw diagrams and make illustrations is another enormous benefit of being with the people you are working with. I'm just kind of stupid about some subjects. If someone can draw me a picture... I was once at the Space Telescope Science Institute and someone was trying to explain red shift to me. A guy finally got so fed up he drew a little diagram on a clear piece of paper—well, a clear piece of something—and he put it on the photocopy machine and blew it up. And everything moved farther away from everything else. And it doesn't translate as I'm telling it to you—which is kind of the point. I love that about being with people.

And finally in terms of conveying the lesson, there are slow days, there are boring days in research. It's so nice to have fun things to fall back on to keep the reader there with you, especially if you are doing day-after-day reporting. So it's nice to be able to fall back on the local culture. How it might relate to the subject. There used to be cabins in Mongolia built out of dinosaur bones. I never saw one. But that's the kind of local color that can buttress the science on a slow day: People have always lived among these things and this science is just a new way of looking at them.

Now, I did mention that there were some occupational hazards. One of them is that this business about nature abhorring a vacuum is just not true. The Monserrat Volcano had not been a toy volcano; it had killed a lot of people. Destroyed an island. Destroyed a culture, more or less. My boat pulled up to Monserrat and the thing went dormant. I was there for three or four weeks, writing every day about the exciting volcano.

A friend and I, a photographer, we did the San Andreas fault, started at the bottom and again it was a daily diary thing for Discovery, for three or four weeks. There were two earthquakes the entire time, and both were in towns that we had just left.

This is a category of problems that I have learned to deal with. I always chart out as best I can what I'm going to cover on any given day. I make contingencies. And I always leave things with my editor—things that are completely researched, written, and done. So if I am stuck in a truck for four days, he has something to put up.

When we went to Mongolia to do dinosaurs, for instance, I left stuff like, "How does a bone turn into a fossil underground?" It had nothing to do with the day-to-day excitement, but it was something about the site, at least.

Another occupational hazard, a little more problematic, is the professional category. When you're living with people you see how cute and funny and smart and fun they are—and you also see that some of them are real jerks.

And again, sometimes you're really stuck there. I've been stuck with a fruit bat who thought I was broadcasting details of her intimate life on the Internet. And she was furious with me the entire time

and there was nothing I could do about it. She just wasn't very healthy.

I've been stuck with a stalker. In this case the guy had control over whether I saw a very special thing ... not that thing! He was in charge of access to a scientific thing. He could say if I got to go on that expedition or not. And he kept me in suspense until the very end. Had it ever turned into a sort of physically threatening situation—as opposed to just extremely annoying—I'm sure I would have done something about it. But I chose to have that access. Anyone else might do something different. It's just good to know that that kind of situation can occur.

Ego issues can be a nightmare. I think often scientists punish their peers if they appear to be too much fun, too casual, too un-serious. Scientists who talk to the press a great deal are sometimes at risk of being slapped by their peers. And that makes them very sensitive about what you write about them and how you portray them. And that can be a battle.

The worst of this category for me—I'll take anything else—is the desperately shy or disinterested subject. There is just nothing to do about them. If they don't want to talk to you, they don't want to talk to you. And there you are for three or four weeks.

As unpleasant as the professional hazards are, they don't hold a candle to the technology hazards.

This is particularly true for the live Internet stuff that Discovery does. I'll just give you a rundown of our Gobi desert experience. This was the American Museum of Natural History with their annual dinosaur and mammal expedition to the Gobi desert.

The photographer and I, we each had a computer. We had a back-up computer. We had a satellite phone. We had a back-up satellite phone. We had two sets of solar panels. And just because of a quirk of Discovery's calendar, we had to start our project a few days before we were actually in fossil country, so we started reporting from Ulan Batar, just with color—local color.

We plugged in satellite phone number one and—snap, crackle, pop—we're down a satellite phone already and we haven't left Ulan Batar. So we hooked up the solar panels, and held them out the windows to charge up the equipment.

Once we got down into the desert, we hooked the solar panels to the computers. And that seemed all right. You'd wrap up the computer in a lot of plastic because it is so dusty and then attach it with a little umbilical out through a Ziploc bags to the solar panel and you'd go off fossilizing with the group for the day. But you'd look back to camp from a half a mile away in the middle of the day and you would see these blue birds. And these solar panels would get picked up by the wind and they would just go. And the little laptop would be going along behind it. So we put rocks on them. We sorted that out.

And then we got an e-mail over the satellite phone from our editor saying, "Discontinue all use of the solar panels." Another guy was on assignment in Brazil using the same configuration and the solar panels had fried his computer dead as a door nail. So now, "Do not use the solar panels." We're out of outlets now. And we have no solar panels. We're left with cigarette lighters in the trucks.

One night we had a big-pressure event: All the expedition scientists were gathered around the cigarette lighter and we were talking to the American Museum of Natural History in New York and this was a big fundraiser/educational event. They had a huge bunch of people asking questions live to the Gobi desert. Everyone is huddled around the Mercedes. (Mercedes gave the museum these trucks with the cigarette lighters.) So they're all huddled around that thing. And we've got the satellite-phone receiver on the hood of the car with big rocks on it. (We have learned: Paint is not the issue.) But once again, a burst of wind out of nowhere, and smack-down with the satellite phone! Smashed it. But it survived.

Then a few days later the phone was in my tent. We would keep all the gear in big aluminum cases in our tents all the time unless we were using it. My whole tent got bowled like a beach ball across the Gobi desert with a hundred pounds of gear in it, including that satellite phone. By the end we were down quite a few pieces of equipment. That satellite phone made it just barely to the end of the project.

The San Andreas fault was actually even harder, which was surprising to me. We were using cell phones to transmit our stories and photos. There was

no service through much of the San Andreas fault zone. And when we could get service, the computer would not talk fast enough to keep the cell phone amused. And the cell phone would shut off and that would crash the computer. Over and over and over and over. The photographer took about four hours to send his photographs one night. After that we resorted to our usual fall-back position, which is go knock on somebody's door and try to look cute. We do a lot of that, and meet a lot of nice people. And if we can't find anybody nice we rent hotels by the hour.

I actually sometimes dictate if I just can't get out by computer. If I can find a phone at all, I'll just dictate to an editor. But you can imagine for a photographer it's a little more challenging. We've had some late-night discussions about just reading off the pixel values. Pixel number 7,458—that's green.

Finally, the category of hazards you are probably dying to know about is the personal hazards.

Number one is just exhaustion. It is a known fact, when you head out on one of these daily reporting things you are going to be totally wiped out and destroyed by the end. Part of it is that you're following somebody else through their day. And their day is probably 10 or 12 or 14 hours long—just to do their thing. And at the end of that when they go have a beer, you sit down and write a story. And that takes a couple hours. And then you fight with the technology, and that can take 15 minutes on a good day, or 4 hours—or forever—on a bad day. It's exhausting.

And add to that that some of these folks are really hard drivers and they do not rest. Or they hike 20 miles a day. Or they don't care much for nutrition and you know, you eat when you find something. Or they're partying like crazy every night. And all of these things add to your sleep deficit. Sleep takes a real beating on these things. I've slept under trucks on these things. And on the ground in sheep doo in New Zealand.

There are some health issues, too, for a lot of these things. And you're sometimes days' worth of travel from a hospital. I've never had an injury, but a friend of mine was thrown down the stairs—they probably have a technical name on a boat for stairs—but it didn't matter to her. She was thrown down 'em and wrenched her knee. She spent four days in her berth

unable to leave. You'd never know it from reading her coverage. She didn't miss a beat. She had people bringing her stuff, but she did have surgery when she got home.

Food is always an adventure. In Madagascar we headed off into the rain forest with a blue plastic bucket with chunks of cow in it. In place of refrigeration we had a colander over the bucket. And we just kept chopping up pieces of that cow for days. It was kind of nice when it was gone because then we were allowed to kill the rooster that was tied to a bush. But after the rooster, we were down to this flat fish that came in plastic bags. Flat dried fish. One of them was so bad that it got flung into the lagoon near where we were camped. And then we ran out of fish. And the fish that had been in the lagoon disappeared—and I think we ate it.

Even on the American Museum of Natural History trip to the Gobi—they take all their own food—people got violently ill with food poisoning.

So how do you cope with this stuff? And why would I ever do it twice?

I try to collect the little miseries and spin them into something fun. And on a slow day I'll put together a story that is just "What you don't know about being on expedition here or there." On the Mongolian expedition, for instance, I did "Life on a dinosaur expedition," or something like that. And I talked about the excitement of fossil hunting, which is really just walking for about 12 hours with your head like this [looks at floor]. And every time you see something white, you bend down to pick it up. And your backpack slides up your back and your water bottle smacks you in the back of the head. And then you picked up a little white rock. That's the excitement of fossil hunting.

I went into personal hygiene. We were carrying all our water with us so showers were not an option. Thirty days. Hygiene really consisted of sitting around the fire at night rubbing those little black logs of grime off your skin.

And then going to the bathroom in the Gobi desert [pause] parts of which are remarkably flat.

And that's probably a good place for me to wrap up. Because the fact is for the readers I screen out the really bad stuff and the boredom and the grind and

the harassment and the egos and all the nasty stuff. For the readers I screen in the excitement and the fun and the mystery and the silly things and the fun people.

And the fact is that after a couple of weeks at home, that's what I'm going to remember too. And then I'm going to hear somebody say, "I'm planning an expedition to outer Spangodia, where there has been a protracted civil war and the only food supply is raw turnips. But we're going down to this really deep cave for about two weeks, and it's lined with toxic bacteria so you don't want to touch anything. But at bottom we've heard that there may be a new species of spider as big as a basketball."

And I think this over and I say, "Take Me!"

Lessons from the Research Roadmap for Communicating Science and Technology in the 21st Century

Rick Borchelt, Director, Communications and Public Affairs, The Whitehead Institute

Note: Due to technical difficulties with the videotaping of the meeting we do not have a transcript available for this talk.

Communicating The Future

Lessons from the Research Roadmap for
Communicating Science and Technology in
the 21st Century

Rick E. Borchelt
Whitehead Institute
March, 2002

Research Roadmap for the Communication of Science and Technology in the 21st Century (R2)

- Initially chartered by NASA/George C. Marshall Space Flight Center
- 3-year charter beginning in 1998
- Focus 1: Set a research agenda for S&T communication
- Focus 2: Identify and articulate "best practices" in public communication of S&T from (mostly U.S.) research institutions
- Initially banked with \$900K annual budget (including webworks)

Science Communication Research

- Reviewed the existing literature
- Identified priority areas for research funding
- Funded pilot projects in critical areas

Science Communication Research -- Funding Priorities

- (1) Relationship (if any) between science communication, science literacy, and science advocacy
- (2) Understand the interests/behaviors of the consuming publics (audience analysis)
- (3) Understand the PIO-researcher-reporter nexus

Science Communication: Best Practice

Finding 1

There is no such thing as a “general audience” for S&T communication -- there are many people with many different uses for S&T information, and many levels of understanding with which to deal.

Audiences That Matter

- Policy makers
- Press (general-circulation and trade)
- Third-party validators and magnifiers (university and industry research communities, scientific associations)
- Science-attentive public

Each audience requires a separate message and message venue

The Science-Attentive Audience

- 10+ % of the population
- Mostly male
- Mostly younger (changing)
- High discretionary income
- High likelihood of voting, political activism
- Technology-friendly, easy to reach *with minimal translation*
- High level of “crosstalk” with other audiences

Dialogue with Policy Makers

- Who are they? Characterization and identification (~10,000)
- What do they care about? Need audience needs analysis
- How do they communicate? Need audience technology analysis

Proactive responsiveness is critical to reaching this audience

Dialogue with Press

- Current focus for most science is on a small number of visible national reporters
- TV network news no longer dominates public discourse--focus on specialty press
- Need to understand what a reporter *wants* and *needs* – not what *we* want or need from the reporter

Science Communication: Best Practice

Finding 2

The scientific community and managers of the science enterprise routinely fail to distinguish between *understanding* of science and *appreciation* for science and its benefits

Science Communication: Best Practice

Finding 3

The myriad of audience needs and interests should drive public communication of S&T. Communication should not be driven by the research enterprise's desires about what it believes publics *should* know.

Science Communication: Best Practice

Finding 4

The active involvement of scientists and engineers is critical to the success of science communication.

Science Communication: Best Practice

Finding 5

Science communicators who can foster mutual respect between science and the media also are essential for effective public communication of science.

Science Communication: Best Practice

Finding 6

The impact of new media and the fragmentation of existing media will have profound impacts on how and with whom we communicate about science and technology at all levels.

Science Communication: Best Practice

Finding 6 (corollaries)

- Science communication/public info programs that define success as entrée to the evening news already are dinosaurs -- based on a 1940's model of information flow.
- The convergence period for transition to new media will occur over the next 5-10 years.

Daniel Yankelovich, pollster

"Dialogue is the single most underutilized tool in the public affairs portfolio, and the one most likely to yield the greatest long-term credibility and success in the communications arena of the 21st century."

How Science Books Drive Public Discussion

Bruce Lewenstein, Associate Professor of Science Communication, Cornell University

Introduction

Why should we care about books? We live in a “new media” world where we’re all using the Web, and creating public discussion and dialogue, and putting in the infrastructure for electronic chat rooms, and so on. In that kind of world, what’s the purpose of looking at “old fashioned” books?

There are several reasons. The first is that books have clearly been influential in public debate. It’s so easy to point to some examples of books that have been influential in science or public issues over the last few generations. We can easily come up with examples like Rachel Carson’s *Silent Spring* or the phenomenon of Stephen Hawking’s book, *A Brief History of Time*. So one reason to study books is to understand: What’s going on here? What role have books played in public debate?

Another issue is a more general one about history. I’m trained as an historian. Those of us who are historians don’t just do it because it’s fun, because we like reading other people’s mail—though we do. But we also do it because we think that there is something that you gain by looking at new things with an understanding of old things.

So, for example, those of you have been following the news know that there’s a new claim of tabletop fusion coming out today in *Science* magazine. As an historian, I created an archive on cold fusion at Cornell 13 years ago, where we looked at not just how the media covered cold fusion, but also at general questions about cold fusion, like, How did it develop? What were the social issues that led to that development? Figure 1 shows an issue of *Time* magazine from those days—slightly altered, to show that an almost identical issue could appear this week featuring the new research. What appears to be a new furor may be very similar to an old furor. I think there is something to be gained by looking back at history.

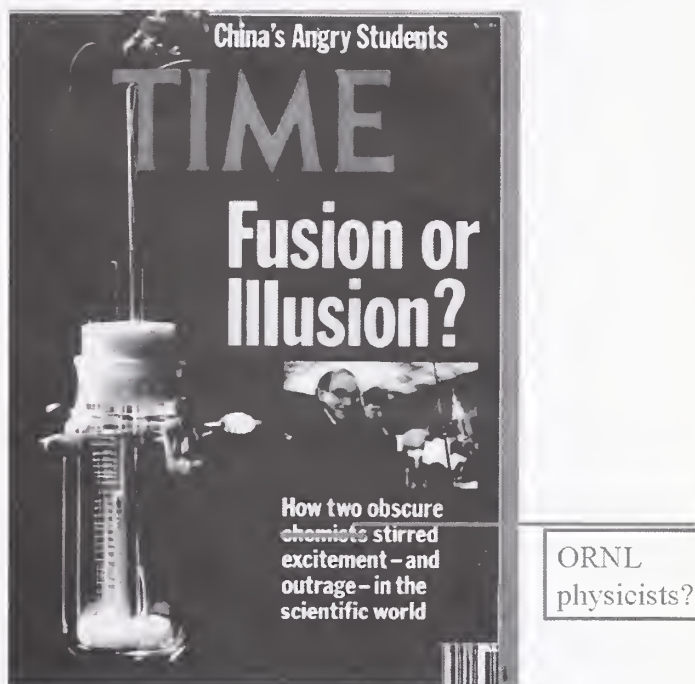


Figure 1. Why studying history matters: Does cold fusion repeat itself?

A third reason for thinking about books is that we traditionally think about books as being carriers of culture. The World Wide Web and other new media are part of culture, but they don’t carry culture (although maybe soon they will). Books are where we traditionally turn for culture, and so they’re a valuable point of study for understanding ourselves and our culture.

Conceptual Models

Finally, I think it’s worth studying books because they force us to think about all forms of media. There is something to be gained by thinking about science communication generally. We shouldn’t just ask: What are good ways to reach people? We need to ask more theoretical questions. What are the models of science communication? How do we imagine that information flows? We need to ask those questions because rethinking that conceptual model can affect what we consider to be “best practices” (which is what this meeting is all about). We tend to think

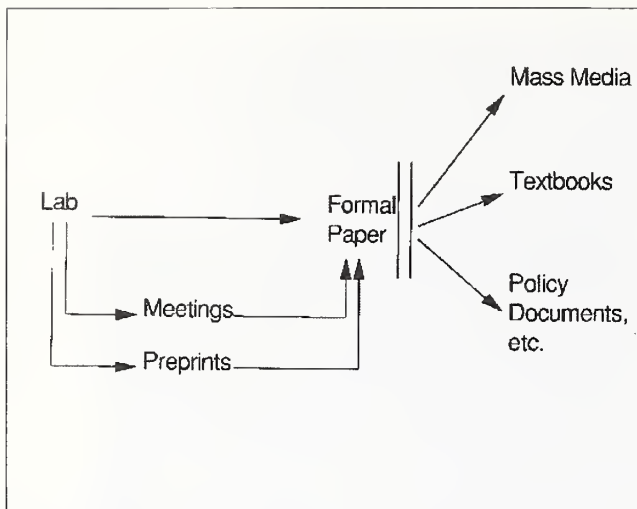


Figure 2: The traditional model of science communication.

about science communication as a formal process (Fig. 2). Science happens in the lab. It goes through some meetings and preprints and it is finally published in a formal paper and then it is “science.” Only after it gets to “science,” does it get out to mass media and textbooks and policy documents.

From studying the cold fusion case and other instances where the daily processes of science become more easily visible, we have learned that the science communication process is a lot messier (Fig. 3). Stuff happens in the lab and in field work and it doesn’t necessarily go through formal publication, but instead goes to e-mail or straight to a museum or (as Hannah Holmes suggested in her presentation at this meeting) straight from a journalist out in the field to a documentary or Web site. Science information flows all over the place.

The value of this kind of conceptual approach is to remind us that, as we think about public communication of science, we have to think about it in a more complex way, not as

a simple linear process. We have to think about the multiple ways that information is flowing.

A second conceptual issue is to think about the models of what we are trying to accomplish with public communication:

- Deficit model
- Contextual model
- Lay expertise/lay knowledge model
- Public participation model

The labels I’m using here are slightly different than those used by Susanna Priest and Rick Borchelt in their presentations at this meeting, but the ideas are similar. The traditional deficit model is the idea that if we simply provide information, things will get better. As we’ve heard over and over at this meeting, such as in Joe Schwarcz’s presentation, there is a tremendous need to provide information. There’s nothing wrong with the deficit model: we do need to provide information. But that only captures part of the need. The contextual model addresses the issue that there is not a single audience, but in fact there are multiple audiences. We need to think about those audiences in context: For what reason do they need information? In what situation do they need information? This model highlights that we need to provide information in different ways to different groups at different times, to address the contexts in which they use information. Somewhat more controversial is the model of lay knowledge or lay expertise—the idea

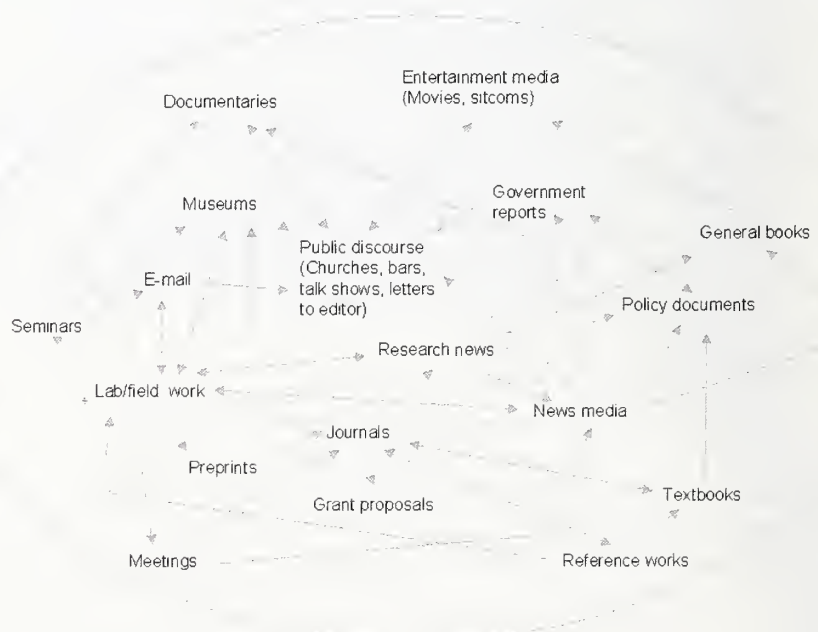


Fig. 3: The sphere of science communication. Adapted from Lewenstein, B. (1995). From Fax to Facts: Communication in the Cold Fusion Saga. *Social Studies of Science*, 25(3), 403-436

that sometimes public communication is about communicating ideas from what we would traditionally call “non-experts” into the research enterprise. For example, AIDS activists and cancer activists have shaped the research agenda by bringing to the table their knowledge and their expertise about what issues are salient. They don’t change nature itself, but they change what we know about nature and what we think about nature and where we put our efforts in terms of understanding nature. That’s a different kind of communication setting than a setting of simply providing information to fill a deficit.

The final model is what Susanna Priest called the public opinion model, what Rick Borchelt called the dialogue model, and what I call the public participation model. They are all essentially the same thing. As a society, we claim we’re interested in this issue of public communication because science is important in an democracy. The key thing about a democracy is public participation in all facets of discussion of public issues. The public participation model of science communication highlights the need to create venues and opportunities for public discussion.

These conceptual models provide a background. When we start talking about books, we are thinking about books in the context of the overall web of communication. We are talking about them in the context of multiple models of public communication of science. So then we can ask questions about what multiple roles might the books be playing.

Are Science Books Important?

To understand the role(s) of books, I am looking at the history of science books since World War II. I’m looking both at books within science, such as textbooks and conference proceedings, and more public books, such as bestsellers, Pulitzer Prize winners, and other contributors to public and intellectual debate. In this talk, I’m just looking at the public books.

There are a couple of different ways of identifying books that play a role in public culture. There are the ones that have some kind of official presence: they have won an award, a Pulitzer Prize, a National Book Award, etc. Or, they have been certified as being popular by virtue of being on one of several bestseller

1947 (history):	Baxter, <i>Scientists Against Time</i>
1967 (history):	Goetzmann, <i>Exploration and Empire</i>
1978 (gen nonfiction):	Sagan, <i>Dragons of Eden</i>
1979 (gen nonfiction):	Wilson, <i>On Human Nature</i>
1980 (gen nonfiction):	Hofstadter, <i>Gödel, Escher, Bach</i>
1982 (gen nonfiction):	Kidder, <i>Soul of a New Machine</i>
1984 (gen nonfiction):	Star, <i>Social Transformation of American Medicine</i>
1986 (history):	McDougall, <i>...The Heavens and the Earth</i>
1988 (history):	Bruce, <i>Launching of Modern American Science</i>
1988 (gen nonfiction):	Rhodes, <i>Making of the Atomic Bomb</i>
1991 (gen nonfiction):	Hölldobler and Wilson, <i>Ants</i>
1995 (gen nonfiction):	Weiner, <i>Beak of the Finch</i>
1998 (history):	Larson, <i>Summer for the Gods</i>
1998 (gen nonfiction):	Diamond, <i>Guns, Germs, and Steel</i>
1999 (gen nonfiction):	McPhee, <i>Annals of the Former World</i>

Figure 4: Science-oriented Pulitzer Prize Books after World War II

lists. Or they fall into a category I call “remembered books,” the ones where someone I’m talking with remembers the book and then says, “But you’re going to include that book, aren’t you?” These are the books that have become touchstones for us.

Let me start with the Pulitzer Prize winners (Fig. 4). In the first 30 years after World War II, there were almost no science books. One book, James Phinney Baxter’s *Scientists Against Time*, published right after the war, was a story about the atomic bomb. William Goetzmann’s book, *Exploration and Empire*, was about exploration of the American west. But beginning with Carl Sagan’s *Dragons of Eden* in 1978, then every year or every other year, the Pulitzers begin honoring a science book. They are not all history of science, either. They show up in both the general non-fiction and the history category of the Pulitzers. Clearly, something happens in the late 1970s to make science books more central to American culture. Science becomes a part of the general public discussion. Interestingly, that same time period is also about the time of the “science boom.” There were some new popular science magazines that started in the late 1970s and early 1980s. There were new science television shows—*Nova*’s first broadcast was in 1973. The science museum industry was booming. All this data suggests that the relationship of science with American culture went through a change in the late 1970s, in which science became a necessary part of any cultural discussion.

The pattern continues in more recent years, with books like Jared Diamond’s *Guns, Germs and Steel*

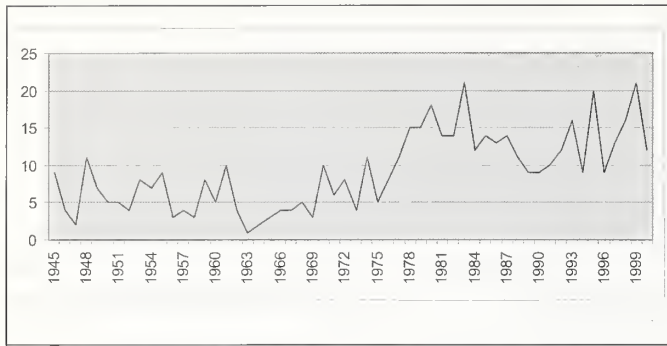


Figure 5. Number of "science" titles added to New York Times bestseller list.

and John McPhee's *Annals of a Former World*. Those of us who are science attentive have been reading McPhee for years, but only recently has he received this national award recognition.

Looking at bestsellers, I see a similar pattern. Figure 5 shows data from the weekly *New York Times* bestseller list. Although the data shows lots of variation, there is a clear change in the late 1970s. Before then, only rarely did more than 10 new science-oriented books a year become added to the list. But after 1978, only rarely do fewer than 10 science-oriented books get added to the list. More science books are being sold. That's another marker to suggest that science is a necessary part of ongoing cultural conversations. The Pulitzer Prize data and the bestseller data suggest that the idea that there are "two cultures" (of science and arts) that don't speak to each other may no longer hold (if it ever did).

To understand this new cultural debate, we need to know more about what specific types of books were appearing on the bestseller lists. There are at least two kinds. First are the books in which "science" appears as a main character. These are the books that are about physics, or astronomy, or biology or so forth. The second set of books are those that I call "public science." These books are about, for example, sex, but they draw on the science of sex. These are the inspirational books that draw on psychological research. Many of the diet, health, fitness, and medicine books draw on scientific research or at least the appearance of scientific research. I don't want to claim that all of these books use science well. As the examples cited in the talk by Joe Schwarcz at this meeting demonstrated, many books that claim to be

scientific are not. Nonetheless, it is important for us to see that these "public science" books get some of their credibility precisely because they lay claim to the authority of science. Some people argue that science is not valued in our society. I disagree. These books become bestsellers by claiming to draw on science, which they do because science is respected in the community of ideas. The book data indicates that science actually plays a very important and respected role in general culture.

Figure 6 shows titles from the annual *Publishers Weekly* bestseller list. This list again shows the importance of "public science" topics, such as sex. Consider the two books on human sexuality by Alfred Kinsey and his colleagues, published in the late 1940s and early 1950s. These are not books that anyone would predict would become best sellers, once you get past the title, because they are actually dull, dry academic treatises. But the titles alone seem to have sold a fair number of copies. We also see Sherry Hite's *Hite Report* and the Masters and Johnson book on *Human Sexual Response* there. Another "public science" topic is exploration. Many books on the list, such as Thor Heyerdahl's *Kon-Tiki* and Rachel Carson's earlier book, *The Sea Around Us*, fall into that category. (Carson was a bestselling author 10 years before *Silent Spring* came out.)

Then there are the "grand" books, such as Jacob Brownowski's *Ascent of Man* or Carl Sagan's *Cosmos*. These are perhaps the first of the books that we would think of as "science as science" books (not counting Kinsey and Masters and Johnson), books about scientific ideas. It's interesting to note that these "science as science" books, too, appear only in the 1970s. The breakthrough clearly comes in 1980 with Sagan's *Cosmos*. The TV show, of course, was tremendously powerful and well known and is partly what drove the sales. But the book itself was also a bestseller—a bestseller so great that shortly after it was published, Sagan was given a \$2 million contract for what would become the novel *Contact*. At the time, that was the largest advance ever given for a fiction book that was not even in manuscript form. *Cosmos* marked the moment that something different was clearly going on.

In the “science as science” category, the next big moment was Hawking’s *A Brief History of Time*. Hawking’s book is the one that everybody bought but nobody read. He says in the introduction that he left

Year	Place	Author, title
1948	4	Kinsey et al., <i>Sexual Behavior in the Human Male</i>
1950	5	Heyerdahl, <i>Kon-Tiki</i>
1951	6	Carson, <i>The Sea Around Us</i>
	9	Heyerdahl, <i>Kon-Tiki</i>
1952	4	Carson, <i>The Sea Around Us</i>
1953	3	Kinsey, <i>Sexual Behavior in the Human Female</i>
1958	8	Heyerdahl, <i>Aku-Aku</i>
1966	2	Masters and Johnson, <i>Human Sexual Response</i>
1975	4	Bronowski, <i>The Ascent of Man</i>
1976	9	Hite, <i>The Hite Report: A Nationwide Survey of Female Sexuality</i>
1977	7	Sagan, <i>Dragons of Eden</i>
1980	2	Sagan, <i>Cosmos</i>
1981	5	Sagan, <i>Cosmos</i>
1988	3	Hawking, <i>Brief History of Time</i>
1989	6	Macaulay, <i>The Way Things Work</i>
	13	Hawking, <i>Brief History of Time</i>
1992	30+	Sagan, <i>Shadows of Forgotten Ancestors</i>
1994	24	Preston, <i>Hot Zone</i>
	26	Herrnstein and Murray, <i>Bell Curve</i>
1995	14	Goleman, <i>Emotional Intelligence</i>
1996	30+	Goleman, <i>Emotional Intelligence</i>
1997	30+	Merck Manual

Figure 6: Science-oriented bestsellers after World War II

out all the mathematical equations so that he wouldn’t lose readers, but the book is still a pretty tough read. It sold 700,000 copies in hardcover in its first year, 400,000 copies in its second year. That’s just in hardcover. It sets a new sort of expectation about what books can accomplish. There are changes in what counts as a bestseller during this period, so it appears that the ranking of science books goes down. But Hawking’s book opens up the book publishing world—and thus the broader cultural world—to science. After it appears, science books get entire aisles in the book store, agents go seeking authors like Hannah Holmes to write books about engaging in science.

All of this evidence suggest that books have played a role in general American culture. Some of the evidence shows that books are even more important in recent years than they were in an earlier time, even with all the changes in media.

How are Science Books Important?

Books exercise their cultural importance by contributing to public discussion in four areas.

First, books are important to the intellectual development of science itself. Even though some of the bestselling or prize-winning books are targeted to the public, they also are targeted to the scientific community or they play a role within the scientific community. That should not surprise us, given the conceptual understanding that the “sphere of science communication” gives us, which stresses the feedback among different forms of communication and the loops that connect different types of communication.

The second role that books play is to recruit people into science. This function is not unlike the goal of many of the Websites or community-based projects that have been featured at this meeting. That makes sense, because if books are part of general cultural discussion, then the functions of books should be similar to the functions of other activities within the culture.

The third role is one that cannot easily be expressed in English. The French call it *culture scientifique*, the idea of everyday culture as infused with science. If we say “a scientific culture” in English, it doesn’t carry the same meaning that it seems to carry in the French-speaking countries. The idea is that books show the integration of science and culture in our everyday life.

The final role is one of public debate, in which books are the location or the forum in which public issues can be discussed.

A. Intellectual development of science itself

For an example of how a prize-winning book contributes to science itself, consider E.O. Wilson’s *Sociobiology*. This book was partly intended for the science attentive public, elite intellectual community. But it was also an argument within science itself. It was Wilson’s full, complete statement of the socio-biology program. It was intended for use within the scientific community as a statement of that program. In a very real sense, it pulled that field together, making explicit some of the connections and ideas that had previously existed only in separate papers or only in specialist communities. Wilson’s book made the new field concrete.

A similar function was played by one of the textbooks I've looked at, James Watson's *Molecular Biology of the Gene*, published in 1965. That book pulled together the field of molecular biology, which had not existed before. Whole courses were created to teach that textbook. In the same way, courses were suddenly created called "Sociobiology," based on Wilson's book, pulling together the field in a way that had not been true before. Yet, especially because of Wilson's last chapter on humans, the book also became part of a general public discussion about the nature of who we are.

Another example is Joseph Weizenbaum's *Computer Power and Human Reason*. The book is a key text within artificial intelligence. At the same time, it is also part of the general discussion about the role of computers in society, the workings of the human mind, and all those related topics.

James Gleick's *Chaos* is interesting because it also seems to serve this intellectual role within science, even though it was written as a popular science book. It was just another journalist going out and writing a book that would explain some area of science. And yet, the book served the function of pulling that field together, the field of complexity and chaos, in a way that it had not previously been pulled together. If you look at some of the more recent books that are histories of the fields of chaos or complexity, they will cite Gleick's book as being one of the things that pulled all those people together, that made them suddenly realize that they were all talking to each other. The public discussion shaped the intellectual discussion as well—through the medium of books.

B. Recruitment

Recruitment books pull people into science. These are books that people cite as "Hey, the reason I'm a scientist is because I read that book." Paul De Kruif's *Microbe Hunters* is the epitome of these books. (Although it was published a generation before the period I'm considering, it continued its powerful pull for many years.) It is astonishing how frequently that book appears in the memories (and sometimes memoirs) of senior scientists who became biologists in the 1930s, 1940s, and 1950s. They read *Microbe Hunters* and that's what turned them on.

James Watson's *Double Helix* is a very different kind of book, but served much of the same purpose in the 1960s, 1970s, and maybe even the 1980s. If you look at the people who are today at the forefront of biotechnology or genomics, many of them read that book as graduate students and said "Yeah, That is the kind of scientist I want to be! I get to make a Nobel Prize-winning discovery, and then I get to go play tennis, and then I get to go get the girls." That sounded like a cool kind of career.

More recently, particularly in astronomy or physics, you get people for whom *Cosmos* (either the TV show or the book) served the same function. These are often people who were so turned on by the TV show that they went out and got the book. *Cosmos* has had the same kind of recruiting power as the De Kruif and Watson books: "Why are you an astrophysicist or an astronomer?" "Because I saw Carl Sagan's *Cosmos*" or "I read *Cosmos*."

C. Culture scientifique

The third role of books is this *culture scientifique* idea. This is the idea that you are expected to have read some particular books if you want to call yourself "cultured." The books by Isaac Asimov, Stephen Jay Gould, or Bronowski, are "required reading" in cultured circles (although the list does change over time—Asimov is probably less read now than he was during his lifetime). You can't consider yourself a cultured person if you haven't read the essays of Lewis Thomas about medicine, or more recently Dava Sobel's *Longitude*. Not all of these books have tremendous amounts of "science" in them. Thomas's essays are as much about philosophical approaches to illness as they are explanation of disease, and Sobel's book is more adventure story than science explanation. But you are "expected" (in some circles) to have read those books. Among the "science attentive" public, you are expected to have seen the excerpts of these sorts of books in the *New Yorker*.

Asimov is an interesting case in this category. Asimov is actually best known for his science fiction books. Of his 400-plus books, Amazon.com lists about 285 of them. His Foundation series is first, and it ranks about 9,700—in the top 10,000 items on Amazon.com. Some of his nonfiction books rank in the top 50,000, but they tend to be his books about

the *Bible* or about bawdy limericks (he had range!). The first of his non-fiction science-oriented books is *Atoms: A Journey Across the Subatomic Cosmos*. That book ranks about 50,000 on the list. It's the 26th of his books on the list, so it's about 10 percent of the way down.

Asimov also is interesting because he reflects the commitment to a scientific worldview that is often at the core of these *culture scientifique* books. To illustrate, let me use a personal example: In the late 1980s, I wrote an op-ed piece for *The Scientist*, a weekly newspaper for scientists, in which I talked about what I called the "arrogance of pop science." I was addressing the question of who should popular science be directed toward. I was arguing that a lot of the popular science magazines that had been produced at that time, and that by then were in trouble (many of them had failed or been sold to new owners), had failed not because they aren't pretty, but because they were speaking from the scientific point of view. They were not starting where audiences were, which was a concern about their personal situations or their personal interests or their personal diseases. Too many of the magazines, I argued, were stuck in an elitist scientific point of view. Asimov got a little annoyed at that, and he wrote a letter to the editor. I'm proud that I generated a letter to the editor by Isaac Asimov. He said; "I don't understand what this Lewenstein nut is saying. Because he is saying that if people are stupid, then I need to start where they are. That doesn't make sense. "By Newton," he thundered (not "by God," but "by Newton"), "I'd rather be arrogant than stupid."

D. Public Debate

The final role is the role of public debate or public opinion. Books do not just provide information, nor do they just excite people, but some of them are in fact making arguments. Rachel Carson's *Silent Spring* is the most obvious example. That book made an argument about chemicals in our society and is widely cited as being the founding document of the environmental movement. The argument did not go uncontested. Carson's book was not attacked just by chemical companies, it was attacked by science writers. In 1963, a well-known science writer named Lawrence Lessig won the American Chemical

Society's Grady-Stack Award (for excellence in science journalism). As part of his award speech, he called Carson's book "highly emotional with a biased thesis." Much of his talk was an attack on *Silent Spring*. This example demonstrates the degree to which there was an argument which many people felt was needed.

Similarly, Evelyn Fox Keller's *The Feeling for the Organism*, a biography of Barbara McClintock, was part of a discussion about the nature of science and whether feminine science was somehow different than masculine science. Did McClintock do science differently? Did she have some kind of female connection with her materials that males didn't have? Fox Keller was making an argument, one that's part of an on-going argument. Lots of people have criticized some of the technical details of Fox Keller's book, but for our purposes, the important point is that she was engaging in public discussion of a contemporary issue. Richard Herrnstein and Charles Murray's book on *The Bell Curve* is similar: Many people will argue with the science in it, they will argue about whether it properly reports research findings or interprets data correctly. But the point is that it became a topic of discussion. *The Bell Curve* was the kind of book where there were public debates, op-ed pieces, magazine pieces, newspaper articles, policy discussions, and so forth. It's an example of how books can play a role in public discussion.

Conclusion

Books drive public discussion most simply because they are part of the media mix that permeates our culture. While we focus on the World Wide Web and other new media because of their freshness, we can't forget that there are lots of other pieces in the sphere of science communication; books are there. More deeply, books drive public discussion because of the multiple roles they play in providing information, engaging lay expertise, and contributing to public discussion.

Books bring new perspectives into science. As we think about the functions of public communication of science and technology, we need to remember examples like *Chaos*, the book in which the journalist James Gleick pulls together an intellectual field in a

way that hadn't been done before. We need to think about stimulating discussion—not just making you feel good the way a Lewis Thomas book did, but making you argue with a book in the way the Herrnstein and Murray book did. That is a role that books can play. That role highlights the public participation or public opinion model.

Ultimately, books create the culture that we live in. They are elements both of the scientific culture and of our more general culture. By looking at them we can actually see the ways in which science and modern culture are not separate but are—to use a jargon word from the sociology of science—co-produced. Neither science nor society exists without the other one. Books provide an example of how that interaction exists in a real, material way. If we think about the multiple ways that books demonstrate the interaction of science and society, then we can also see the ways in which the other activities that participants in the Best Practices for the Communication of Science and Technology to the Public meeting are engaging are contributing not just to solving some particular problem, but in fact are serving to create a scientific culture, a *culture scientifique*.

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Graphic Science: New Venues for Science Communication

Frank Burnet, Faculty of Applied Science, University of the West of England

Burnett: The microphone is a genuine formality, I'm afraid, because my first departure ever into the communication of science was when I volunteered for The Loudest Voice in Britain award on BBC TV, the *Late, Late Breakfast Show*, and I won.

Interestingly, they wanted me to shout something that a university lecturer, they imagined, might shout, like, "Get out of my lecture theater and never come back, you!" and instead I shouted (I won't shout it), I shouted, "Eureka! It's a 4-androstene 3,17 jam diol!" which doesn't exist, but it's a steroid in chickens.

Anyway. So, I was such a huge success my children from then on for about 10 years never introduced me as their father, just the man with the loudest voice in Britain, so there you go. If I boom, I boom.

But today, it's my great pleasure, and I do feel very privileged to have been asked to come and speak here. Very privileged indeed, I find this conference very stimulating and it's great to be able to present work, which may not have been seen on this side of the pond too much, and that's a great privilege. Thank you for asking me.

New venues for science communication, what I'm going to talk about, picks up on some of the themes that have been in discussion here today. For example, I will touch, definitely, on dialogue. I'll be touching



Frank Burnet

Ben Johnson

Madeleine Ings

on audience targeting, definitely, and I have my own particular interest, which is generic venues for communication, and I'll be touching on that, as well.



Where Are We?

Bristol

The most beautiful, interesting and distinguished city in England

-Sir John Betjeman



So, who are we? That's me, a little younger. That's Ben Johnson, who's my principal researcher always coming in slightly sideways, and this is Madeleine Ings, who actually keeps us both in order. Graphic science, as an organization, works through an associate principle. We're the small core team. We take on projects. We bring in people to run the projects with us, so we have a rolling group of associates—some roll more than others—who are associated with the team.

Where are we? We're in Bristol, which is there. And just so you can get to know what it's like, it is the most beautiful, interesting, and distinguished city in all England. It's in the West.

So where do we work? Well, we work in supermarkets. We devise ways of taking science to people in supermarkets. Now why do that? Well, I've just picked up this new term, "*culture scientifique*." I rather like it. Although I'm doing it, possibly not, for the attentive. I'm generating "*culture scientifiques*" for the inattentive, so to speak, and the supermarkets are good venues for that. People are wandering around, there's all this stuff around them, which of course is very science-loaded.

For example, there happens to be a picture of a flower stall in the supermarket. We devised a multiple-choice quiz with a prize at the end. Ten questions, prize at the end, which you did as you went around the supermarket. And, above the flower

Where Do We Work?

Supermarkets



stall, we hung a huge sign which just said, “Are flowers male, female, or male and female?” End, my multiple choice question. And the answer is, “both,” quite so. Anyway, so, we did that in the other aisles. For example, here’s the one we put on the Web: “Tomatoes ripen faster if you put them in a brown paper bag, because: It’s dark. It keeps the air out. It keeps the air in. The ripening gas can’t escape. You

Q. Tomatoes ripen faster if you put them in a brown paper bag because

- ☐ a) It’s dark
- ☐ b) It keeps the air out
- ☐ c) It keeps the air in
- ☐ d) The ripening gas can’t escape
- ☐ e) I give up

give up.” Can I have a concerted shout of a letter of your choice? 1-2-3, go. D. Yeah, right. Now, it’s interesting you should all know that so well because of course, the world is full of people who space their tomatoes out on window ledges. Yeah, not a great place for ripening stuff and gas going on.

So, we did that kind of thing. This is about the centrality of science to everyday experience. That’s what we’re trying to do. We’re trying to point out the fact that people are surrounded by science. They live in a *scientific culture*. And, that’s all we’re intending. Before I go any further, I must say, we are not trying to educate people. That’s not our purpose. We are simply bringing science out of the closet where it has managed to get itself hidden, and placing it back alongside music and literature and so on, within culture. That’s what we see ourselves as doing, relocating it. We’re not trying to ensure that absolutely

Where Do We Work?

Supermarkets Schools



everybody in Britain is ripening their tomatoes correctly. This really doesn’t bother me. They can do with their tomatoes whatever they wish. What about tomatoes? This is sort of a tomato-dominated conference. Let’s hope they don’t throw them.

Anyway, so we work in schools. Very interesting leading up to this discussion about the importance of getting people young, this has been very much taken up by the British Government. This year is “Science



11-14 year olds



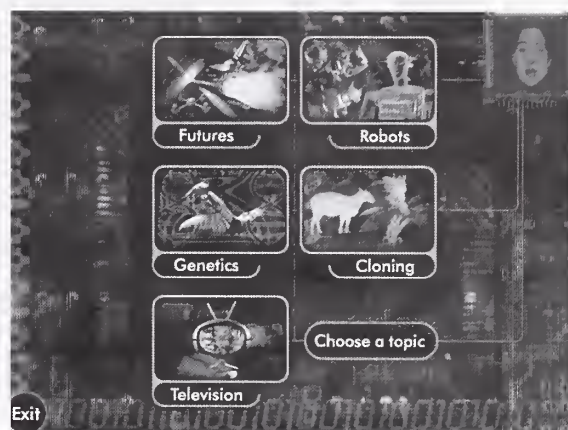
Year”—fast forward to the future—in British schools. And we’ve been working in schools using one of the techniques that we have developed with designers. Now, one of the things that I never understood about design, because incidentally I’m a biochemist by training, was that designers can target audiences. Designers can identify, get you a particular audience with great accuracy using design motifs and colors. And for that reason, we work with designers when we’re given a specific target audience.

In this particular case, the target audience is 11 to 14-year-olds. And we’ve created two posters for Science Year. One was their launch poster, which simply, it’s not a science poster, it simply says, “Catch the Wave.” So it was about getting on the

wave. Aimed at 11 to 14-year olds, specifically trying to focus on girls, but also on boys, Manga-style cartoon, you'll notice, it's the one on the—it's the one I could tell you if I knew how to use this machine. It's this one. Manga-style, because that is used if you go to Web sites, aimed at this age group, Manga-style's in use, and a color palette which is also used very much in those kinds of magazines and Web sites.

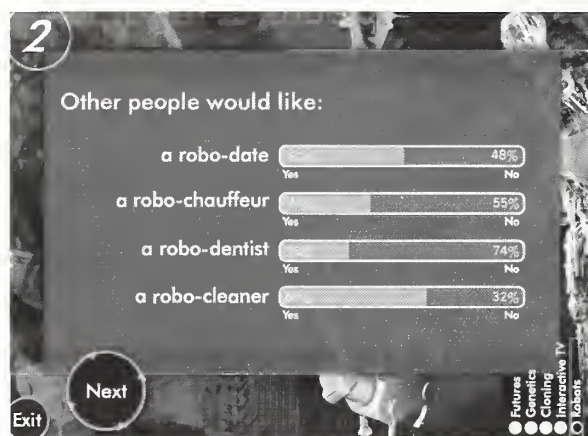
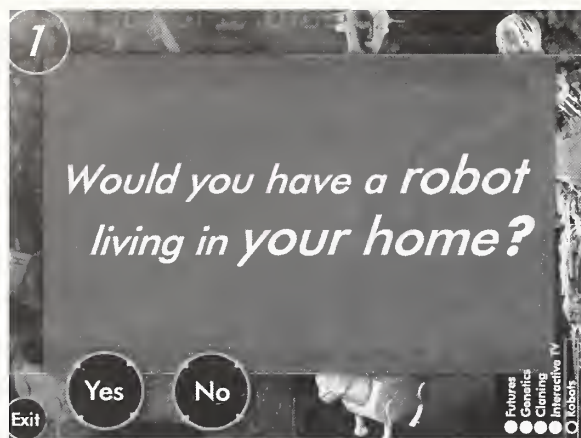
So this is—it may not be to you, in fact, you'll probably hate it—but it will catch the eye of that group, reasonably effectively. We just produced another poster for them, which actually isn't out and this is a draft so the pics missing, but I've got the real thing out in the hall if you want to see it. It's quite large. This is called an “empty belly” poster; delightful term. It just means that it's there so the school can stick their own message, whatever it is, in the center where it says “text message,” and the rest of the poster uses, now, not just colors, uses words. They're in common parlance within that group, like, *Neighbours* is the most popular soap, *Matrix*, as you know, a movie, Hearsay is the most popular pop group, Destiny's Child, another pop group, uses these words to draw attention to the graphic and to put science in the context of their culture. So, this is work we're doing with Science Year and these posters are going to every school in the UK—every secondary school.

We also work in science centers—and I've had very interesting conversations with people who work in science centers here. Our work in science centers, is actually dialogue-focused. It's looking at a problem, which has been alluded to by an earlier questioner, which is “Okay, so we want to have some dialogue. How do we do this? How do we structure dialogue? And do people have to be prepared in some way for the dialoguing process?” Do you simply send them an invitation and say, “Come and discuss genetic screening tomorrow,” or do you try and brief them? Are you trying to get some deliberation by them before they express their opinion? We were asked to develop tools for use in a science center environment—so things that would be fun to use, but which would give people opportunity to explore areas, “hot topics” as we call them, of science and technology, and to do two things. One, is to express their opinion and compare that opinion with everybody else who'd ever used this particular installation, because it's software that



remembers people's reactions and responses, but also to get them to explore the dimensions of their opinion.

Let me give you an example. So, this is about robots. A brief introductory—three sentences: A computer called Deep Blue can beat the world chess champion. Robots have replaced people in many factories. In the future, robots could do more and more things for us. And then a question: Would you have a robot living in your home? And then an answer ‘yes’ or ‘no,’ and then feedback—now this is a prototype—it's now run for about a year, so we've got tens of thousands of responses to this but this was when we were in development. Essentially, what the machine does is it tells you everybody else's opinion, whether or not they'd have a robot in their home. It also tells you about people of your age, and if you like, people of your gender's opinion about that question. So, you're expressing your opinion, and you're also com-



paring your opinion with those of everybody else who's ever used the installation.

When you logged in, incidentally, you gave an age range. So, you have two bits of information you're asked to give when you log in; only two: your age—an age range, not your exact age—and your gender. And then you ask them to look at questions like, "Would you have a robo-date?" Fifty-two percent said, "Yes." Now, there's a reason for this. It's not a technical fault. At this very early stage, a day or two to actually using the thing, lots of young children had used it. So, would you have a robo-date? Would you have a robo-chauffeur? Robo-chauffeur? Show of hands, fancy a robo-chauffeur? Yeah, you people are, 45 percent—we'll go dentist. No? Robo-cleaner? Yeah! So, the purpose here is, what's your robot tolerance? In other words, are there things you'd have a robot do for you and others you would not? And we just got people to look at that. We weren't telling them, we're just getting them to look at it.

We also worked in pubs. You'd never have guessed. Those of you who've met me over the last few days, you'd never have guessed I ever worked in pubs. I'm a complete stranger to pubs. In fact, when I decided to work in pubs I had to be taken into one just to see what it looked like, really. But they turned out to be okay, and they are interesting venues for science communication. I don't know whether this—and this has been done. This has been done in Australia—there is science in the pub, and in Britain, there are a very interesting set of talks and debates in pubs called "cybars." So, and this actually is built on the "*café scientifique*" principle—we keep going back into French—which—yes, it's French. Anyway, but pubs—this is slightly different. This is called "Pub Genius," and it's a quiz; not just a science quiz like lots of science questions you happen to ask at a pub, but lots of questions about the science you find around you in pubs. Back to the same theme, the science that supermarket goers have around them; their scientific culture. So, this is about the science you have around you when you're in the pub. And this combines two methodologies. One is a series of questions. Now, pub quizzes are very popular things in the UK, and pubs specialize in them, and so you could just get people to pick up this specific event in this generic venue. You'll notice all the venues, so far, are generic. The supermarket is everywhere. Once you devise something, you don't have to go out and do it all again, you just let it go. You just put it on the Web, and anybody who wants to can do a supermarket thingy. The pub quiz, anyone who wants to can do this quiz. You could come and get the questions from me after this, if you like, they're all there.

So, the idea is to create events which are infectious, which travel, which have their own way of going, which people will pick up and go, "That's good. We've got a social club. We've got nothing to do next Thursday. Why don't we have this idiot's quiz?"

So, within the quiz there are eight questions about beer. There are eight questions about wine. There are eight questions about whiskey. There are eight questions about toilets. There are eight questions about fast food. There are eight questions about hangovers, and so on. This one is about wine, just asks about the alcohol limits in wine: "What limits wine to an alco-

Q. What limits wines to an alcohol content of between 11% and 14%?

- ☐ a) Yeast dies above this alcohol concentration
- ☐ b) Licensing laws
- ☐ c) Excise duty
- ☐ d) Fussy landlords
- ☐ e) I give up

hol content of between 11 and 14 percent? Is it the yeast die? Is it licensing laws? Is it excise use? Is it fussy landlords?" And the answer is, "A."

So, it's a question chosen to underline that making something like wine is a process which involves science, it involves organisms, and that's the question. We don't just have questions, because in a pub you can't just do questions. We also do tricks. Thank you.

This is a very simple one. A very simple one, indeed. I gather you have these in the States, they're Alka Seltzer. And you have these, film cans. Take an Alka Seltzer, put it in a film can. Take a little water—they thought I was going to do a rather bigger trick—clip the top, tightly on the film can [pop!]. Ah, that was a little undramatic, but all great failures tend to be.

I've got another, and hopefully—actually, what you can do to make an appalling mess, is to put the can upside-down. I hope. The wait's a good thing. [pop!] Ah, yes! So, and of course the question you ask the audience, and the prize is a bottle of beer, is why? Why? Why does that happen? And I won't, of course, you know why it happens; that's sodium bicarbonate, tiny bit of citric acid in there, carbon dioxide is produced. Film cans are specially designed to be light tight, and therefore have tight tops—you're off!

graphic science

Where Do We Work?

Supermarkets
Schools
Science Centres
Pubs

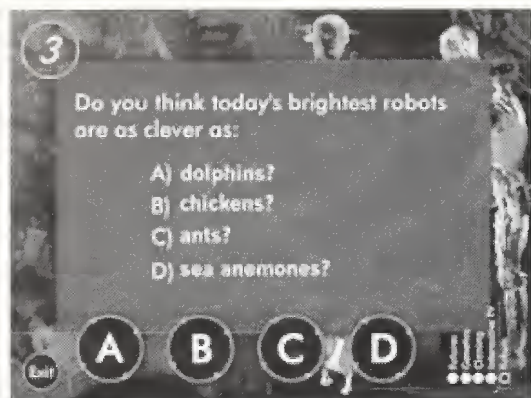


There are a number of such tricks that we do. So, two sets of questions, a trick—an opportunity for people to explain why it happens that way—then another two, another trick, and so on.

So, it's a pub event. It's fun, and what we hope people will say at the end of it is, you know, "It was only at the very end I realized this was about science." It was only when someone said this was sponsored by—Pfizer, that I understand—that's imaginary—it wasn't sponsored by Pfizer—but it was only then that people say, "Oh, this is science." Most of the time, they're not aware of that at all. They're just at a pub quiz having a good time with their mates.

Now, we're about to work on freeways. Not in the middle you'll be glad to hear, but in the service stations, because boredom is a big feature of travel, on our motorways, certainly, because you don't go—actually, travel is a misnomer on our motorways—it's just sitting in the car, really. Where they play this movie of the countryside going by. So, basically, there's another common element that, I'll pluck it out for you here, is "dwell time." These things, the things we're devising, are all about people having the time. They're in the supermarket going from end to end. They're in the pub for a couple of hours, or in my case, 35 seconds, but anyway, however long they're going to be in the pub. They're on the motorway and they wish they weren't. Dwell times are important. And the dwell time on motorways can be very long, and what we're about to do—we haven't done it yet, we just got funding for this—is to devise a quiz, probably on a multiple-choice basis, sponsorship from service stations that are off freeways, use their forecourts to hand out—I should probably do some tricks because they're always good for gathering kids around us—but then hand out these things for continuing the journey, have a free post number to turn them in to, have a prize sponsored by someone.

So, once again, this is done. We're not inventing something. I mean, you know, Esso has been doing this for heaven knows how long. You've got some—I'm sure it happened here in the States, certainly it does. They produce whole packs of material to give to your kids on the journey. We're not coming up with anything new. None of this, it's very important to understand—none of this is new. We are building on things that have existed for an extremely long time



that are very valuable to us in the work that we do. We have no way we could say we were incredibly original. We are simply building on what's there. So freeways, I think, will be interesting, and we will be looking to involve the traveling family, particularly. So the target audience there—this is where I begin to talk about targeting—target audience would be the traveling family.

We actually do work in boardrooms a bit, we're now and again asked to advise bodies, like The Royal Society of London, and this one's called "Listening to the Public: Dialogue and the Royal Society." Which turns out to be a bit of a misnomer, because firstly, we're on the phone:

"The Royal Society wants to"

"The Royal Society of what?"

"No, it's the Royal Society of 'where.' It's the Royal Society of London."

"Oh, the Royal Society—what does the Royal Society of London do, then?"

"Well, science."

"Oh, does it! Oh! Oh, good! Good! That's great!"

So, they've got a itsy, bitsy, tiny little hill to climb in terms of contacting the public.

Nothing they can't handle. They've got 700 fellows all over the age of 80, but ...

We had to break it to them it was going to be a bit tricky. All right.

Also, I suppose our work in that area shows up the fact that there's a big interest in this "dialogue" word and the "listening" word in the UK, just as there's been here at this meeting.

And on to buses. The buses that brought Rick and I together. That's a bus, just in case you don't know what they look like, and this is what we do on them. I'll tell you a story.

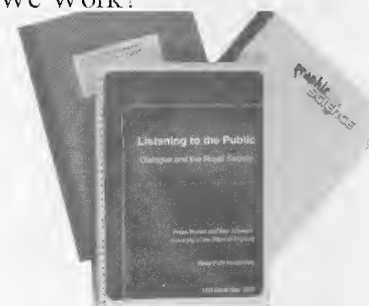
When I moved to Bristol, I wanted very much to do something new. Something which would, you know, be exciting, which would give me a good start in Bristol. And, I woke one 3:00 in the morning thinking about poetry on the underground—I know you've some of that. I know there's one in New York and so on—where people have put poems on the underground trains. Very, very popular campaign in the UK, and I decided, why not put science on the underground? And so, I devised, with some Millennium funding, posters—but I didn't put them on the underground. The underground turned out to be incredibly expensive, but also interesting, the underground audience there in the underground is not the audience I was interested in. What I wanted to get to was an audience that is seen in the UK as being hard to reach, in terms of science communication. It's young adults: 15- to 25-year-olds.

Young adults, surveys show in the UK anyway, don't watch science on TV. They certainly don't go to

graphic
science

Where Do We Work?

Supermarkets
Schools
Science Centres
Pubs
Freeways
Board Rooms



science-based visitor attractions, and essentially, science is not a major thing in their world. And we decided to try and target young people, using posters which are designed, targeted, at people who like to go, for example, to nightclubs. The Lizard Lounge is a young persons' club in Bristol, and you would have seen these kinds of colors and these kinds of fonts probably here in the U.S. These bright reds, these bright yellows, and this kind of fonting and this kind of banding is very characteristic of this type of advertising.

And so, we decided we'd create posters which were aimed specifically at young adults, and we produced a first set, which I was very proud of, I have to say, and my friends thought they were great—unfortunately as I'll show with the evaluation—the bus-traveling public were deeply confused by them. But we learned quite a lot from this. For those who can't read from where you are, I'll just read out the top one. It's called "Cloning."

"Identical twins are clones and have the same genes. Identical twins look the same but behave differently. Cloned Hitlers wouldn't behave the same. They might look like Hitler but behave like Charlie Chaplin."

So, the idea is to point up—it's actually not about explaining or some kind of treatise about cloning—actually, the idea is to intrigue. The idea is to get people just to go, "Hey, that's odd."

Prions, now prions as you know, can avoid destruction by radiation or incineration. Are probably

graphic
science

Where Do We Work?

Supermarkets
Schools
Science Centres
Pubs
Freeways
Board Rooms
Buses



just proteins with attitude. So a choice of words about proteins, what we usually use:

"Have harmless relatives in the brain. May cause BSE by corrupting their relatives."

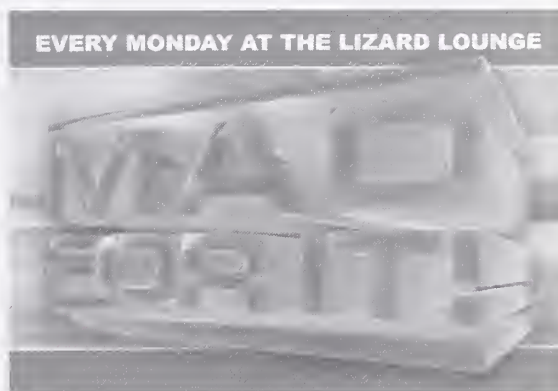
So, the idea was to have these final lines which people would remember.

Now I gave the game away—actually, buses are different from the underground, not just in who rides on them, but in terms of viewing things. Now I don't know about you here in the States, but in Britain, the insides of buses are incredibly boring environments. The only things there are are telling you how badly your wrist will be slapped if you haven't got a ticket. Or the maximum number of people in the bus is some astronomical number you can't imagine how they got everybody on the bus to begin with. But advertising is of very low quality inside buses in the UK and also tends to be infrequent. So, advertising space inside buses is cheap. Outside buses, of course, is very expensive. Buses are moving billboards, the best form of advertising. Essentially, to buy space in

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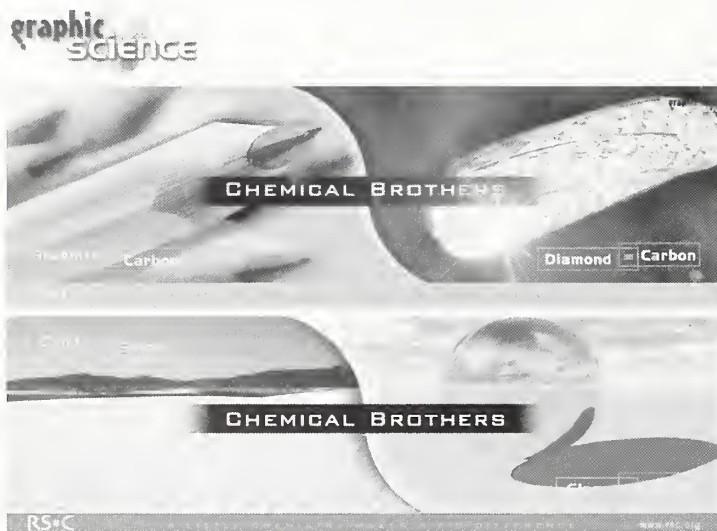
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science



the public on the outside of a bus is a lot trickier. We didn't want to buy space on the outside of a bus, as it happens, because we wanted to target young people who we knew were a very high percent of the audience within buses.

So, these were the first posters we generated. As I say, they were wildly admired within the science communication community within the UK, but not widely admired by the target audience. So we tried again. We got some funding from the Royal Society of Chemistry, this time, and we'd learned some lessons by then. First of all, you'll notice we're not using as many words, and there are no clever, clever poemettes of anything here. Chemical Brothers, they'll be someone here or many people here who know what they are or who they are. I feel in the position of that wonderful story about the old Bailey Judge in the 60s and some witness mentioned The Beatles. The judge said, "Excuse me. Who, exactly, are The Beatles?" and the learned counsel said, "I believe they're some kind of pop group My Lord."

Well, this Chemical Brothers, they're some kind of dance group, my lords and ladies. I'm not quite sure what kind of dance group, but they're an electro-pop dance group, very popular in the UK, top-selling



album out at the moment. So, Chemical Brothers are a well-known brand in the UK, and well-known word—pair of words. We picked up on it a different way. Showing things which are, physically, very different, but chemically, very similar. So they are related by the fact that they are, chemically, very similar, but

they are, physically, very different. That's one level of message within the posters.

But the message the Royal Society of Chemistry wanted to get across was the one at the bottom, which you can't really see very well on this, I don't think, and actually it is too small—it is, "A little chemistry makes a big difference." The idea of a little chemistry generating a big difference—a play on words. That was the sole slogan.

Now, these were significantly more successful—I'll show you a little more data at the end about what I mean by successful—they were significantly more successful in reaching the target audience. The use of the catch words helped, and the message seemed to go across, at least in terms of what we were trying to do. And we were trying—once again, it's the same thing trying—to point up centrality. Trying to say, "Why not have some science here on a bus?" We're not saying it is absolutely compulsory that you understand that graphite and diamond are both carbon.

Our final commission was the Institute of Physics, and you can see, we've really learned our lesson about words, now. Words are problematic—someone in introducing this very conference said that they quite—they remembered the "physics is phun" slogan with a "ph," but they didn't like it much. I thought, "uh oh, here we go," because we just happened to use that as one of the motifs in this poster. But, this is, once again, the Institute of Physics now in London, who had decided they wanted people to know that it was their 125th year of existence, and they commissioned us to produce these posters for the insides of buses, and now, you'll notice, very, very strong image of a racing car, for example, the word "Fast: thanks to physics." And then, "physics, physics." So wherever your eye goes on this poster, "physics—physics, physics, physics." But, that doesn't mean that people—and this is very interesting in terms of Joe Schwarcz talking about the elephant and people getting the message. There were a lot of old people who don't take their glasses onto buses, by the way, who thought that was a cabbage. But we're very hard people to discourage, you'll notice.

There's one interesting lesson possibly here which I can share with you, which is with this kind of, sort of, issue-based campaigning, the one thing to avoid

like the plague in any poster is an identifiable product, something they might think they can buy. And this commits cardinal sin “A.” Notice she’s holding a mobile phone. Now, due to what’s known as the “silk cut effect,” by me anyway, that people just don’t work it out. They think, “Well, I don’t understand it, but it’s got a mobile phone in it. They must be trying to sell them.”



Basically, that’s what happens with that kind of poster. You must avoid having consumer products in posters if you can, because the person just glancing will immediately take it to be an advert for that product, which is a problem. There’s a lovely one—the Millennium Commission in London, who I’m deeply grateful to because they paid for my first set of posters—had a campaign to recruit more millennium fellows to do things in their community. And it was pictures of lots and lots of armchairs—big billboard—lots and lots of armchairs, and at the end, there was one guy who turned the armchair around and was up there, about to become an active millen-



nium fellow. And they were absolutely deluged with calls asking, “Where’d you get the armchairs?”

And also, we got our only chance to date, because the Institute of Physics are what’s known as “jolly rich.” None of them are here, are they? No. All right.

They’re jolly rich, and they were willing to pay for us to put—to have to do something which is called, and I do apologize for this, it is called “a mega rear,” and this “mega rear” is on the back of a bus actually in Trafalgar Square. And we devised this as part of the physics set. The idea is to point up the role of physics in medical imaging. So, these two naked characters—the acceptable bit are skin and the less acceptable bits are X-rays. That went fine in London, “Phull Phrontal,” it’s called, and thanks to physics, of course, and “physics, physics, physics,” but we were commissioned to do it twice. To put this same thing on the back of a bus in Manchester, and they refused. We thought that this would be fabulous publicity. It would be the first ever censored public understanding of a science project. I was deeply disappointed. I had really high hopes. But in the end, they tried editing it, would you believe, making it all blue, which wasn’t too brilliant. We negotiated a sort of, some kind of—they put the number plates somewhere else, I think. Anyway, whatever they did.

So, that was the work of science on the buses. Where did it happen? Well, it happened all over the UK. It happened in Cardiff, in Bristol, in Leeds, in London, in Edinburgh, Belfast, Birmingham, and Manchester. So, we ran campaigns—and Cambridge—and we ran campaigns on different scales. The ones in Manchester and Birmingham and

graphic
science

Science on the Buses

Cardiff
Bristol
Leeds
London
Edinburgh
Belfast
Birmingham
Manchester
Cambridge



London and Bristol, Edinburgh, and Belfast were funded by the government through the Office of Science and Technology. That was the campaign in terms of organizing and paying for the space on the buses. We already had the posters, and, of course, we didn't own the copyright to the posters, but the people who did were absolutely thrilled to have the government put them up for them, so to speak, one more time. So, that was how we did it in the UK. We got about 130,000 pounds from the government. But to mount that kind of campaign, if you count all the costs—costs about 400,000 pounds, so about \$500,000.

Very little bit of evaluation, there is more evaluation on the Web site. The Web site address will come up, so you'll see this whole evaluation document, yes, but there's no time for it here. This is the actual age distribution the bus users in the—in our sample, what we did was we did 750 face-to-face interviews on buses around the country. So, we clambered onboard buses where there were posters and we talked about them to people in two ways. We talked to them about whether they liked the poster, what they liked about it or they didn't like about it. And also, we talked to them a bit—and this is interesting, because it comes back to this business about drawing people into discussion—we also did then talk to them about their attitudes toward science and explored that a bit

with them. So, we gathered data on that, too, but only after we, in a sense, got them talking about these posters.

So, this business about “build-up to dialogue,” rather than cold-turkey dialogue, is, I think, an important one. I mean, the devising of dialoguing events, I'd like to think that that's something which will become much more sophisticated. The preparation of people for dialogue, rather than the thrusting of them into supposed arenas where they're meant to immediately express extremely cogent and interesting opinions.

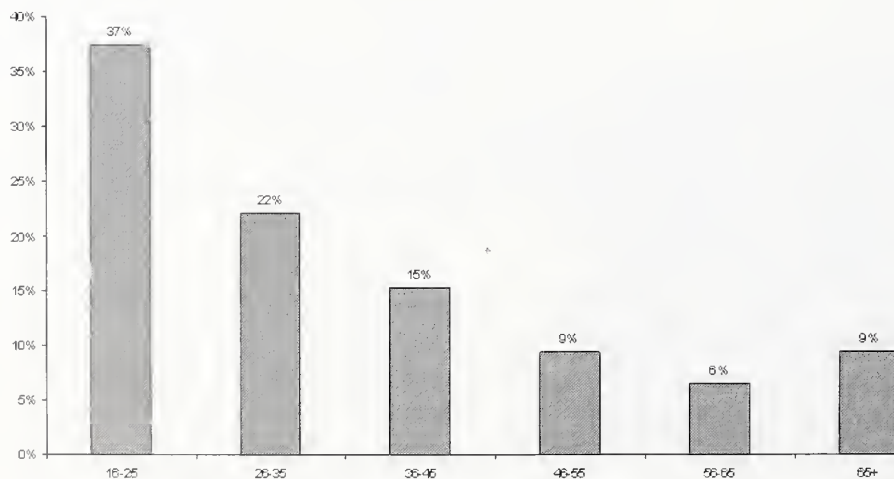
So, here's a little bit of a complicated slide, but it's an interesting one. To remind you, the target audience for the poster was the 16 to 25 age group, so along the bottom here we've got all the age groups we looked at. The code is, message in red means that the response to the question, “What's this poster about?” was, “It's something about science being central to everyday life,” or words to that effect. The green is content, in other words, that's a response saying, “It's about physics.” They must have seen it, “physics, physics, physics.” Anyway. “It's about physics” would be green.

Blue was about theme, so that would simply be, “Oh, it's a science poster,” or, “It's something about science.”

I think you'll probably notice that for the target age group, you've got these kind of percentages. You have the message, those who have the context, and these who have the theme, and quite a lot of people have their own views. Look at the oldest age group. Yeah. Now, this is not because I have some kind of thesis that old people are stupid or anything. The reason that that happens, we think, is because they don't pay a lot of attention to these posters because they're not formatted in ways which would hold or draw or excite their attention. So essentially, this is

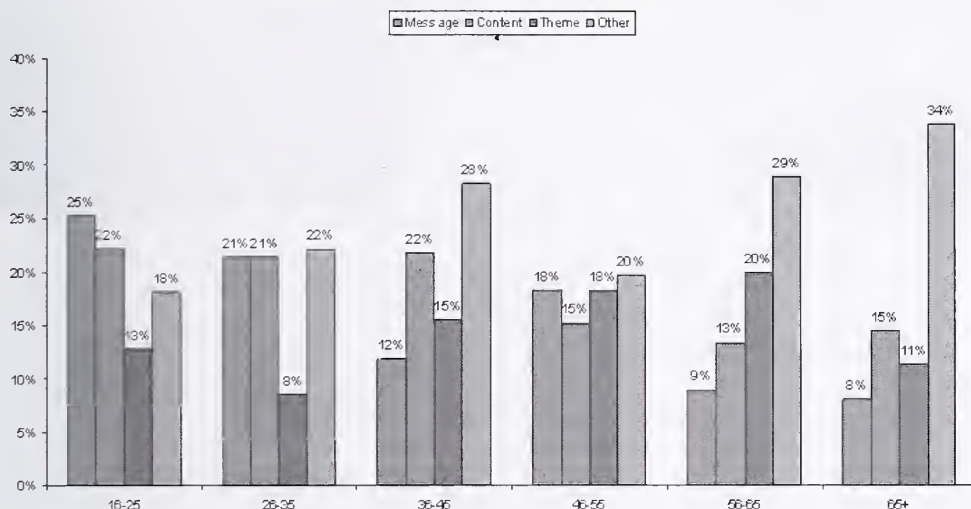
graphic
science

Evaluation Age of Bus Users



Evaluation

What is the message of this poster?



more to do with attentiveness, it's a word that's been flying around quite a bit, then it is about some innate ability to read the meaning of our posters.

So, that's the bus story, and I now get on to the advertising section—well, not quite. Science in the buses actually is now in China. In fact, it's trumpling around in Chun Ching, which I, would own up to having never heard of until we went to China to talk about this project to the Chinese, originally to the Science and Technology Commission of the Beijing government, and then we were referred on to Chun Ching, a massive city on the banks of the Yangtze, estimated 30 million population, four times the size of London. They have a pollution problem, and their interest is in, as they were saying to us, "We want to take science to the mass of the masses." Now, I'm not quite sure how you decode that, but I would guess that in China they feel they don't want to go the way of the X-Tiger economies in the Far East. They want to have a skills-based economy, and therefore they need to have many more people retraining in science and technology or beginning to think about working in those kind of areas, at whatever level. And so they're trying to reach people with this kind of message.

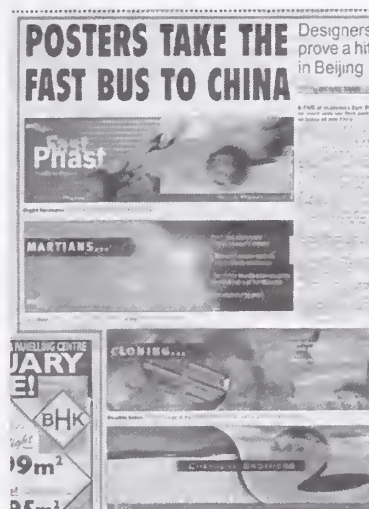
I put this up partly because we were in China, but partly because it illustrates another advantage of work-

ing through graphics, which is people go on reprinting your stuff! The papers like to have pretty pictures, so if you generate pretty pictures, they'll reprint them. This is the local paper in Bristol, and this is the third time it's reprinted our posters, because they say, "We're writing this piece. What can you give us to illustrate it?" We say, "Oh, we've got some posters." They say, "Fine, send us down a PDF and we're off."

If you've got those kinds of things there they also are infectious. They disseminate themselves to a significant extent.

The next step for what is now "Sci-Bus" is a bit of an outrageous ambition, but we're in the middle of trying to do it. We have funding from the European Union to take a campaign, mount a campaign, simultaneously, in all 15 capitals of the European Union during European Science and Technology Week, which is November—it's burned to my brain—4th to 10th, 2002, so we're coming up quite close really. And the main coordinating began yesterday. I think, I raise it partly to show that's what we're doing next, but also—and the scope, but also to give

Science on the Buses





you an idea of what we're doing right now.

So what are we doing right now? Well, now is the audience research phase. We're carrying out focus groups in five of these capitals, and we are looking to see, "Who are these people? What are they like?" And this is partly in terms of graphics, we're taking, actually, color panels to them, and also with different sorts of motifs. For example, we have a mechanical motif, or with a human figure motif, or with a highly

graphic science Audience Research and Campaign Planning

- Who are they?
- What do they like?
- What do they dislike?
- What are their needs?
- Are buses the best way to reach them?



abstract motif. We're looking to discover what would capture their attention in this rather difficult environment of the bus.

What do they dislike? One thing about our evaluation is, what people like in buses is color. They like the color pulse. What they don't want is loads of text. So, you may find there are some very text-heavy people in Europe—the French tend to be quite text-heavy, so who knows, maybe they'll want lots of text, but certainly in the UK, the amount of text has to be

- Test designs at every stage
- Pilot materials
- Evaluate
- Redesign



very small; somewhere between 9 and 12 words is the maximum, 9 or 12 words.

What are their needs? What are their interests? What will attract their attention—what do they want to know about, and are buses the best way to reach them? Those were our questions in terms of campaign planning. We don't have to go on buses. We could go, for example, on roadside advertising if we want, or we could look at some trams. We don't have to stick with buses, but is that the place to get to them?

The design and production of posters—we test the designs, so we're going to go into this process, come back to the focus group where we'll test the designs. Then we'll go back to the focus groups and show them what we've done, and we'll say, "How's that grab you?" basically, and get their comments, what they see as being powerful, what they see as being irrelevant, what they see as whatever. And we will then work with that.

We pilot materials. We evaluate, and we often redesign. The posters which I showed you are actually the third versions of the posters that we've created.

On to something more immediate, even than November, which is the Cheltenham Festival of Science. The UK does this festival thing. It's probably known, Cheltenham is a festival city. It has a festival of music, which goes back to just after the war, a festival of literature, and a festival of jazz. They asked us to come up with a festival of science, and myself and one other person, Kathy Sykes, have now devised a five-day science festival for Cheltenham, which will happen in May this year. The program has just been published, and there are copies of the program out-

side on the table I set up with my stuff, which is sort of at the entrance to the poster sessions.

It has a number of ingredients. It's got to have appearances by top popularizers of science in the UK. That brings audiences in. So, Lord Winston who did the *Human Body*, he'll be here, Richard Dawkins, Adam Hart Davis, who does this local heroes program, which is very, very popular in the UK, Simon Singh, who has written the *Code Book*, but is also a code specialist. And, of course, this is Cheltenham, and you're not supposed to know but it's where all the secret listening goes on. Because GCHQ, the big pair of ears for NATO, is in Cheltenham—Collin Blakemoore, one of my childhood heroes because he wrote *Mechanics of the Mind*, which is one of the great books about the brain, and Steve Jones.

So, we've got the names there, but I thought it's been interesting in the context of what we've been discussing, just to show you a bit more, because in the program, and we've found this really easy to get funding for I have to say, we have debates and discussions, both on a large scale and on a small scale. We've got discussions about human cloning, genetic modification of plants, and because we're in a country area, about the future of the countryside. Of course, in the UK, the future of the countryside is an enormous issue, post-PSE, post-Foot in Mouth, post everything that's happened. The future of the countryside is a huge, huge issue.

Now remember that in the UK, we live amongst our plants, our crops. There isn't an area where there's crops and then there's us. We live with them in our back garden. So, there's the whole business about the future of the countryside, and, as I say, these are partly quite largely set pieces which are going to be hosted by Milton Bragg, who's very well-known in the UK as a media figure, but also in much less formal settings. There's a Café Scientifique within the festival, for example.

The theme is "pleasure," and there are going to be events about music, about chocolate, yes, and about sex. So, essentially, there'll be all aspects on how science bears on pleasure. The science behind music—we have a number of celebrity chefs. In fact, that picture at the bottom of the last slide—if I can get to it, sorry—was Heston Blumenthal, who's Chef of the

In association with **Pfizer**
Cheltenham Festival of **Science**
22 - 26 May 2002

- five days of science in one of the UK's premier Festival cities
- appearances by top popularisers of science like: Lord Winston, Richard Dawkins, Adam Hart Davis, Simon Singh, Colin Blakemoore and Steve Jones.



In association with **Pfizer**
Cheltenham Festival of **Science**
22 - 26 May 2002

- a programme of **debates and discussions** about human cloning, genetic modification and the future of the country-side
- a theme, **pleasure**, and events about music, chocolate and sex
- a robot arena and a free **hands-on science** space for families
- **live shows** for kids



Year in Britain, and he uses a lot of science in his cooking.

And there will be a robot arena and a free hands-on space for families. So, that's what we're up to. That's a spectrum of what we do. I hope what I've done is given you a bunch of flowers to hold. I'm not sure at all, I haven't had the time to give you a complete picture of where in the garden they came from, though I hope you've got an idea of what we're up to and why we're up to it. And I would love to hear from you.

Thank you very much.

Keynote Address: Sex, Lies, and Science Television

Paula Apsell, Executive Producer, NOVA, WGBH Public Television

Aspell: Thank you very much. As the saying goes, “No one has ever lost money underestimating the taste of the American public.” That works in spades for the television industry, where networks, cable channels, and local broadcasters are racing down market at velocities literally approaching the speed of light. And science isn’t exempt from this ratings race. It’s even generated its own genre—weather porn. Not to mention, monsters of the deep, alien abductions, angels, ghosts, all of which pass for science in the feeding frenzy that characterizes the television industry today.

Beginning next January, *Nova* will enter its 30th season, and 30 years is an eternity in television. My daughter would be pleased to know that *General Hospital* still has a safe lead. It went on 40 years ago. But *Nova* has outlasted *Seinfeld*, *I Love Lucy*, *M.A.S.H.*, *Hill Street Blues*, and *CBS Reports*. Not that we haven’t had our crises. In fact, with the intense competition for eyeballs in the television industry, it feels as if every moment is a crisis. It makes me nostalgic for the old days in the early ’70s, when Michael Ambrosino started *Nova* amidst almost universal skepticism that any red-blooded American would watch a science show on television. Science was for school. But Michael brought a new approach. He believed that science is a story, and if told with visual flare and strong characters, people would watch. And watch they did. *Nova* was a success right out of the box.

But nothing stays simple. With the advent of cable, the broadcast environment has totally changed since the beginning of *Nova*. Instead of four networks, there are 40 and more. With the spectrum as crowded as it is, like everyone else, we’re challenged to get our message out. Now, speaking to a group of science writers, it seems appropriate to quantify the ups and downs of *Nova*.

From the beginning, in 1974, the sky was the limit, until the late 80s, when cable really started to

cut into our audiences. In 1987, we began to fight back, reinventing ourselves, producing programs with higher production values, better storytelling, and more innovative formats. To better understand our audience, we did a little study to assess how different subject areas rated with our viewers. We learned, not surprisingly, that topic counts a lot. Viewers clearly preferred certain categories that we referred to by code names, such as “boys and their toys,” that’s jet fighters, lost airplanes, and random military hardware. “Old bones,” dinosaurs and human origins, and a category we referred to as “TRSH,” for “transparent ratings seeking hype,” shipwrecks, pirate gold, the Bermuda triangle, etc. By changing our program mix even slightly, we were able to improve our ratings and put *Nova* back into the game.

But, a decade later, with our competitors going after the same topics and the same eyeballs, our fix stopped working. Ironically, the niche that opened up is one that we should be occupying anyway: science: the real thing: genomics, cosmology, and string theory. The name of the game now is tinker with style, but not with substance. Maintain the mission, which remains as valid and necessary today as it was at the beginning. As all of you know, the level of science literacy in the United States remains distressingly low, and no less an expert than Jay Leno decided to investigate.

[video clip]

Leno: “You know, a recent survey by the National Science Foundation found that the average American, when tested on their knowledge of basic science, answered correctly only 55 percent of the time. We here at the *Tonight Show* felt that was way too high. We talk to people every day. Not half, America, it’s a lot less than that. So we took our cameras. We went down to city walk at University—just picked people out of the crowd, asked them simple, basic questions.

What controls the tides, folks? That seems easy, doesn't it? What is a homo sapien? It's a person. All right, that seems to be an easy question, doesn't it?"

"Rachel, where you from?"

"Jerico, Long Island."

"Oh, did you go to Jerico High School?"

"Oh, yeah."

"Is that a good school?"

"It's amazing. I was valedictorian."

"You were valedictorian!"

"Yes."

"How many moons does the earth have?"

"I guess, eight?"

"Eight moons?"

"Yeah."

"Where do the moon and stars go in the daytime?
No looking up for the answer."

"How long does it take the Earth to go around the sun?"

"Twenty-four hours."

"The earth goes around the sun in 24 hours."

"Yeah. I went to the planetarium. I know that's what it is."

"How long does it take the Earth to go around the sun?"

"Twenty-four hours, 360 degrees."

"360 degrees? It goes 24 hours at 360 degrees?"

"How many cells does a single-cell creature have?"

"Like 36."

"36 cells in each single-cell creature?"

"Something like that."

"How many cells does a single-cell creature have?
Think about it."

"One. I'm kidding. I don't know."

"What causes the tides?"

"Wind?"

"What causes the tides?"

"The boats."

"What causes the tides?"

"Uh, fish?"

"What causes low-tide?"

"Uh, not enough water."

"Not enough water in the sea. Where does the water go?"

"Uh, that's when people drink it out of their faucet."

"Oh, they drink it out of the faucet, and that's why we have low-tide."

[end video clip]

Jay's survey may draw laughs, but the reality of the situation is hardly funny. The Earth goes around the sun once a year. It's hard to think of a more basic scientific fact, yet one out of every two Americans doesn't know it. In Canada, half of all incoming college freshman believe in astrology and can't say how it differs from astronomy. An NSF survey tells us that most Americans learn about science from television. Now, I don't know if that's the problem or the solution, but it does make our unique public television mission all the more important. For in commercial television, the bottom line is almost always the bottom line. If boosting ratings means stooping to sensationalism and pseudo-science, so be it. The main question for *Nova* is how to retain our dedication to cutting-edge scientific ideas. The ones that change the way we see ourselves and the world around us, and at the same time, be entertaining.

People watch television voluntarily. We'd like to tie them to their chairs Tuesday at 8:00, but we can't. We have to entice them with good stories that they can understand without an advanced degree. Striking the right balance between education and entertainment is the essence of what we do. Occasionally, what we do is so entertaining that Hollywood can't resist copying us. In 1999, the special effects blockbuster, *Twister*, told the story of a young scientist struggling to uncover the mystery of tornadoes. Michael Crichton, the screen writer, was sued by another writer who

claimed that the *Twister* script was based on his idea. Crichton countered that the idea actually came from *Nova's* episode, *Tornado*. Take a look at a section of the Hollywood film and the *Nova*, and see if you can tell which is which. I'll give you a hint: the blonde belongs to the Hollywood version:

[video clip]

"It's moving west. We're going to deploy Toto. Right here Steve. Somewhere in here. Somewhere in here."

"Deploy time is 19:02. A little farther Steve a little farther."

"We're moving to intercept guys. Get ready to set up. You've got it."

"Hurry. Let's go. Come on."

"Okay, that's good."

"Let's go. Let's go. Contact!"

[end video clip]

I mentioned a few minutes ago that one of the few shows to have survived longer than *Nova* is *General Hospital*. That's no coincidence. Science has more in common with soap opera than meets the eye. Although we don't always succeed, we're after dramatic storytelling, not exposition. Fortunately, science lends itself to that approach because science is a process. Our programs are less about the moment of discovery than the blood, sweat, and tears that so often precede it. We try to humanize science by revealing the passion and the people behind it. Most great films have a simple three-part story structure: conflict, climax, and resolution. The question is whether this structure can be applied to science documentaries without dumbing them down, I think the answer is 'yes.'

A recent program that we did, called *Runaway Universe*, is a classic example of how to take a really complicated subject and make it dramatic. Let's take

a look at the very beginning, what we call the "prologue:"

[video clip]

"High above the deserts of southern Arizona, a team of scientists is about to unveil a new secret weapon. But first, they have to get it up the mountain. Engineer J.T. Williams is in charge of protecting the 25-ton cargo. 'Around this next turn, we'll be clearing the guardrail by inches. The whole trick is not to stop.'

With every hairpin turn, disaster looms. Finally, the summit of Mt. Hopkins. And the \$10 million package can be unwrapped. 'Yes. Lift! Everybody get hands on the mirror. Don't let that sucker move, okay. Going up.'

Dozens of suction cups grasp the object. A colossal mirror, 23 feet across. A crane lifts it 100 feet into the air and lowers it into its new home. An enormous telescope. It is destined to play a key role in a dramatic new quest: to hunt down evidence of a mysterious force lurking in outer space. Already, the discovery of this force is shaking the very foundations of scientific thinking. 'These results have enormous implications, and if they're correct, it really will revolutionize our understanding of what the universe is like, and how it came to be.' This strange force was predicted by Albert Einstein, who later discarded the idea. Now, his bizarre theory is suddenly back in fashion, as scientists rethink their vision of our universe and its ultimate fate. 'In the distant future, there'll be nothing in the universe left to see, it'll just be us. And that seems to me to be the coldest, most horrible end. This universe is weird. It's creepy.'

The world of astronomy is in an uproar about the possibility of a 'runaway universe.'"

[end video clip]

By the way, it's always great to include Einstein in any program. He has the highest TV cue of any scientist. But the first principle, as the historian David McCullough always puts it, is "Get your hero in trouble, and keep him there."

In *Runaway Universe*, the heroes are a group of astronomers led by Brian Schmidt and Alex Filippenko, who are on the horns of a dilemma. With telescopes in Chile and Hawaii, they're trying to find some elusive exploding stars called type 1-A supernovae. Like mileage markers in the universe, these stars will help them measure how fast the universe is expanding. But these guys have all kinds of troubles. They're tired and scruffy. The weather is bad. The stars they find don't quite fit the bill. And they have stiff competition from another cosmologist, Saul Perlmutter, who developed many of the techniques that they're using. You'd have to have a heart of stone not to be rooting for these appealing stud muffins of science. But as they learn, be careful what you wish for, because you may get it. When Brian and his colleagues finally do get some data, they are appalled. The findings are not what they expected. They're the kind of findings that can make careers, but can end them, too. Let's see why:

[video clip]

"The team expected the supernovae to confirm that the expansion of the universe was slowing down, but when the results finally came in, something seemed terribly wrong. 'Well the other thing that worries me is that these are very narrow features, right here.' Adam Riess and I were analyzing the results, and Adam made a graph of brightness versus the red shift of the supernova, and the dots, the data fell along a curve in the graph that did not indicate that the universe was slowing down in its expansion. It indicated that the universe was speeding up. And my jaw just dropped.'

The data showed that the distant supernovae were dimmer and, therefore, much farther away than the team expected. Instead of slowing down, the expansion of the universe has been speeding up. With galaxies moving apart at greater and greater velocities.

'I was actually scared that I had made an error, and, you know, one-by-one we started checking off sort of a long list of possible errors, and none of them seemed to be the case. Finally, we had come to grips with this unusual result. I no longer looked at it as a likely mistake, but rather as something very

bizarre that nature was trying to tell us.' The bizarre message was that the universe is accelerating. For the team's leader, Brian Schmidt, the results were especially difficult to swallow. 'It was not something that I particularly wanted to be in my data. So I was horrified, because I knew that it was going to be very difficult to sell this to my colleagues, because my colleagues are the ones who have educated me, and they're just as sickened by this thing as I am.'

The discovery seemed to contradict everything we thought we know about gravity and its impact on galaxies and stars." 'If our discovery is correct, it suggests that the universe is beginning to accelerate in its expansion, to go faster and faster. Now this is really reminiscent of what we think the universe went through in its first tiny fraction of a second of existence. You know, the universe was created somehow, and then it went "whoosh," really fast, something pushed it out. And then that something stopped, and the universe kept on coasting. So, we think now it's beginning to go "whoosh" again, maybe not quite so quickly, but a "whoosh," nonetheless.'

What could possibly be causing the "whoosh?"

Something must be countering gravity, pushing all the galaxies apart. Some mysterious repulsive force, unlike anything we've encountered on Earth. The thought of such a form of energy is strange, but it's not new. It sounds like Einstein's old idea, the cosmological constant, which he had so famously called his greatest blunder. Now, it seems, Einstein may have been right, after all.

'If Einstein heard these results today, he would say, "Yahoo!" It would be such a thrill for him, I think, to see that his original prediction that such weird stuff might exist in the universe turned out to actually be true.'

[end video clip]

A camera was there as the scientists grappled with their dilemma. Before our eyes, science becomes human drama. Science becomes a story. And story and character are absolutely essential for a good *Nova*. But, there's another ingredient: good visuals.

We shot *Runaway Universe* on high-definition

video, which has six times the information of a normal video frame. We got an NSF grant to help us find this program, and this enabled the National Center for Supercomputing Applications to develop some fantastic animation, both for our show, and for the Hayden Planetarium.

The most extraordinary piece they did with us was a four-minute voyage from inside our galaxy to the heart of the Virgo Supercluster, an immense conglomeration of galaxies centered 50 million light years away. Unlike nearly all prior broadcasts, this animation was not simply based on artistic license, but it was a 3-D model developed from actual astronomical data, both optical and infrared. Objects like nebulae and galaxies were based on 2-D astrophotographs, which were then interpolated in 3-D so that we could fly through them. The simulation required about 10,000 hours of computer time. Let's take a look:

[video clip]

"Strange as it sounds, this is not the first time that scientists have found evidence that behind the visible features of the universe lurk unseen and profoundly mysterious forces. Since the days of Hubble and Einstein, astronomers have explored the contours of the universe, mapping landscapes shaped by the force of gravity. Gravity binds our sun to 100 billion other stars, interspersed with pockets of dust and gas, in a vast rotating spiral we call the Milky Way Galaxy. But things are not always what they seem. The galaxy is spinning so fast that centrifugal force should have flung the stars into space. All the matter we can see does not exert enough gravitational pull to hold the galaxy together. There has to be something else there, but it's completely invisible.

Beyond our galaxy, the mystery only deepens. Gravity ties our galaxy to a group of 30 others within a distance of 3 million light years—our cosmic neighborhood. This local group is bound to a still larger region. It is 50 million light years away. The 10,000 galaxies that make up the Virgo Supercluster. These galaxies move so fast, that some unseen presence must be holding them in. Scientists call it "dark matter," a strange form of matter that exerts gravity, but does not emit or reflect light. Little else is known about dark matter, except there's a lot of it. In the regions of

space we can see, there seems to be 10 times more dark matter than ordinary matter, and now there's another mysterious ingredient in the universe: 'dark energy.'"

[end video clip]

Now, even animation like this won't work if it's just eye candy. It has to play a genuine role in the unfolding of the story. And in this case, it did, giving a scientific context for the Schmidt-Pearlmuter findings, and introducing the audience to the idea that some mysterious force, call it "dark energy, vacuum energy, or quintessence," whatever you want to call it, is causing the entire universe to not just expand, but to accelerate. It's a truly profound discovery. Our heroes are finally out of trouble, as their colleagues embrace their work and struggle to fit their findings into a picture of the universe that is becoming stranger with every passing day.

Science producers have benefited enormously from visualization techniques developed by scientists who need to see things to understand them just as we do. Photographic advances that were unthinkable when *Nova* first went on the air now allow us to obtain extraordinary microscopic visuals. None more compelling than those photographed by the well-known Swedish cinematographer, Lennart Nilsson. Almost 20 years ago, we worked with Lennart on *Miracle of Life*, a film about human reproduction that became the most-watched *Nova* ever. A generation of Americans learned about the birds and the bees from it. But a few years ago, we decided to work with Lennart again to make a new program, *Life's Greatest Miracle*, using improved photographic techniques, and describing new science about the role of genes in human development:

[video clip]

"People do all sorts of things to get attention. And why? It may be the last thing on his mind, but this man's body is working toward this. Whether we're thinking about it or not, our bodies want to make babies. And our bodies are very good at it. Around the world, about 365,000 new babies get made every day. But as ordinary as it seems, creating a new

human being is no simple feat. Just think of it. No matter who you are, once upon a time, you looked like this. From a single cell, you built a body that has 100 trillion cells. You made hundreds of different kinds of tissues and dozens of organs, including a brain that allows you to do remarkable things. How did you do it? Today, we can look closer than ever before into the womb, into a cell, into the essence of life itself. Not only can we see what's happening, but now, we're beginning to see how it happens. The forces that build the embryo. The molecules that drive this remarkable change. We're uncovering the most intimate details of how life is created. The secrets behind life's greatest miracle."

[end video clip]

Of the many advances that have taken place in television production since I've been with *Nova*, none is more astounding than the role of CGI, or Computer Generated Imagery. Techniques like those used in feature films, such as *Jurassic Park*, are coming down in price to the point where they're affordable for high-end television production. Discovery Communications and the BBC have taken advantage of that to produce shows like *Walking With Dinosaurs* and *Walking With Beasts* that create for the viewer entirely believable prehistoric worlds. I've heard that *Walking With Cavemen* is in the offing. These innovative shows entertain viewers with graphics that are light years away from the old *Encyclopedia Britannica* approach.

The problem with such intensely real computer imagery is how easy it is to believe that the world it creates is real, instead of hypothetical. If we don't go back to ask, how do we know? The essence of the scientific process is lost. Now, we don't have this problem, because for the most part, we can't afford these techniques, and don't think that doesn't make us mad. But with support from the NFS, Sloan, and the Department of Energy, we'll be using CGI in an upcoming mini-series to explain one of the most abstract and strangest of all the ideas in science. In a three-part series, physicist Brian Greene, author of the best-selling book *The Elegant Universe*, will show how the quest to unite general relativity—there's Einstein

again—and quantum mechanics has given rise to string theory, which some physicists consider the last best hope of finding a unified theory of everything.

What I'm going to show you now is a work in progress; two scenes from the first of the three-hour mini-series to be broadcast next January. You'll see material we filmed in the studio with a green screen, and then you'll see how our animators replace the green screen with a CGI background and what's called a "composite image." When it's finished, the first scene will be used to explain how electromagnetism is the unification of magnetism and electricity. And the second scene demonstrates how this force is actually much more powerful than gravity. Intercut is a behind-the-scenes glimpse of life in the studio and some of the hardships that we forced Brian to endure for the sake of public understanding of science. You'll also see why we ask ourselves, "Why go on location anymore?"

[video clip]

"If you've ever been on top of a mountain just before it thunderstorms, you'll get the idea of how electromagnetism is, itself, a unified theory. When a stream of electrically charged particles flows, like in a bolt of lightning, it creates a magnetic field, and you can see evidence of this on a compass. 'We tend to think that gravity is powerful force. After all, it's the force that, right now, is anchoring me to this ledge. But, compared to electromagnetism, it's actually terribly feeble. In fact, there's a simple little test to show this. Imagine that I was to leap from this rather tall building. Actually, let's not just imagine it. Let's do it. You'll see what I mean. Now, of course I really should have been flattened, but the important question is, what kept me from crashing through the sidewalk and hurdling right down to the center of the Earth? 'How do you feel? All right?' 'Yeah.'"

[end video clip]

Now, lest you think we can't do without these fancy, new fangled graphics, I'd like to show you how sometimes, the most rudimentary approach does the trick, as in "keep it simple, stupid." Last year, we decided to make a two-hour program on the human

genome project, which turned out to be an enormous challenge. We brought in a correspondent, ABC's Robert Krulwich, who is, in my opinion, one of commercial television's outstanding talents and one who is genuinely interested in science. But we were more than a little nervous when Robert walked in to interview Eric Lander, with just about the cheesiest prop I've ever seen in my life, but it worked. Let's take a look:

[video clip]

"If it's DNA, if you turn it so that you can look at it from just the right angle, you will see in the middle what look like steps in a ladder. Each step is made up of two chemicals, cytosine and guanine, or thymine and adenine. They come, always, in pairs called "base pairs," either C and G, or T and A, for short. This is, step by step, a code three billion steps long; the formula for a human being. 'We're all familiar with this thing. This shape is very familiar—double helix. First of all, I'm wondering, this is my version of a DNA molecule. Is this what DNA looks like?' 'Well, a cartoon version.' 'So there, in almost every cell in your body, if you look deep enough, you will find this chain, here.' 'Oh, yes. Stuck in the nucleus of your cell.'

'Now, how small is this? In a real DNA molecule, the distance between the two walls is how wide?'

'Oh, golly. Look at this. He's asking for help.'

'This distance is about from—this distance is about 10 angstroms, which is...'

That's one billionth of a meter when it's clumped up in a very particular way.

'Well, it's curled up something like that, but you see, it's more than that. You can't curl it up too much, because these little negatively charged things will repel each other, so you fold it—I'm going to break your molecule. Well, you got this, and then it's folded up like this, and then those are folded up on top of each other, and so, in fact, if you were to stretch out all of the DNA, it would run, oh, I don't know, thousands and thousands of feet.'

'OK.'

'But the main thing about this is the steps of this ladder.'

'If I knew it was A and T and C and C and G and G and A ...'

'Oh no, it's not G and G, it's G and C.'

'If I could read each of the individual ladders, I might find the picture of, what?'

'Well, of your children.'

'This is what you pass to your children.'

'You know, people have known for 2,000 years that your kids look a lot like you. Well, it's because you must pass them something, some instructions that gives them the eyes they have and the hair color they have and the nose shape they do. The only way you pass it to them is in these sentences. That's it.'

[end video clip]

So, what does the future hold? I'm tremendously excited about the prospects for science programming, especially on PBS. Paradoxically, all the competition has opened up a niche for *Nova* to be what it really is: a unique vehicle to tell real stories about real science. While our competitors are tripping over each other for the best tsunami, the biggest shark, the most horrifying unsolved mystery, we're in a league of our own with string theory. Striking just the right balance between education and entertainment will always be a challenge, but I hope that *Nova* will continue to find drama in the stories that reveal the quirky brilliance and grating persistence that so often pave the way for scientific progress.

I'd love to take some questions from you in just a moment, but first, I'd like to show you a clip from this season of *Nova*:

[video clip—music and video only, no narration]

I'd be happy to take any questions. Thank you.

Poster Session Abstracts

Becoming Enthusiastic About Math and Science



U.S. Department of Energy's
Thomas Jefferson National Accelerator
Facility (Jefferson Lab)

Contact

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Budget

About \$250,000 for 1,400 students

Web Sites

Program: <http://education.jlab.org>
Poster: www.nist.gov/public_affairs/Posters/beams.htm

In partnership with the local school divisions and the surrounding community, Jefferson Lab is dedicated to providing educational opportunities in math and science to students, teachers, parents, and the general public. During FY 2001, about 10,500 students and 750 teachers will interact with Jefferson Lab scientists and engineers who share their knowledge, experience, and enthusiasm.

The BEAMS—Becoming Enthusiastic About Math and Science—program brings classes of sixth, seventh, and eighth grade at-risk students with their teachers to Jefferson Lab for science and math interactive activities. The goals of BEAMS are to:

- redress the problem that minorities and females are lost from the science, mathematics, engineering, and technology career pipeline long before they reach college,
- strengthen the motivation and academic preparation of students, and
- provide teachers with activities based on the science and technology at Jefferson Lab.

Since 1991, BEAMS has involved about 15,000 students and 375 teachers. Students participate in the BEAMS program for three consecutive years. In the sixth grade, students come to Jefferson Lab with their teachers for a specially modified version of their regular academic week. For five consecutive days during school hours, the children and their teacher are immersed in Jefferson Lab's forefront research environment, where they participate in science and math events and activities conducted with scientists, engineers, and technicians. BEAMS takes place in an on-site classroom, in laboratories, assembly areas, and at the accelerator site. A family night is held for the participating students' families to increase the parents' understanding of science, math, and technology;

stimulate greater involvement in their child's education; and reinforce the BEAMS experience. The ongoing interactions in the seventh and eighth grades extend the initial positive influence BEAMS has shown at the sixth-grade level.

The schools which participate in the BEAMS Program are chosen by representatives of Newport News City Public Schools and Jefferson Lab. Selection guidelines include students who:

- would not normally have an opportunity for exposure to science, scientists, engineers, or a high-tech workplace;
- are traditionally under-represented in math and science, including ethnic minorities, females, and the economically disadvantaged;
- are traditionally not electing to take challenging math and science courses.

Results from the ongoing evaluation of BEAMS include: (1) students attending BEAMS are significantly more positive about science and school than students not attending; (2) teachers report that BEAMS increases their awareness of hands-on science, applications of math and science, and careers in math and science; and (3) parents report that the BEAMS program is a unique positive influence on their children. Preliminary results from Virginia standardized test scores show that BEAMS is helping to close the disparity gap between traditionally low scoring schools and average scoring schools. Huntington Middle School, where students attend BEAMS in grades 6, 7, and 8, showed improvements in test scores from 1998 to 2001 of 29 percentage points in mathematics and 26 percentage points in science. Huntington Middle School's parent school division showed increases of 17 points in mathematics and 13 points in science.

Theater of Debate Program



Sponsors

Wellcome Trust
The Office of Science and Technology
The Council on Bioethics
Copus
John Innes Centre
The Teacher Scientist Network

Contact

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Y Touring Theatre Company
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Budget

To research, develop and produce an original play, debate, and support materials for a 10-week tour of the United Kingdom averaging eight performances a week, visiting 10 different regions and reaching over 150,000 young people, teachers, and adults is £100,000.

Staffing: Project director, playwright, education director tour administrator, four actors, a company manager

Web Sites

Program: www.ytouring.org.uk
Poster: www.nist.gov/public_affairs/Posters/ytouring.htm

"Ways of engaging the public in debate on scientific issues, like the applications of genetic technology, are desperately needed.... a highly imaginative theatrical venture by Y Touring Theatre Company have found a brilliant solution."

Prof Lewis Wolpert, *The Independent*

"Y Touring has shown that theatre can be a powerful tool for the communication of science to a wide audience."

Prof Colin Blakemore

Professor of physiology, University of Oxford

■ Between 1995 and 2001 Y Touring, Central YMCA's Touring theatre company, commissioned, developed, and produced five plays exploring issues arising from advances in biotechnology:

The Gift looks at genetic selection; *Pig in the Middle* considers Xeno-transplantation; *Cracked* explores the biological basis of mental illness; *Sweet As You Are* explores genetically modified foods, and *Learning to Love the Grey* deals with cloning and stem cell therapy.

■ Each play is followed by a live debate involving the audience and the cast who stay in character to field questions.

■ Each play is written in consultation with scientists, doctors, and patients and is supported by a resource pack available on CD and on the Web.

■ The programs are performed in schools, theatres, prisons, science centres, and at arts festivals such as the Edinburgh Festival. Individual programs have been performed at the House of Commons for MP's, at Whitehall for Government Ministers, in Amsterdam for Dutch government ministers, and other events.

Target Audiences

We primarily target young people aged 14+ in schools, youth clubs, and Science Centres. By May 2001, over 106,021 young people, teachers, gover-

nors, parents, scientists, and the general public throughout the United Kingdom will have seen one or more of the five programs.

Developments (a wider audience)

■ *The Gift* has been made into a video by Y Touring and Zenith Productions shown on BBC 2.

■ *Sweet As You Are* as a theatre performance has been filmed by the BBC.

■ *Pig in the Middle* was translated into Dutch and toured throughout Holland funded by the Rattneau Institute.

■ *Learning to Love the Grey* has been adapted into a three-part television drama commissioned by the Open University's Open Science program.

Process

Each play takes about 10-11 months to research, write, produce, and tour. The theatre company and partners establish the program's theme, aims, and target audience. A steering committee is established for each play.

Evaluation

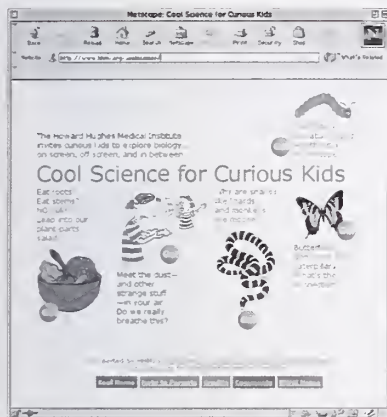
There have been several evaluations of these programs. Conclusions include:

■ Arts projects such as these are seen to be very successful in delivering scientific education. The drama is a way into a lot of areas, enhances the subject especially for those students who are alienated or threatened by science.

■ It successfully contributes to science teaching—its strength is in personalising science rather than delivering biological information.

■ Changes in the teaching of genetics has occurred at many of the participating schools—the program has brought in the human element and the personal, making it far more powerful.

Cool Science for Curious Kids



Sponsor

The Howard Hughes Medical Institute

Entry submitted by

Burness Communications

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Budget

Web Site Design & Development:
estimated budget \$25,400
Promotion & Marketing:
estimated budget \$11,000

Web Sites

Program: www.hhmi.org/coolscience
Poster: www.nist.gov/public_affairs/Posters/coolscience.htm

Science is not "for adults only." In September 1998, the Howard Hughes Medical Institute launched a new Web site containing hands-on science activities from five children's and science museums. This site, called "Cool Science for Curious Kids" at www.hhmi.org/coolscience,

features animation, sound, quizzes, and other techniques to encourage kids to explore science.

The activities were developed by five museums that received support from HHMI's Precollege and Science Education Program: the Chicago Academy of Sciences, the Children's Discovery Museum in San Jose, the Children's Museum in Boston, the Minnesota Children's Museum, and the Scotia-Glenville Children's Museum in New York.

Mark Hertle, senior program officer of HHMI's Precollege and Science Education Program, worked with the museums to determine the best activities for inclusion on the site. Once the activities (originally print-based for use in a museum or classroom setting) were identified and adapted to an interactive Web format, the site was created by a team of writers, artists, and Web developers, in collaboration with HHMI staff. (For the list of credits see www.hhmi.org/coolscience/credits.html.)

Burness Communications worked with HHMI to attract elementary school children, parents, and educators to the site. Prior to launch, Burness Communications identified Web sites, on- and off-line publications, associations, lists, and listserves used by our target audience.

Our multidimensional promotion plan included a media outreach effort, a postcard mailing, and Web-marketing efforts. We optimized search engine placement, posted announcements on listserves, and launched a link-solicitation campaign. The promotional effort was implemented by two members of the Burness Web team who specialize in Web marketing and members of HHMI's communications staff.

The site was chosen as a *USA Today* Hot Site, featured by *Popular Science*, *Chicago Sun-Times*, *Chattanooga Free Press*, and *St. Paul Pioneer Press*.

Education organizations such as the National Science Teachers Association and National Association of Elementary School Principals promoted the site in their newsletters.

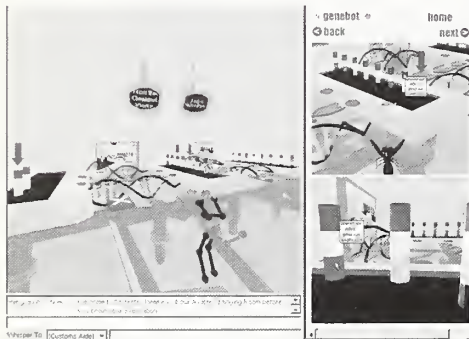
More than 27 listserves posted information regarding the "Cool Science" site, including EARTHK-12: K-12 (Earth science teachers discussion list); ECENET-L (early childhood education/young children); and WYCOOL-L (Way Cool software reviews by children, teachers, and parents). One month after promoting the site, more than 25 education sites had established links to "Cool Science for Curious Kids." These sites included ABC's of Parenting (www.abcparenting.com/index.cfm/10), Berit's Best Sites for Children (http://db.cochran.com/li_showElems:theopage:theo:4590:o.db), and The Online Educator (<http://ole.net/ole/educator>).

From October 1998 (a few weeks after the launch) to February 1999, when the site received more than 1 million hits, traffic to the site rose 76 percent.

Three major lessons were learned. First, when promoting a new Web site, reach out to the target audience through both on- and off-line mediums. Do not limit efforts to on-line promotions such as e-mail announcements, search engine optimization, and establishing links. Print media coverage and postcard promotions help maximize visibility. Second, a multidimensional marketing strategy is important to increase the probability of multiple visits by the target audience. Third, present the product in a consumer-friendly way. HHMI was extremely successful in translating this print-based work into a useful and exciting interactive site for families, educators, and kids.

At present, more than 2,000 sites link to "Cool Science," one of the most visited (and useful) sections of the HHMI Web site.

Science Center Virtual World



Sponsors

Cornell Theory Center with additional support from Intel Corp., USDA - Agricultural Research Services, the Cornell Presidential Research Fellows program, the National Science Foundation, the Spencer-Van Etten School District, the Ithaca Youth Bureau Youth Employment Services, the Ithaca SciCenter's Computer Clubhouse and Youth Alive projects, and the Learning Web of Tompkins County, along with other local and national organizations.

Contact

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Budget

About \$40,000 for 2001 was bare bones and includes staff and student salaries and tools. Small equipment donation from Intel Corp.: \$26,000.

Web Sites

Related Program Web Page:
www.scicentr.org
Poster: www.nist.gov/public_affairs/Posters/sciencecenter.htm

The Cornell Theory Center (CTC), Cornell University's high-performance computing center began in 1998 to focus our science and technology outreach efforts on the new multi-user 3D Internet technology, virtual worlds. Our belief was that this new tool, which combines online chat, gaming technology, and all the features of the World Wide Web in a secure and easily monitored environment, appeals to youth and offers us the opportunity to engage them in fun, constructivist learning activities focused on our research.

Our goal is to found and support a hands-on virtual science center that exists only in cyberspace and to build a community of users engaged in its programs. We are now working in two areas: development of 3D interactive, multi-user exhibits in the primary world, SciCentr, created by undergraduates at Cornell with help from high school student interns; and a related after-school program for teens that takes place in the sister world, SciFair. Content for all projects features research supported by CTC, including crop genomics/bioinformatics, wave science, structural biology, and materials science. World development is a team-based activity that takes place in a secure online multi-user environment that allows the teens, undergrads, researchers, and experts to work together from distant locations.

The first SciFair team, 12 teens at rural Spencer-Van Etten High School in Chemung County, New York, has been meeting with two undergraduate mentors coming online from Cornell. They come "inworld" to learn about bioengineering of crops, and to be introduced to a new online digital medium. They call their project the Tomato Islands. It is a series of virtual greenhouses that comprise a

knowledge space where they display what they have learned about the crop's biodiversity, cultural requirements, history, biogeography, and modern production. SciFair teams at participating locations need to provide standard computers with reliable network connections and adult supervision at the remote site.

CTC has several approaches to the ongoing evaluation of the SciCentr virtual worlds project. These include demonstrations and recently have become more focused on evaluating the prototype exhibits. As of June 2001, several hundred youth (at least one-half girls) have visited our worlds for tours hosted at CTC's Collaboratory in conjunction with such programs as National Science and Technology Week, 4H Career Explorations, Expand Your Horizons, and Cornell's Bring a Child to Work Day. Nearly 50 teens have been involved in creating content for both SciCentr and SciFair, more than 25 currently active.

The response to exit questionnaires is consistently and overwhelmingly positive, even when girls are examined separately. Users tend to become "immersed" after 20 minutes in the environments. Recent post-test results from the 4H workshop suggest positive learning outcomes. We are working with the department of communications at Cornell to implement semantic network analysis of the chat logs of the SciFair program. Early analyses of sessions for fall 2000 independently confirm that the chat among the students and between students and mentors focused on the activity of building and filling out the content of the knowledge space in a positive and supportive way.

MicroWorlds

MICROWORLDS

Exploring the Structure of Materials
Science education for grades 9-12
from Lawrence Berkeley National Laboratory (LBNL)

Welcome! MicroWorlds is an interactive tour of current research at Berkeley Lab's Advanced Light Source. Along the way, you'll find out:



- What the Advanced Light Source is and how this amazing machine works
- What it looks like inside the ALS
- What it's like to work at the ALS
- What a student can do at the ALS
- What polymers are and why they are so useful
- How trace elements can change a material for better or worse
- How materials science is helping us solve environmental problems

Well, first for students in grades 9-12 and their teachers, MicroWorlds features information about research programs at Lawrence Berkeley National Laboratory. Each article has learning activities to help students understand basic concepts related to the research described.

For more information on MicroWorlds, please contact:

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Lawrence Berkeley National Laboratory

Sponsor

Advanced Light Source, Lawrence Berkeley National Laboratory

Contacts

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Budget

\$9000/year (for salaries)

Web Sites

Program: www.lbl.gov/MicroWorlds
Poster: www.nist.gov/public_affairs/Posters/microworlds.htm

MicroWorlds is an electronic science magazine on the Web. Written primarily for students in grades 7-12 and their teachers, it features information about research and the people who make it happen at Lawrence Berkeley National Laboratory's Advanced Light Source (ALS). Each "article" has learning activities to help students understand basic concepts related to the research described. The site seeks to engage students in activities that help them learn about the type of science going on at one of the newest DOE facilities and realize that science is accessible and fun.

MicroWorlds has several unique features that set it apart from many educational projects: it features real science that is happening today, rather than textbook examples; it connects key science concepts like electromagnetism and light to the way the concepts are used in everyday life, engineering, and science; the material is integrated with hands-on activities that make the student a participant in the learning process; and it is developed by ALS writers who are used to describing science to a lay audience, in collaboration with teachers and students. It is also an integral part of the other ALS outreach activities, which include teacher workshops, class visits, and curriculum materials.

Students and teachers have played a leading role in the development of MicroWorlds. The initial articles were developed with a teacher consultant, and curriculum materials grew out of a teacher workshop held at the ALS. We have taken advantage of Berkeley Lab summer programs for both students and teachers to get input on an ongoing basis.

The Bright and Busy module that features people who work at the ALS is almost entirely written by student interns who get to learn about what people do in careers at a national laboratory. New science articles, also written by students, include "the eXperiment files," which follows an experiment at the ALS from start to finish, and "Students' Corner," which is a first-person story about what it is like to be a summer student working with scientists at the ALS.

Microworlds is Internet based so that it can reach a worldwide audience, especially students and teachers who may not have access to any real science facilities (versus science museums) or do not have many curriculum materials on the science and engineering challenges of today.

The interactive nature of Microworlds lets the students ask questions of the person featured in the biography section and try to figure out the answer to a related technical or scientific question.

Besides getting feedback from the teachers and students with whom we work directly, we also have a registration and feedback area. This is well utilized and often gives us a sense of what people are reading most closely. In addition, we collect information from server statistics. In the future, we would like to expand Microworlds to allow students and teachers to contact scientists directly.

Ultimately, we hope to permit students to be directly involved in the planning of an ALS experiment and/or in the interpretation of actual scientific data from an experiment.

Passport to Knowledge



Sponsor

Passport to Knowledge, through grants from NASA, NSF, NOAA, in-kind support from science centers, universities, and project-generated revenues (license fees, sale of materials, etc.)

Contact

Geoff Haines-Stiles, Project Director
(alternate: Erna Akuginow, Executive in Charge)

Passport to Knowledge
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(ea@passporttoknowledge.com)

Budget

From 1994-2002, inclusive, P2K has cost some \$6 million, resulting in 65 hours of broadcast television, a family of award-winning Web sites, and print publications (Teacher's and Implementation Guides, and Factbooks) including 200 inquiry-based hands-on activities. A small core staff (<20) expands through contract employees to support live productions and major events. LIVE FROM materials are available from P2K: the PASSPORT TO Modules are distributed via GPN, the nation's leading educational AV supplier.

Web Sites

Program: passporttoknowledge.com
Poster: www.nist.gov/public_affairs/Posters/p2k.htm

Passport to Knowledge's mission is to energize the core content of secondary school science by relating classroom

instruction to real-world research and connecting students with leading scientists. Since 1994, P2K has developed, disseminated, and evaluated two complementary series of multiple media instructional materials and experiences. The LIVE FROM "electronic field trips" have become public television's longest-running interactive learning project. They are also carried by NASA-TV, and streamed and archived on the Web. Four PASSPORT TO Modules (Rainforest, Weather and Climate, Antarctica, The Solar System) each include eight 15-minute classroom videos and two 30-minute teacher resource programs. These Modules can be implemented using videotape, the Internet, mail lists, and inquiry-based hands-on activities at any time throughout the school year. They offer an integrated suite of current and comprehensive instructional materials, directly linked to core Earth, space, life, and physical science content targeted by the National Science Education Standards and Project 2061's "Benchmarks." Each LIVE FROM mini-series reaches from 1.5 to 2 million viewers. PASSPORT TO Modules, broadcast as instructional TV by PBS stations and educational networks over multiple school years, may be seen by up to 10 million students. P2K's interdisciplinary team of media developers, education researchers, classroom teachers, and consulting scientists has been supported by NASA, NSF, NOAA, the Department of Energy, and public television and has partnered with major science museums, planetariums, universities and school districts, and other public and private institutions. A three-year evaluation by the Center for Children and Technology, EDC, documented measurable improvements in learning outcomes (including knowledge, attitudes, and skills) through

content analysis of student work, an unusually large (3500+) survey of educators, and other scientifically based quantitative analyses. P2K has prototyped and tested several innovative video and Internet techniques, such as "You Are There" tours of sites as remote as Earth's Amundsen-Scott South Pole Station, and as scientifically significant as Fermilab. Online BIOographies and Field Journals personalize the scientific enterprise and provide role models for future careers in science and high technology through portraits of working researchers, both male and female, and from varied backgrounds.

P2K has demonstrated the effectiveness of transforming the hard work of real-world research into "teachable moments" that excite and inform students and their teachers. It has shown that ongoing support is required to encourage mainstream educators to implement inquiry-based pedagogy and new technologies, but that in-service experiences using the Internet can be successful and reach national scale. Both real-time and "evergreen" materials are required, in flexible formats, to accommodate the great diversity of school schedules and technical resources. Evaluation, however, has shown that this new kind of instructional resource can have measurable, positive impact on students of diverse intelligences and aptitudes, in schools of widely varying demographics.

Both NSF and NASA have cited Passport to Knowledge as an example of the successful integration of research with education and outreach in reports to Congress. P2K was twice a finalist in the Education category of the Information Infrastructure Awards, and was the winner of the 1997 EdNET "Hero" Award for Excellence.

Science Controversies: Online Partnerships in Education (SCOPE)



Sponsors

Science magazine/AAAS,
Washington DC
University of California, Berkeley
University of Washington, Seattle
Funded by the National Science
Foundation (NSF)

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Budget

\$1,840,000 over 3 years

Web Sites

Program:
scope.educ.washington.edu/forum
Poster: www.nist.gov/public_affairs/Posters/scope.htm

"Science Controversies, On-Line Partnerships in Education" (SCOPE), supported by a grant from the NSF, investigates use of computer resources to aid research and learning around unresolved scientific questions. The principal investigators are Marcia Linn, (PI, U.C.-Berkeley), Phil Bell (co-PI, U. Washington), and Pamela Hines (co-PI, Science, AAAS).

SCOPE's goal is to bring knowledge about the practice of science and unre-

solved scientific questions into middle-school classrooms, and to offer opportunities for research scientists to pursue their own interests and contribute to educational efforts. The project aims to stimulate scientific knowledge acquisition and debate between different segments, such as scientists, policy makers, students, and teachers.

SCOPE has focused on selected scientific controversies, such as amphibian growth and development, malaria control, and genetically modified food. With each topic, we explore different ways to present information and promote interactions between participants. School teachers direct classroom projects using the Web-based Inquiry Science Environment (WISE) combined with the material posted at the SCOPE Web site. WISE is an on-line science learning environment for students in grades 4 through 12 that provides the necessary tools to participate in a scientific debate. Students can interact by expressing their opinions and ideas. Material posted at the SCOPE Web site, the main resource for students, includes scientist-written commentaries on recent research, reports on scientific conferences, and a "virtual panel discussion" that highlights how divergent scientists' opinions can be. The SCOPE Web site also leads to additional web resources. The dynamic and recorded nature of the SCOPE Web site allows students to see how researchers' ideas, questions, and conclusions evolve over time. Additional material developed by SCOPE team members bridges the knowledge gap between research scientists and middle-school students.

For scientists and policy makers, SCOPE supports multidisciplinary exploration, interaction, and collaboration. Additionally, SCOPE offers scientists an

opportunity to learn about the public's understanding of science.

We have used various measures to assess the outcomes of SCOPE. Middle-school students' understanding of science is assessed by pre- and post-tests, classroom observations, and various written contributions. Participation in structured e-mail or classroom debates challenges the student to pose and substantiate an opinion. The effectiveness of these debates and the extent to which the students' statements reflect current scientific understanding are assessed by the teachers. The teachers' involvement is observed by SCOPE team members. Refinements to the various curriculum units are made by the SCOPE team on the basis of feedback and teachers' experiences. Scientists' interactions are assessed by tracking Web site usage statistics and e-mail discussion, and by follow-up telephone interviews.

The SCOPE/WISE project incorporates 15 years of classroom experience. Formative research involved projects directed by Marcia Linn at U.C.-Berkeley studying the use of computers as learning tools in middle-school education. Other formative experience relied on editorial experiences at *Science* magazine, working with research scientists as authors and readers, developing content suited to particular audiences, and exercising skills in science writing and editing.

The SCOPE resources have been spontaneously adopted by various others not actively involved in SCOPE's classroom activities. For example, a scientific journal has reprinted a selection of the scientist-written commentaries; a private book-club has used the site to inform their discussion; and a professor has used the site to direct his undergraduate students through the debate about genetically modified foods.

The High School Biomedical Research Program for Disadvantaged Youth



Sponsors

The University of Maryland at Baltimore
The National Institutes of Health

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Budget

\$20,000 per year

Web Sites

Poster: www.nist.gov/public_affairs/Posters/biomedical.htm

The High School Biomedical Research Program is an opportunity for young men, women, and teachers to be involved in important hands-on biomedical research at a great university. The purpose of this program is to expand the horizons of disadvantaged high school students, inspire them to pursue careers in biomedical research, and give them training and experience to help pursue that goal. This program is significantly different from other high school scholastic experiences because training is intense and focused in a highly scientific environment, concentrating on scientific methods, scientific writing and oral communication. This full-time, eight week summer program, which has been continuously funded by the National Institutes of Health and the State of Maryland, was started in 1988 by Dr. Norbert Myslinski.

The primary focus is the student-scientist relationship. Each participant is matched with a different research scientist at the University of Maryland, Baltimore campus. They are placed in the schools of medicine, dentistry, pharmacy, and nursing, and the biotechnology and psychiatric institutes. Their projects involve heart disease, cancer, molecular biology, the human genome, brain disorders, pharmacology, psychiatry, and many others. They spent 80 percent of their time in their mentor's laboratory and 20 percent in weekly group activities such as science seminars, career seminars, bioethical/biomedical debates, oral presentations, competitions, and lab visitations. Science seminar topics include the use and care of lab animals, lab safety, biomedical informatics, scientific methods, ethical conduct, and oral and written communication of scientific data.

Seventy-nine Baltimore area schools have participated. Since 1988 they worked in 32 different basic, clinical, and support departments under 76 different mentors. This Program has contributed more than 70,000 staff-hours of student help during the 14 years of its existence. The evaluation process consists of six parts that are a modified version of the recommendations in the National Science Foundation publication, *User-friendly Handbook for Project Evaluation*. These evaluations help determine if the project meets its goals, the aspects of the project that were the most effective, and if the project could be replicated elsewhere. Ninety-five percent of the students have gone on to college with 88 percent majoring in the sciences. Some of the student projects have been published in medical journals and have won national awards.

The Biomedical Research Program is a great way of communicating advances in science and technology to today's youth. High school teachers also participate and then transfer what they learned to students in their schools. The seminars and laboratory experiences can be easily adapted to other institutions of science research. These disadvantaged students are paid while they learn about the new advances in science and technology, oral and written communication of science, and career options. This experience helps them in their admission and retention at the universities of their choice.

Base Pair



Sponsors

Howard Hughes Medical Institute,
Univ. of Mississippi Medical Center

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Budget

Approx. \$100,000 budgeted for
2001 academic year

Web Sites

Program: <http://basepair.library.ums.edu>
Poster: www.nist.gov/public_affairs/Posters/basepair.pdf

Base Pair, initiated in 1992, is a biomedical research mentorship program that cultivates career awareness in public high school students, trains such students as effective "Communicators of Science" to lay persons, and advances inquiry-based science curricula within secondary school districts. Base Pair was created from discussions among the leadership of the University of Mississippi Medical

Center (UMC) and the Jackson Public School District (JPSD) that articulated a substantial need for stimulation of secondary school education by exposure of students and teachers to university-level biomedical research. Incorporation of electronic information and communication technologies in Base Pair activities followed the results of a district-wide formative evaluation of JPSD technology needs. Pairing of faculty from UMC with students allows each student to spend a substantial portion of an academic year experiencing "hands-on" biomedical research under UMC mentor guidance. In preparation, Base Pair created a novel, graduation credit-accruing high school course, Biomedical Research, that prepares students for research activities. Mentors subsequently host students, in their laboratories, during afternoons for a full semester. Teacher professional development during the summer and science curriculum enhancement activities throughout the year complement student participation to create a highly coordinated impetus for communication of contemporary biomedical science ethical concerns, techniques, and philosophies.

Success in communicating science is highlighted by over 32 scientific abstracts/publications or presentations co-authored/presented by high school students in professional scientific forums, while over a dozen teachers have accomplished similar professional goals. In addition, a Web site, <http://basepair.library.ums.edu>, enhances communication with the public and helps users locate Web-based and library resources relating to biomedical research and mentorship. The program uses innovative communication devices, such as videophones, to impart greater flexibility for interactions among mentors, students, and teachers.

Eighty-eight students have participated in Base Pair, of whom 52 percent have been African-American, and 60 percent have been women. Of those eligible (18 remain in high school), 100 percent have continued to an undergraduate experience, 41 of whom have chosen a science major. Twenty-four have completed undergraduate training, and of those, 13 have either enrolled in graduate training or have entered a science-related career. Nine have entered an M.D. or an M.D./Ph.D. training program.

Intensive training of over two dozen teachers, from six school districts, during summer sessions has emphasized grantsmanship, curriculum design, and contemporary laboratory/information technology. To date, 83 percent of Base Pair teacher-initiated grant applications have been funded, demonstrating a lasting influence on the communication ability of teachers. Ancillary activities, including hosting live, interactive presentations of annual Howard Hughes Medical Institute Holiday Lectures in Science, and participation in electronic mentoring forums, have extended the Base Pair influence to hundreds more.

Base Pair offers a unique, yet readily reproducible, conjunction of mentorship, information technology, biomedical research, and curriculum development that is a model for improving science literacy among the American public. Implementation of an advanced preparatory course, and application of the philosophy of mentorship that is fundamental to all academic researchers, is an eminently "portable" concept that can be adopted wherever professional scientific research is active (colleges, universities, corporate research, government agencies).



Sponsor

Science and Innovation Administration

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Budget

Starting costs:
Lorry: \$340,000
Content: \$290,000
Annual exploitation costs:
Total: \$110,000
Staff and expenses (2FT): \$70,000
Transport: \$19,000
Repairs and maintenance: \$6,000
Communication & marketing: \$8,000
Miscellaneous: \$7,000

Pupils reached each year:
6,000 pupils at 15 locations

Web Sites

Program: www.technopolis.be/en
click "what is Technopolis?" then
"Technopolis is more"
Poster: www.nist.gov/public_affairs/Posters/experion.htm

In 1995 we wanted to set up a project proving to pupils in their first year of secondary school (age 13) that science is related to everyday life and not boring. For this very critical public we had to create a challenging content (hands-on experiments) in a nice cover. The practical problem of bringing pupils and project together was solved by transporting our project in a lorry covering a 750 sq. ft space once folded open.

Experion® was born.

Experienced in educational outreach, we knew we needed:

- a compelling and appealing story to present the experiments;
- a final target: a "problem" that is "solved" if the experiments are conducted accurately; and
- experiments dealing with topics corresponding to secondary education.

Thus, afterwards pupils can relate their experiences to the theory.

Several stories and experiments were tested. The result of three years of brainstorming, building, and testing was revealed in October 1998.

The pupils enter Experion® in a mysterious atmosphere. In true "Mission Impossible" style they receive their mission from a very secret organization through "live" satellite connection: "disclose the secrets of a huge object which fell down on Earth after collision with a satellite." In teams of two or three, they carry out tasks dealing with geography, language, biology, physics, electricity, creativity... Each team carries out three of the nine experiments. Their success in accomplishing an experiment provides them with (part of) a picture. Two hours of piecing together the picture leads to a code that prevents the disintegration of the wreckage.

Carrying out the program contained two major parallel parts: design and construction of the lorry (carried out externally under internal supervision) and conception, design, and construction of the interior (a mix of internal expertise on content and external expertise on design). Coordination was done by one project manager.

Experion® is evaluated after each session. Teachers think highly of it because of the availability of experiments and the way science is "sold." The best proof of the success is the change of attitude in pupils during the session, changing from being skeptical to real die hards wanting to "save the wreckage." One even fainted during the session.

If we had to do it again ...

1. We would change the way the computers communicate (now linked in a network) and look for other (wireless) means of data transfer (chips, ...).

2. We underestimated the effort and cost of exploitation. For this reason, the original plan of going on school grounds was replaced with parking on a central location:

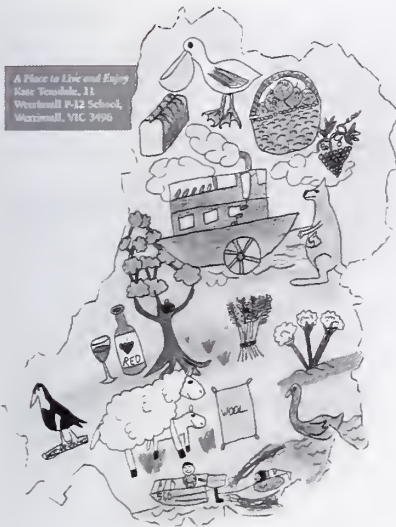
- building up Experion® and setting up the experiments takes two to three hours

- choosing locations is important because of the size of the lorry; and

- personnel have to travel and stay overnight.

3. We would consider the changing mentality in the course of the first year of secondary school (outgrowing childhood). The skepticism about the story increases as the school year progresses: luckily it doesn't survive during the sessions. At the end of the school year, the experiments become more easy to accomplish.

Special Forever



Sponsor

Murray-Darling Basin Commission

Contact

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Budget

\$1.2 M AUS over three years. This funds all operating costs, staff development and a full time project coordinator, and part time clerical assistance.

Web Sites

Program: www.mdbc.gov.au
Poster: [www.nist.gov/public_affairs/
Posters/specialforever.htm](http://www.nist.gov/public_affairs/Posters/specialforever.htm)

Communication goal. Special Forever is a unique environmental communication project undertaken across the Murray-Darling Basin (the Basin) in eastern Australia. It is funded by the Murray-Darling Basin Commission and is implemented by the Primary English Teaching Association of Australia. The project provides the opportunity for the personal involvement of primary school students in thinking, writing, and drawing what is important to them in the Basin, and provides guidance in how to effectively express and communicate their views and values.

Through the involvement of over 400 schools (25 percent of the total in the Basin) and approximately 25,000 children each year, it has created:

- a “sense of belonging” and pride in the Basin by students;
- greater discussion of the Basin in schools and families; and
- greater awareness of the topography, land use, cultural heritage, and flora and fauna of the Basin.

Science content. Since 1993 the program has been successful in making a unique connection between English and science. Special Forever has given students another dimension to their science-based field activities by guiding and encouraging them to write and express what they value about their “special” part of the environment.

Contributions of artwork and writing are collated with the best entries sent for review and possible inclusion in an annual Anthology. The National Museum of Australia has featured Special Forever in a permanent exhibition and regards the Anthologies as a unique collection and snapshot of children's perceptions of environmental and social issues over the last decade.

Target audience. The target audiences for this project are primary school children (6 to 13 years old) and primary school teachers within the Murray-Darling Basin.

Background research and evaluation. The program evolved over seven years before an evaluation was undertaken. Key findings from the 1999 review indicated a high degree of satisfaction with the primary school teachers and students, and a perception by funding partners of outputs being of a very high standard. This review became the foundation for a restructure, basis for the creation of new objectives and performance indicators. In 2000 it led to a 300 percent increase in annual investment to \$400 000 AUS p.a. The new investment strategy also moved the project from an annual basis to a three-year term.

Keys to success. An essential feature of the success of Special Forever is the use of a national professional organization such as the Primary English Teaching Association. This has ensured an extremely high level of quality assurance and adherence to current national best practice in English teaching.

The project could not be effective across the Basin without the assistance of 23 volunteer regional coordinators who are either English teachers or librarians. Guidelines for the project are based on the development of modules by the regional coordinators ensuring relevance to local and regional curriculum.

Special Forever is a substantial long-term investment in encouraging future generations to value the many natural and social assets of the Murray-Darling Basin.

Communicating Science to Children in Brazil



Sponsors

Museu da Vida (Museum of Life)/
Casa de Oswaldo Cruz/Fiocruz

Contact

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Budget

We use the resources already available in the Museu da Vida, including the staff. There is a 10-person staff working in this project, all of them sharing their time with other activities in the Museu.

Website:

Poster: www.nist.gov/public_affairs/Posters/brazil.htm

Educational experiments have shown that in general children are very receptive to ideas related to science and are extremely curious. Therefore, scientific popularization initiatives for this age can succeed. Based upon our experience producing a science magazine and a book series for children, and taking into account practical examples, we will discuss the benefits, the obstacles, and the limitations of this activity aimed for the juvenile public. Both the science popularization magazine and the book series are products of Brazilian scientific community initiatives, involving science communication professionals. There is, therefore, in these cases, an intimate association between scientists and communicators in the task of transmitting science for children.

The magazine is *Ciência Hoje das Crianças* (Science Today for Children), a monthly publication of the Brazilian Society for the Advancement of Science (equivalent to the AAAS). The criteria for the choice were: it is the most significant science popularization magazine in Brazil aimed at children and takes very seriously the issue of content accuracy (including analysis of articles by scientific referees). As the magazine editor for five years, I have several practical reflections on science popularization for children. With a circulation of around 200,000 copies, *Ciência Hoje das Crianças* has as its objective to stimulate, in young readers, interest about science, literature, and Brazilian culture. Most of its articles (at least 80 percent) are signed by scientists from universities and research institutions. However, the texts

are "translated," adapting them for children's language, by the editorial team prior to publication.

The other product considered in our poster is a children's book series, created this year by the Museum of Life, the science popularization unit of Oswaldo Cruz Foundation (an important Brazilian scientific institution). To design the book series, we are using the know-how generated by my experience. The subject of the first volume is the importance of scientific collections (comparing scientific collections with the children's habit of collecting things).

Some of the general aspects to be considered in the process of science popularization for children are: to deal with young readers as intelligent people, capable of understanding complex thoughts; to make associations with everyday life; to make reference to history and popular culture, but, at the same time, to be aware of international science scenario; to associate art and science; to make use of analogies, metaphors, and humor; to promote intimate associations between scientists and communicators; to actively involve children in science popularization, rendering them into actors of the process; to present risks, uncertainties, and ethical and moral aspects of science.

The team for the children's book series includes about 10 professionals, with different backgrounds (biologists, journalists, educators, and designers). The evaluation also includes professionals with different backgrounds and children, embracing quantitative and qualitative research.

Taking Science to Policy Makers



Participants in the Kansas Geological Survey's 1995 Field Conference board the bus after viewing a coal-mine reclamation project.

Sponsor

Kansas Geological Survey,
University of Kansas

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Budget

2001 Field Conference
Expenses
Survey salaries and wages
\$25,000
Direct costs (motels, meals, bus, etc.)
\$11,500
Income
(co-sponsorships, registration)
\$11,500

In previous years, total expenses ranged from about \$30,400 to \$35,500. Income ranged from about \$4,800 to about \$8,300.

Web Sites

Program: www.kgs.ukans.edu
Poster: www.nist.gov/public_affairs/Posters/geological.htm

An important audience for scientific information is policy makers: legislators, governmental agency staff, business leaders, environmental leaders, and others who need natural-resource information to make policy decisions. These are busy people; they don't have the time or background to read detailed, technical information. But they make natural-resource policy decisions every day.

The Kansas Geological Survey is a non-regulatory, research and service division of the University of Kansas. The Survey studies and provides information about the state's geologic resources and hazards. A prime audience for that information is policy makers. To reach that audience—to provide scientific information in a form that policy makers would take the time to understand—the Survey developed an annual, three-day field conference. It takes policy makers into the field, to locations where natural resources are produced or used, to see, first-hand, the resources they make decisions about, and to talk with researchers and people who carry out (or are affected by) their decisions. The program was partially modeled after a similar, national program at the Colorado School of Mines.

The Survey has operated the Conference since 1995. Attendance is by invitation. Participants are about one-third legislators, one-third agency staff, with the remainder being teachers, business leaders, and environmental leaders. Travel is by motor-coach (between stops, extensive conversations often ensue on the bus's public-address system). A guidebook is sent to participants before the trip. Lodging and meals are provided. A small fee is charged, but most expenses are covered by co-sponsors, chosen from state agencies with expertise in issues being considered. A key to early success was the attendance of especially visible

legislators, which established the program's credibility and led to attendance by other participants. Conferences focus on topics (such as energy) or specific regions of the state. Most of the work is done by Survey extension staff (geologists and writers/editors).

Results

Participants give the Conference high marks. Written, post-conference evaluations are extremely positive and are used in planning subsequent trips. During the law-making process, legislators refer to information learned during the conference, contributing to improved decision making. For example, when legislators make laws about water in the Ogallala aquifer of western Kansas (perhaps the state's most important natural resource), they call on Conference experiences—they have seen the Ogallala, they have talked with irrigators and hydrologists. The Conference has raised the Survey's visibility within the Legislature and improved relationships with state agencies that act as co-sponsors.

The Conference has evolved over seven years. The first conference was held in October. Because legislators campaign for office in the fall, the Conference is now held in June. Early conferences included evening programs. But participants wanted time in the evening to informally talk about issues with each other, so evening programs were eliminated.

Bottom Line

The Kansas Geological Survey's annual Field Conference is a highly effective way of providing scientific information to a difficult-to-reach audience. The concept is being adopted by other state geological surveys and is applicable to a variety of scientific organizations.

Beyond Discovery



Sponsor

National Academy of Sciences

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Budget

Approximately \$60,000 per article including printing and dissemination

Web Sites

Program: www.BeyondDiscovery.org

Poster: www.nist.gov/public_affairs/Posters/discovery.htm

The National Academy of Sciences' Office on Public Understanding of Science (OPUS) has managed the Beyond Discovery project since its inception in 1995. The project currently produces two products: eight-page, four-color print articles, and a Web site that contains the text of all articles with links to additional high-quality information about each topic. Each article describes the often unanticipated role basic research plays in the development of a medical or technological breakthrough. The project is intended to raise awareness of the importance of basic research and to help the reader understand the processes of science. Since 1996, the project has produced 17 articles on a wide variety of topics.

The primary audience for the series is "influential" individuals, including members of the media, government and political officials, industry leaders, educators, and the science-interested lay public. We print and distribute each article to approximately 12,000 members of this audience. The articles also are distributed to libraries and science and technology centers. In addition, the project's Web site receives over 40,000 unique visits per month. We undertook a year-long advertising campaign that promoted the Web site in eight general science and science teachers' publications.

Professional science writers draft the Beyond Discovery articles. The articles are vetted through an extensive review process that includes, when possible, scientists who made the discoveries described. Due to the voluntary help OPUS receives from members of the National Academy of Sciences, OPUS is

uniquely positioned to produce a series of articles about modern science through the personal accounts of those involved in the discoveries. OPUS staff manage each article through several rounds of reviews to ensure that the articles are accurate and clear for a lay reader.

Different aspects of the project have been evaluated since its inception. At the onset of the project, two prototype articles were evaluated by focus groups, and substantial changes were made in design, graphics, and readability before the first prototype article was released in April 1996. Two other major evaluations were conducted: One studied the use of the Beyond Discovery series by middle and high school teachers; the other tested the usability of the Beyond Discovery Web site.

In 1998, OPUS contracted with an independent evaluator to survey members of the North Carolina Science Teachers Association, who were sent copies of six articles. The members were then asked to respond to a survey that was designed to evaluate their teaching style, the usefulness of the publications, whether the materials were shared, and the appropriateness of the materials as a teaching aid. The results indicated that the teachers found the articles to be useful, although many teachers were interested in our developing curricular materials to help them introduce this kind of information in their classrooms.

In February 2001, OPUS conducted a usability test on the Beyond Discovery Web site. The feedback we received from participants in the test was used to redesign the Web site, to improve navigation, and to add extra features.

Public Information Program for the Groundwater Replenishment System



Sponsor

Orange County Water District and
Orange County Sanitation District

Contact

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Communications budget

(1997 to date)

Research: \$30,000
Public Relations Consultant: \$500,000
Staff hours: 10,000

Web Sites

Program: www.gwrsystem.com
Poster: www.nist.gov/public_affairs/Posters/orangecounty.htm

The Groundwater Replenishment System is a wastewater reclamation project that will be the nation's largest indirect potable reuse project using membrane purification. The purification process will use microfiltration, reverse osmosis, and ultraviolet disinfection to produce 35 billion gallons of water per year to be put into the local groundwater basin, using secondary treated wastewater as its source water. The project's first phase will produce 75,000 acre-feet of water per year (an acre-foot is 326,000 gallons) in 2005.

Communications Goal. The overriding goal of the Groundwater Replenishment System is for the project to go on line without public or political opposition.

Target Audience. Key to the success of the current communications program has been the effective outreach to Orange County political and business leaders and active community members on the high quality and safety of the near distilled water that comes from this treatment process.

Research. Public education and outreach for this project began in late 1997 following focus group and telephone survey research. Initial research focused outreach on messages that were understandable and acceptable to the users of this future water supply. Research showed that Orange County citizens did not believe future water supplies would be reliable. Our citizens also had a strong desire for water independence and faith in the reverse osmosis membrane technology used by many bottled water companies. The project was ultimately renamed based on the results of this research.

Description of Program. The major elements of the program include community presentations; active outreach to local media; appearances on cable and

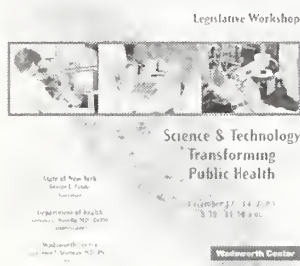
local television; distributing project video and newsletters to libraries; and tours of facilities.

Program Implementation. The public education program was implemented by the public affairs staffs of the Orange County Water District and the Orange County Sanitation District, with assistance from public relations consultants. The public affairs staff members worked with project technical staff to learn the technical aspects of the project and find ways to explain concepts in everyday language. Explaining the high-tech purification process in understandable and credible terms has prevented the "yuck" factor from turning people against the project. For example, explaining that the microfiltration process is also used to produce medicines, soft drinks, and water for the manufacture of computer chips was very effective. Using a graphic diagram that shows the relative size and, therefore, rejection of contaminants by reverse osmosis resulted in audiences asking, why haven't we done this earlier? Research also told us that face-to-face presentations would be most effective in gaining support, so we have given about 500 presentations to key audiences in the county.

Lessons Learned. Being the first to tell a story makes a big difference.

Program Evaluation. By relating the sophisticated technological purification process to everyday items in a person's life, we were able to solicit over 100 organizations to support the project in writing and to gain the support of all the major business, political, and environmental groups in the county. Research conducted in 2000 showed that awareness of the project has increased, and opposition to the project has decreased.

Science and Technology Transforming Public Health: Legislative Workshop



Sponsor

Wadsworth Center, New York State Department of Health

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Budget

\$225 for refreshments
\$255 supplies
Mailing and printing are covered by institutional services.

In-kind staff time: 40 hours for two full-time staff; 15 hours for additional staff involved in production of invitations, binders, etc.

Web Sites

Poster: www.nist.gov/public_affairs/Posters/sciencetech.htm

Wadsworth Center, a research-intensive public health laboratory, provides the New York State Department of Health with a scientific foundation for its policies and practices. Those who craft health-related legislation can also benefit from understanding the science behind public health issues. To provide an educational opportunity, and to establish Wadsworth as a ready source of scientific expertise, the laboratory initiated an annual legislative workshop in 1993.

The target audience is staff of Senate and Assembly members, especially those who sit on Health, Environment, Finance, and Ways and Means committees; policy and budget staff from the Governor's Executive Chamber; and Health Department attorneys who draft regulations. The program's content changes yearly, but the goal remains constant: to explain in a concise, comprehensible manner what is known about a given subject, laboratory application of that information to health threats, and how researchers at Wadsworth are pursuing additional knowledge.

A questionnaire sent to potential attendees listing "hot topics" and significant research developments has proven useful in developing the program. Topics also are chosen based on past participant feedback, laboratory advances, pending legislative issues, and public health stories in the media. Each day has a theme and is composed of 40 minute presentations, demonstrations, tours and informal interaction. For example, a day on Genes and Health in 1998 featured the following units: Model Organisms and Human Health; Hemochromatosis, A Study of Genetics in Public Health; The Continuing Promise of Gene Therapy; and Maintaining the Quality of DNA Paternity Tests.

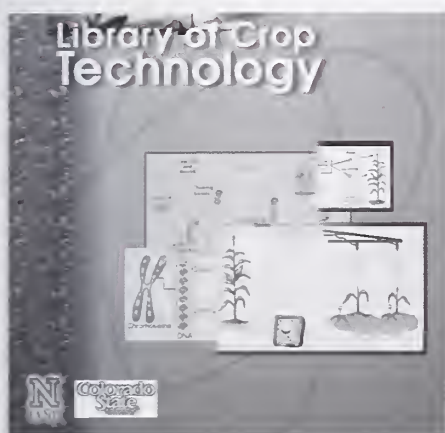
The workshop runs for three consecutive mornings and is held at the Wadsworth Center. It is coordinated by

the director of education and the laboratory media specialist. Their areas of expertise include educational program development, implementation and assessment; science communication; and event promotion and management. Doctoral-level scientists who conduct research or oversee service laboratories are the speakers. They meet with education staff to review the program's goals and to discuss their topics in detail. Speakers draft an annotated outline, glossary, and reading list, which are reviewed for lay accessibility, length and format and are included in a binder, along with a brief bio and contact information. Surveys have indicated that attendees keep the binder in their office for future reference.

A "save the date" card is mailed two months before the program. A month in advance a brochure and registration form are sent to potential attendees and to all legislators, alerting them to an educational opportunity for their staff. While attendance is kept deliberately small to encourage dialogue, it remains a challenge to get busy legislative staff to attend. One remedy has been to schedule the workshop very early, before they go to their office. A challenge is picking the best week to schedule the program, given the busy legislative calendar.

Impact evaluations are generally positive. Assessments include: 1) speakers' knowledge and ability to convey information in a comprehensible way; 2) program strengths and weaknesses; 3) meeting program goals and objectives; 4) benefits of the program; and 5) most/least effective components. No method for measuring outcomes has been identified, however. Follow-up phone calls or visits from legislative staff to workshop speakers are not tracked, nor has it been possible to identify the workshop's role, if any, in policy decisions or legislation.

Diverse Educational Needs in Agricultural Biotechnology



Sponsors

University of Nebraska and Colorado State University; USDA through the Initiative for Future Agriculture and Food Systems program; American Distance Education Consortium (ADEC)

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Budget

\$694,520

Web Sites

Program: croptechnology.unl.edu and www.colostate.edu/programs/lifesciences/TransgenicCrops
Poster: www.nist.gov/public_affairs/Posters/agbiotech.htm

Plant breeders, nutritionists, and agricultural education specialists familiar with genetic modification technology have initiated a project (through the support of an USDA Initiative for Future Agriculture and Food Systems (IFAFS) grant) to provide reliable, accessible, complete and unbiased information on genetically modified crops and foods to as wide an audience as possible. This information is provided through two avenues. The first is through day-long biotechnology workshops. Workshop topics include methods and applications of transgenic crops, health and environmental concerns about their use, ethical dimensions of agricultural biotechnology, and ways of communicating biotechnology risks and benefits. The target groups for these workshops include teachers, extension educators, health and nutrition professionals, journalists, and other professionals who educate others about biotechnology-related subjects.

The second avenue is delivery of information through a partnership of two Web sites, funded in part by the American Distance Education Consortium (ADEC) and USDA-IFAFS, and established to meet diverse educational needs in crop technology. The first Web site (croptechnology.unl.edu) consists of peer-reviewed lesson modules targeted toward credit and non-credit learners and science educators. This open source database has been tested with over 500 students and utilized by teachers and

journalists internationally. Expansions are currently under way for topics in weed science, nutrition, and food safety, with possible translation to Spanish. The second site (www.colostate.edu/programs/lifesciences/TransgenicCrops) is targeted for more general public use, focusing intensely on crop genetic engineering issues. It has been reviewed or mentioned in *Science* magazine, *The Chronicle of Higher Education*, and the Internet Scout Project (an NSF-sponsored organization). Currently, over 125 other Web pages link to this site. Expansions in process include Spanish translation and enhanced agricultural biotechnology educational resources. Over 150 people (e.g., high school science teachers, agricultural and nutrition extension educators, seed company employees) have attended the workshops. Seventy-four participants voluntarily completed surveys that measure awareness, attitude, delivery, and demographics.

Funding: Major funding for this project has been provided by the American Distance Education Consortium (ADEC); the USDA Cooperative State Research, Education and Extension Service (CSREES), under Agreement No. 98-EATP-1-0403; and the USDA Initiative for Future Agriculture and Food Systems (IFAFS), under Agreement No. 00-52100-9710.

A Bridge Not a Barrier

Sponsors

National Academy of Sciences
National Academy of Engineering
Institute of Medicine
National Research Council

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Budget

\$37,500 annually, using existing IT infrastructure

Web Sites

Program: www.national-academies.org
Poster: www.nist.gov/public_affairs/Posters/bestpractices.pdf

The National Academies considers the World Wide Web its primary vehicle for directly reaching consumer audiences. Because of consumer familiarity with news-oriented formats, we intentionally designed the front end of our Web site to emulate news programming—providing updated news feeds about Academies activities nearly every working day. The Academies Office and News and Public Information has managed the site's top-level content since 1996. Since that time, the office's Electronic Outreach group, led by Managing Editor Craig Hicks, has developed a constellation of projects intended to engage a broad range of the science-interested public.

What's New @ National-Academies.org

This is a weekly broadcast e-mail message distributed to some 5,000 subscribers.

The mailing is a dissemination tool that effectively combines pre-existing content from the National Academies Web site and original content written for the e-mail. The message highlights material generated by the news office and other parts of the Academies. In all cases, messages are written for a non-technical, science-interested public.

The mailing reaches a weekly audience of demonstrated breadth and depth, and the self-subscribed audience continues to grow at a regular rate. Of particular surprise to us was the high number of subscribers registered through foreign country domains—72 countries are represented on the list. Also, 149 different federal agencies or elected officials and 40 different state agencies are current subscribers.

In cooperation with the National Academies publisher, the National Academy Press, we have begun tracking “click-throughs” from “What's New” e-mails to individual NAP publications. This gives us an indication of how frequently our list motivates subscribers to connect with our site to read or purchase online publications.

Interactive Webcast Series

Working in close partnership with the institution's information technology and conference support departments, the Electronic Outreach team developed a process for making this new dissemination option more readily available to our research staff.

Some of our more successful webcasts have featured discussions about

intellectual property rights, working conditions for postdoctoral researchers, the safety and efficacy of mammography, and counterterrorism. Our audiences include university students and faculty, newspaper reporters, industry researchers, and government officials from the United States and abroad. We measure each program's impact by assessing server statistics and evaluating participant feedback offered during and after the event.

During 2001, we produced 30 webcasts with a total of 6,224 Web participants.

Web Extra' Series

The news office began producing the Web Extra series in May 2000 to help get the word out on reports that are of particular relevance to the public. Web Extras provide comprehensive summaries of the reports using clear, jargon-free language and visuals such as colorful charts, graphs, maps, and photos.

Interactive features such as quizzes and opinion polls draw people into the subject matter. The news office works closely with research staff to plan content and check accuracy.

More than 140,000 individuals have viewed Web Extra pages. The average person spent about 140 seconds viewing each page—an encouraging statistic, since the Nielsen/Norman Group estimates that most users spend an average of 51 seconds per page. In addition, several other organizations either provided links to the Web Extras or referred to them on their own Web pages, including the American Hospitals Association, CNN, Medscape, and Syracuse University.

Science@NASA

Science @NASA

Direct to People !

science.nasa.gov

Sponsor

NASA Marshall Space Flight Center

Contact

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NASA Marshall Space Flight Center

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Web Sites

Program: See below

Poster: www.nist.gov/public_affairs/

Posters/nasa.htm

What We Are. Science@NASA is a science communication effort sponsored by NASA's Marshall Space Flight Center. It is the result of a four-year research project between Marshall Space Flight Center, the University of Florida College of Journalism and Communications, and the Internet communications company, Bishop Web Works.

The goals of Science@NASA are to inform, inspire, and involve people in the excitement of NASA science by bringing that science directly to them. We stress not only the reporting of the facts of a particular topic but also the context and importance of the research.

Science@NASA involves several levels of activity—from academic communications research to production of content for six Web sites—in an integrated process involving all phases of production. A Science Communications Roundtable Process is in place that

includes scientists, managers, writers, editors, and Web technical experts. The close connection between the scientists and the writers/editors assures a high level of scientific accuracy in the finished products.

The Web sites each have unique characters and are aimed at different audience segments:

1. <http://science.nasa.gov>. (SNG)

Carries stories featuring various aspects of NASA science activity. The site carries two or three new stories each week in written and audio formats for science-attentive adults.

2. <http://liftoff.msfc.nasa.gov>.

Features stories from SNG that are recast for a high school level audience. J-Track and J-Pass applets for tracking satellites are our most popular product.

3. <http://kids.msfc.nasa.gov>. This is the NASAKids site and is aimed at a middle school audience. The NASAKids Club is a new feature at the site.

4. www.thursdaysclassroom.com.

This site features lesson plans and classroom activities for educators centered around one of the science stories carried on SNG.

5. www.spaceweather.com. This site gives the status of solar activity and its interactions with the Earth's ionosphere and magnetosphere.

6. <http://ciencia.msfc.nasa.gov>. This site carries Spanish versions of SNG stories.

How Well Are We Doing?

In 2001, we were awarded the Pirelli INTERNETional Award as best science outreach process. Our Ciencia@NASA site was selected by YAHOO! International as the best Spanish language science and technology site on the Internet.

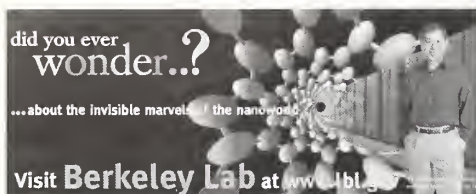
All of our Web sites showed an increase in readership in 2001. Total number of hits for all sites was 637,000,000. The total number of visits (information downloaded to the same Internet address within a 15 minute period) was 54,000,000. This is a 90% increase over 2000.

A significant part of our process is the development and analysis of statistics to measure audience response to our outreach. A survey was developed and analyzed with the help of the University of Florida College of Journalism and Communications. It was sent to all of our science.nasa.gov subscribers. Responses totaled 28,000 (17% of subscribers). Some of the more interesting results:

- 85% rated the quality of our articles as good to excellent,
- 28% said they were students,
- 19% said they were teachers,
- 80% of the teachers said that they used our materials in their classrooms,
- 68% said they read our services at home,
- 63% said that they pass our information on to family and friends,
- 31% were outside the USA; and
- 25% said they were female.

And the most gratifying statistic is that fully 96% of our respondents said that they actually did something as a result of our stories, such as go outside and look for an aurora, meteor shower, or satellite, or talk with their children or grandkids about science! A remarkable measure of impact on people as a result of our outreach efforts!

"Did You Ever Wonder?"



The above image represents the design of one of the first three bus posters, featuring Steven Louie. In a modified form it serves as the banner on Louie's web and print profile.

Sponsor

Lawrence Berkeley National Laboratory

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Budget

Approximately \$70,000 to date
including estimated salary time

Web Sites

Program: www.lbl.gov/wonder
Poster: www.nist.gov/public_affairs/Posters/wonder.htm

A Charlton Research Co. survey in October 1998 revealed that most residents of Berkeley and nearby communities have heard of a place called Lawrence Berkeley National Lab, but few know who we are or what we do. Many of our neighbors are friendly to science, would welcome science help in local schools, and would like to know more about our research and the scientists who conduct it. But 20 percent assume Berkeley Lab is involved in weapons work (we do no classified research), and even more confuse us with Lawrence Livermore Lab, well known for weapons development, or with the Lawrence Hall of Science, a science museum and education center.

To give our neighbors a more accurate picture, "Did You Ever Wonder?" takes advantage of media already in place, namely the Lab's shuttle buses and home page. Our aim is to convey both the diversity of our research—in basic science, technology, energy efficiency, health, and environmental protection—and the diversity of the people doing it.

Berkeley Lab is adjacent to the UC Berkeley campus; our shuttle buses circle the campus and move through the heart of downtown Berkeley six times an hour every working day. About every five weeks, new sets of colorful posters have appeared on these buses, stimulating curiosity with "Did you ever wonder" questions.

"Did you ever wonder about the invisible marvels of the nanoworld? ... How new discoveries could help cure breast cancer? ... How a portable water purifier saves children's lives?" For answers, readers are invited to visit our Web site: "Visit Berkeley Lab at www.lbl.gov."

Personal profiles of researchers, written for nonspecialists interested in science, are posted on the Web site. So far we have featured the work of 12 scientists who differ in age, gender, ethnic origin, and the varied paths that brought them to scientific work—whether they were born into a family of Ivy League scientists or began life as a farmer's daughter in China.

Web profiles give short answers to the "Wonder" questions on the bus posters and link to existing articles, press releases, research papers, and other online documents of increasing technical content. Printed broadsides, which are distributed to schools, businesses, and community centers, contain the same material and also give URLs.

The program has required the part-time efforts of two writers, two designers, an editor, a photographer, and specialists in poster manufacture, Web layout, and printing—all on staff—plus the Lab's bus drivers, who mount the posters themselves.

The great challenge was coordinating many separate departments and many disparate tasks, meanwhile maintaining the usual public-information-department workload. In some cases, integration with education, recruiting, or community outreach efforts has suffered.

Web site hits have averaged about 11,000 a week, comparable to our online magazine *Science Beat*. Apparently the majority of these are generated by bus posters alone, judging from the jump in hits following the appearance of new posters with no other publicity. Better information may come from another professional community survey to be commissioned soon.

Current Science & Technology Center



Sponsor

Museum of Science

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Budget

Capital Costs (Design, Construction,
Hardware, Systems): \$2.5 million.
(Lead corporate sponsor: EMC
Corporation)
Annual Operating Budget: \$250,000
Grant-Funded Programs: \$400,000

Web Sites

Program: www.mos.org/cst
Poster: www.nist.gov/public_affairs/Posters/currentscience.htm

The Current Science & Technology Center is a museum-based experiment in science communication aimed at enhancing the public understanding of research by focusing on new discoveries, breakthrough technologies, and science in the news stories. The center serves as an information resource, showcase, and forum for many of the museum's 1.5 million annual visitors, while developing new audiences through the Web, cable television, and networking with other science centers.

The centerpiece of the roughly 5000-square-foot exhibit area is a dramat-

ically suspended oval stage and large plasma screen array. Live presentations are given daily, backed by colorful digital video and graphic displays, and include opportunities for questions and discussion. Guest researchers with a knack for public speaking are invited in on a regular basis. Exhibits often feature new technologies still under development, in partnership with university and industry R&D labs. Attractive touchscreen displays carry science news and stories on current research, utilizing text, images, animation, audio, and video. News and stories are updated daily from an in-house digital production studio by a team of dedicated scientists, educators, and multimedia producers, who also prepare and deliver the live presentations. Much of the material also is uploaded to the center's web site, www.mos.org/cst, with links to related sites.

CS&T hosts live events, demonstrations, and forum-type gatherings. It has live links to NASA-TV via satellite, to the Gilliland Observatory telescopes, and to cable, Web, and video-conferencing resources. New fiber lines and robotically controlled cameras will allow CS&T to begin cablecasting in the spring of 2002 as a regular feature on New England Cable News. CS&T also pursues opportunities for live communications with research expeditions in the field, such as the International Trans Antarctic Expedition and Woods Hole deep sea dive research expeditions.

Partnerships and grants help provide staffing and resources for various areas of research. For example, the center pursues a major focus on health science research in partnership with local research institutions, funded by a SEPA grant from the National Institutes of Health's National Center for Research Resources. The NSF-

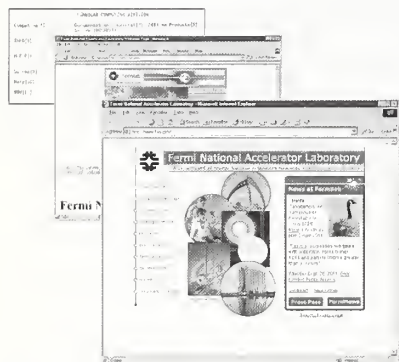
funded Nanoscale Science and Engineering Center headquartered at Harvard University includes CS&T as an educational outreach collaborator. The museum has a NASA broker/facilitator grant that assists CS&T staff in developing educational outreach in partnership with space science researchers. Working with the Public Understanding of Research initiative at the National Science Foundation, the CS&T Center also is exploring various ways of sharing and networking educational resources with other science centers and broadcast media.

The pace of research and innovation is quickening, opening new possibilities, new career choices, and often new controversies. CS&T seeks to empower public and school audiences with information and perspective on science and technology in the news and to encourage widespread participation in meaningful dialogue on our future. The center serves as a safe place where some of the trickier ethical and social issues associated with current research can be teased out and understood on a factual basis, without reference to political or cultural agendas.

The CS&T Center is an ongoing experiment in designing the science and technology center of the future. With the help of the Institute for Learning Innovation, we are conducting a four-year formative and summative evaluation program in order to develop and improve on all aspects of the center's multifaceted approach and to assess its value as a science communication model for further dissemination.

Physics to the People: Reinventing the Fermilab Web Site

Physics to the People Reinventing the Fermilab Website



Sponsor

U.S. Department of Energy/Fermi National Accelerator Laboratory

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Budget

\$60,000 for Web design consultant, plus significant staff time and expertise—the equivalent of about one full-time staff member.

Web Sites

Program: www.fnal.gov
Poster: www.nist.gov/public_affairs/Posters/fermilab.htm

The World Wide Web came from high-energy physics, so perhaps it is not surprising that Fermilab, a Department of Energy high-energy physics laboratory, has an historic Web site: the second ever established in the United States. Created in 1992 as tool for sharing physics data, the site developed through the 1990s into a tool for communicating with a wide range of audiences. As for Web design, navigation, architecture, graphic standards—we made them up as we went along. The result was a site that held a trove of physics knowledge and other information but was all but inaccessible to the average Web user.

In 1999, the Fermilab Office of Public Affairs undertook a complete overhaul of the laboratory's entire public Web site: some 1,200 pages. Rather than attempting to rehabilitate the current site, we elected to start fresh—*tabula rasa*. We wanted to make the byzantine Fermilab Web site into a supple and effective communication tool.

The first step was to form a small, focused laboratory Web Group with both the requisite expertise and the authority to make decisions. (Lesson learned: Avoid big committees and long approval chains.)

The Web Group took time and care in the selection of a Web consultant. (Lesson learned: Unless you are a Web design firm, don't try to do it yourself, especially if you're a physics lab.) We chose Xeno Media, a local company with a portfolio of scientific and educational Web sites and a collaborative approach. We wanted great Web-design expertise but also the opportunity for significant participation ourselves. (Lesson learned: Location counts. E-mail proved no substitute for weekly onsite meetings between the contractor and the Web Group.)

We began the project with input from the laboratory community, audience analysis, a survey of comparable Web sites, and technical specifications. A look at the make-up of the audience reveals the biggest challenge we faced: physicists, students, teachers, the interested public, the media, funding agencies, government officials, employees, users—plus bird-watchers, folk-dancers, and patrons of the arts, each seeking something different from the Fermilab site. How to make it easy for all of them to find what they were looking for?

Building the new Web site took nearly a year. Xeno developed and refined the navigation scheme, with ongoing feedback from users. Public affairs staff wrote and edited content. We designated one day a week as "Web Day," devoted entirely to work on the new site, with the contractor toiling alongside laboratory staff.

On March 1, 2001, we rolled out the new Web site, standing by to fix the inevitable glitches. Response was fast, and people liked it! Even the press weighed in. When *Wired.com* called our site "euro-cute," we took it as a compliment.

Measuring the effectiveness of the new Web site in reaching audiences is straightforward. Weekly Webtrends reports—shared with laboratory management—and plenty of direct e-mail feedback tell us who uses the Web site and how, and where the problems are, allowing us to change to meet the needs of users, to build audiences and to strengthen our messages. (Lesson learned: A Web site is never done; its care and feeding must be someone's daily responsibility.)

Dive and Discover—Expeditions to the Seafloor



Sponsor

Woods Hole Oceanographic Institution (WHOI), the National Science Foundation (NSF), and Center of Science and Industry (COSI)

Contact

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Budget

We estimate that over the past two years, Dive and Discover has cost approximately \$500,000. This figure is an approximation because of the many people hours volunteered to the project. We are currently in the process of determining the cost of running Dive and Discover on a per/cruise basis.

Web Sites

Program: www.divediscover.whoi.edu
Poster: www.nist.gov/public_affairs/Posters/dfino_poster.pdf

Dive and Discover is a live-from-sea Web site, which involves Internet users in the daily activities and discoveries of scientists at sea. The site is the brainchild of Dr. Susan Humphris and Dr. Dan Fornari, senior scientists in the Geology & Geophysics Dept. at the Woods Hole Oceanographic Institution (WHOI), the world's largest independent oceanographic research and education institution. The project is funded through a grant

from the National Science Foundation's Awards for Geoscience Education Program and WHOI. The Web site specifically targets middle school students and their teachers, engaging them in interactive distance learning. The primary goal in creating the site was to show young people how science is conducted and to share with them the excitement and sense of discovery scientists experience while carrying out deep sea research that uses submersible vehicles.

Broadcast since January 2000, Dive and Discover has covered five research expeditions to the seafloor in remote regions of the Pacific and Indian Oceans. It is planned that the site will serve in the future as a model and template for other scientists conducting research at sea. Documentation exists to assist others in using the site or developing their own near real-time at-sea Web sites based on the Dive and Discover model.

Dive and Discover's most immediate challenge was a technical one: How to transmit large amounts of data from a research vessel out in the open ocean where satellites are less numerous and more expensive. To solve this problem Fornari and Humphris involved research engineers at WHOI who had developed a technology called SeaNET and were in the process of installing it on some ships in the nation's fleet of research vessels. SeaNET provided Humphris and Fornari with satellite and communications hardware and software protocols that permit large quantities of data to be transmitted relatively inexpensively between a shore-based server and the ship at sea.

With the first technical hurdle overcome, Humphris and Fornari enlisted the help of WHOI Web Communications Manager Danielle Fino to develop a Web interface that would stimulate students

and still be a manageable size to transmit from sea and to load quickly on the older, slower computers used in many classrooms. Fino also made sure the interface was adaptable to expeditions focusing on different scientific questions. WHOI Illustrator Paul Oberlander, and WHOI Science Editor Lawrence Lippsett worked to help create the site's graphical and textual components. These include: interactive learning modules; a daily journal; detailed explanations of the research vessels, the remote vehicles, and other tools used in scientific research; a mail buoy for communicating with shipboard scientists; interviews; hot topics; videos; slide shows; and quizzes.

After the second expedition, Humphris and Fornari embarked in a partnership with Ohio's Center of Science and Industry, COSI, to expand the project's reach among teachers. COSI developed a free educator's companion to give to any teacher requesting it, and a WHOI-based outreach campaign followed, enlisting teachers in using and helping to evaluate the site. Expedition 4 recruited more than 80 teachers from five countries to use the site and evaluate it.

Dive and Discover uses access statistics, awards won, teacher response, and verbal and email feedback to measure success and effectiveness. Though it is near impossible to determine exactly who is using the site, our access statistics show that the site is being used extensively by students and the general public, and feedback and the list of awards won shows that it is well-liked by Internet audiences. Access statistics indicate that 4,278,183 Dive and Discover pages were accessed from February 27, 2000, to May 20, 2001.

Virtual Labs and Animation Console at BioInteractive.org



Sponsor

Howard Hughes Medical Institute (HHMI)

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Budget

A single virtual lab requires approximately three full-time developers, including outside technology consultants, for four months. Additional staff time is required to evaluate and make modifications to labs. Some effort can be saved in reusing some tools from previously developed labs. Each animation requires approximately three full-time staff for three months.

Web Sites

Program: biointeractive.org
Poster: www.nist.gov/public_affairs/
Posters/biointeractive.htm

The virtual labs (vlabs), animations, and other supplemental instructional materials available at BioInteractive.org are designed to teach, in an engaging manner, about important, cutting-edge concepts in the biomedical sciences. Content is rigorously reviewed for scientific accuracy and designed to be of practical value to educators. The materials are intended primarily for high school AP biology students, although they have found wide use in introductory college biology, and Web usage statistics indicate that the materials are popular with a general audience.

Vlabs are used to prepare for, or reinforce a wet lab, or to provide an experience when a wet lab is not possible. They reveal science as a process while teaching key biological concepts and current methods and technology for laboratory investigation. In the Bacterial ID Lab, for example, students use PCR amplification, DNA sequencing, and an actual BLAST search engine to identify an unknown pathogen. Other vlabs enable students to diagnose heart disease, assay human antibodies, and examine the function of the nervous system.

The animations cover diverse topics, from E. coli infection to the molecular basis of biological clocks. Although not intrinsically interactive, they reveal hidden worlds and complex biological functions that cannot be easily conveyed via text alone or static illustration. The animations are bundled in an Animation Console that incorporates indexing and navigation features, making it easy to find and view them. Animations are displayed on one side of the screen and explanatory text on the other, allowing students to study either the animation or the text. Some animations feature audio narration. "Tabs" link to background information, references, and teaching tips.

The quality and effectiveness of the vlabs and animations depend on a multidisciplinary team of staff and consultants: scientific and educational advisers, animators and software designers, content developers, and evaluation coordinators. A key member of the team is a science liaison who coordinates and monitors the team's activities and is a critical link between the scientific advisers and the artistic and technical developers. The science liaison must have a strong science and education background to balance scientific content with the interests of the learner. A defined, iterative workflow refines the vlabs and animations from original concept to storyboard to final product.

During product development, the team conducts formative evaluations with scientists and educators to assess scientific accuracy, concept and design, and informational value. Large-scale summative evaluations are conducted to determine if completed products meet the team's educational goals. Results of evaluations are used to refine materials and assessment instruments.

We have learned that development of materials with rigorous scientific content and complex technological requirements requires a detailed work plan and a single individual—the science liaison—to manage the process. Originally, we intended to publish our materials only on the BioInteractive Web site. However, feedback from teachers and others convinced us that there were advantages to publishing materials on CD-ROMs, which are portable and do not depend on an Internet connection. We are preparing to publish in DVD video and DVD-ROM formats to take advantage of superior storage capacity, indexing, and interactive features.

Choices and Challenges



Sponsor

Center for Interdisciplinary Studies at Virginia Tech

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Budget

The Choices and Challenges project's budget has varied on a forum-to-forum basis. No registration fee has ever been charged so as to encourage a broad spectrum of participation. The typical forum budget ranges from \$40,000 to \$50,000, with significant cost-sharing provided by the university.

Web Sites

Program: www.cddc.vt.edu/choices
Poster: www.nist.gov/public_affairs/Posters/choices.htm

Over the last 15 years, the project has received financial support from foundations such as: the Virginia Foundation for the Humanities and Public Policy, NIH, and NEH. Support has also been provided by various divisions, colleges, and departments at Virginia Tech.

Grant monies typically provide salary support for one half-time Research Associate; publicity; video/broadcast services; forum production costs; and

travel expenses and small honorarium for invited speakers.

Founded in 1985 at Virginia Tech, each forum is designed to determine the ethical and social issues created by advances in science, technology, and medicine and to examine the often highly complex components—historical, philosophical, societal, legal—in a balanced manner.

The 20 forums conducted since the start of the series have covered a wide range of topics in biology, medicine, psychology, chemistry, physics, and engineering. Each forum is tailored to the specific needs of the subject under consideration but there are three basic components:

- tutorial sessions at the beginning of the program to provide necessary background information to participants;
- a main session at which a panel of scholars and practitioners discuss, with each other and with the audience, the various issues raised; and
- closing sessions geared toward fostering individual decision-making and examining how citizens can contribute to policymaking.

Our typical audience includes scientists, clinicians, lawyers, theologians, educators, businesspersons, students, the press, and the general public. Attendance now exceeds 500 at each full-day forum. Professional societies for physicians, teachers, nurses, dietitians, and social workers have granted continuing education credits or in-service credits.

For more than a dozen years, the main session of each forum has been broadcast throughout the U.S., thereby bringing the forum to national audiences in either an interactive teleconference format or through the use of edited videotapes shown to community audiences and schools. More than 700 sites nation-

wide (with an estimated viewing audience of 25,000) have participated in this way.

The Choices and Challenges series has received national awards for its work. Most recently we are recipients of an Innovation Award by The Woodrow Wilson National Fellowship Foundation.

Our upcoming forum, 'Food Frights'—scheduled for April 11, 2002—explores food safety issues such as genetically modified foods and the risk of bioterrorism. We are currently seeking funding for our next forum, tentatively entitled "Big Brother Technologies," scheduled for March 27, 2003.

By bringing the researcher together with the practitioner, the scientist into dialogue with the humanist, the citizen into conversation with the legislator, the Choices and Challenges forums serve as a unique living laboratory for identifying, exploring, and addressing some of the most crucial and demanding human issues confronting modern society

What We Have Learned

■ Involve community members at all stages of planning, from topic selection to program design.

■ Invite speakers and discussion leaders with experience in developing links to the public so as to promote partnership over adversity in the discussions.

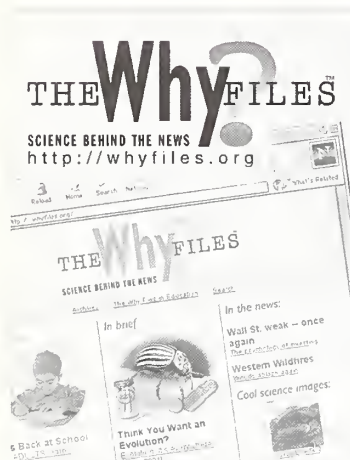
■ Include local as well as national discussants to encourage continued dialogue following the scheduled event.

■ Recognize and respect the expertise and knowledge that members of the public bring to the discussion.

■ Allow no formal "papers" and insist that participants speak in lay language.

■ Use new technologies, but don't rely on them as a "solution" to communication with the public.

The Why Files



Sponsor

The University of Wisconsin-Madison

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Budget

\$110,895 annually

Web Sites

Program: <http://whyfiles.org>
Poster: www.nist.gov/public_affairs/Posters/whyfiles.htm

The Why Files (whyfiles.org) is a non-profit, Web-based source of entertaining and informative science information. Founded in 1996 by the National Institute for Science Education and funded by the Graduate School of the University of Wisconsin-Madison since 1998, The Why Files has helped pioneer the art of reaching mass audiences with salient, accurate, and accessible science stories via the Web. Each week, the site features clearly written, often humorous, and always fact-checked stories explaining “the science behind the news.” News hooks are the headlines; stories range from 800 to 3,500 words, and are richly illustrated with photographs, drawings, and tables. Each story includes links to relevant Web sites and a bibliography with further information.

Although humor is a vital component of the project’s success, we take our mission to explore the science behind the news seriously. When Princess Diana died, we covered the science of grief. When an ominous asteroid was sighted, we looked at the numbers and rationale for worrying about stray rocks from space. And when blackouts rolled through California, we looked at methane hydrates and nuclear energy.

When the project started, the Internet was an untamed wilderness. With no models to follow and the excitement of the frontier ahead, The Why Files began life based on the idea that “the science behind the news” was an opportunity to address myriad scientific topics in accessible language.

While traditional journalistic standards, snappy writing, and timely reporting have helped The Why Files achieve international recognition, it is the non-parochial approach to reporting that sets it apart from most university science Web

sites. Instead of focusing on Wisconsin stories, we frequently avoid them. Science goes far beyond a single institution to form a foundation of modern society. Our mission is to help people realize the critical nature of science; an understanding that ultimately benefits our university as well.

Despite a small marketing effort, this formula has enabled our work to reach a broad and growing audience of science laymen, educators, and students. Currently, The Why Files reaches 130,000 computers per month—an achievement that clearly demonstrates the educational potential of this vehicle. In addition, The Why Files has sparked several for-credit courses based on our material. We have also expanded beyond higher education to K-12 science teachers by hotlinking from the national science standards to more than 200 relevant Why Files stories.

Of course, there have been challenges. Constantly changing technology, variations in user software, and the usual hurdles associated with news writing have all added to the adventure. Yet, even with these challenges, The Why Files has consistently functioned as a successful communications tool.

The tiny staff (equivalent to three full-time employees), rapid pace of scientific discovery, and dizzying news cycle means The Why Files model can be adaptable to institutional communications programs with science news expertise. The model requires science writing savvy and a willingness to be innovative, irreverent, and non-parochial. The latter requirement may be most difficult for institutions used to promoting their own programs, but is essential to success.

The Ashkui Project—Linking Traditional Knowledge and Western Science

Sponsors

Environment Canada, the Innu Nation, and Saint Mary's University

Authors

Geoff Howell and Alex T. Bielak

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Budget

Sponsoring Agency: \$180,000 (Canadian) salary and 75K operational

Partner Leverage

250,000 per annum excluding partner salaries.

Web Sites

Program: www.stmarys.ca/administration/gorsebrook/ashkui.htm
Poster: www.nist.gov/public_affairs/Posters/ashkui.htm

The Innu people of Labrador have a world view of the land they occupy, known to them as Nitassinan, which views the landscape, the processes that interact with it, and the plants and animals that live on it as a collection of inseparable elements. Innu and western knowledge both provide valuable insights into the Labrador ecosystem, but we need to develop new approaches to record, understand, and transmit this knowledge between scientists and the Innu. A cultural landscape unit concept has been developed which starts with Innu terminology and knowledge of an element on the landscape which has value and meaning for them and then builds an enhanced knowledge base from a number of different perspectives.

Zones known as Ashkui in the Innu language have been identified by Innu elders as being of primary importance to them and will form the basis of this case study. Ashkui are areas of early or permanent open water on rivers, lakes, and estuaries and are valued as areas for camping, hunting, fishing, and collection of traditional medicines.

Innovative Communication Practices

The Ashkui project attempts to capture knowledge on the nature and function of Ashkui from Innu and western science perspectives and then develops ways of sharing the knowledge across cultures. The communication approach used throughout the Ashkui project is based on three key elements: Special People, Special Places, and Special Products.

Special People:

The concept of sharing knowledge across culture requires that the project attract special people that have an inherent respect for new and different ideas and perspectives. The Ashkui project is based on Innu knowledge and from the beginning has been developed with ideas derived from discussions with Innu elders and hunters. The science agenda for the project has been developed from these discussions and as such has attracted scientists that recognize the value of knowledge based on lifelong experiences on the land. From the outset, an Innu co-researcher has been an integral part of the project team and is involved in all aspects of the work. The co-researcher represents the project in the Innu community, provides information in the Innu language, provides guidance to the project partners, and helps translate elder questions and ideas into project activities.

Special Places:

An essential component of the Ashkui project is communicating results back to the community in a setting that

has significance to the Innu people. The In-country meeting concept—which involves setting up traditional Innu campsites at Ashkui sites—has been extremely successful. A gathering of Innu elders, hunters and families, and project scientists spend up to three days living on the land in an Innu camp where results are presented in an informal Labrador tent setting, participants get a renewed sense of the landscape, and collective discussions generate new project ideas. The Innu elders, in particular, appreciate the scientists taking time to better understand the landscape and the Innu way of life.

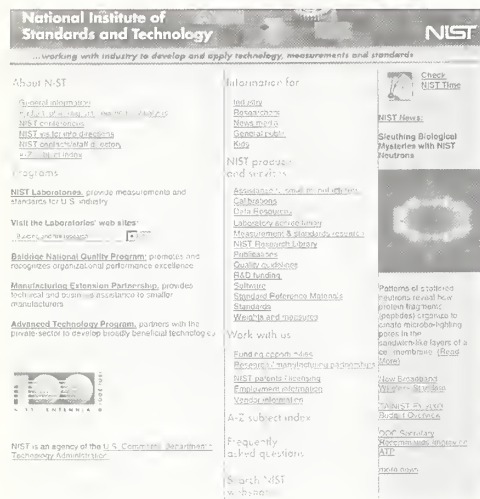
Special Products:

To be successful, the Ashkui project has attempted to develop new approaches to the interpretation and presentation of results. The general concept is to continue to value the guidance of the Innu elders by building products which try to answer their questions in a way that is meaningful to them. For example, rather than providing a technical report on water chemistry, pictorial-based posters describe whether the water will make good tea or will be favoured by wildlife. Educational CD-ROMs on the project have also been produced for the Innu school system. These describe the project in both Innu and English through a series of games, photographs, and text snippets.

Program Evaluation:

The program is still relatively in the early stages, and evaluation presently consists of input from the community and others. This feedback has been very positive, the project is gaining considerable attention and recognition for its innovative approach, and a number of the approaches used have been adopted by other northern research projects. Evaluation of progress also occurs annually during Branch project planning, including review by external peers.

Revamping a Web Site to Improve Navigation and Content



Sponsor

National Institute of Standards and Technology

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Budget

About \$150,000 (includes salaries of primary staff)

Web Sites

Program: www.nist.gov
Poster: www.nist.gov/public_affairs/Posters/nist.htm

Prior to March 2001, the NIST Web site was a hodgepodge of eclectic styles and types of content. Each of NIST's major departments maintained their own set of Web pages using their own formats and content outlines. Visitors to the site commented that they were not always sure which pages were in fact part of the NIST site and which were not.

Adopting the slogan, "One face for NIST," the NIST Public and Business Affairs Division embarked on a year-long effort to work with the NIST departments to implement a single visual format and consistent content elements. At the same time, an extensive set of new pages was created to improve access to NIST research results for lay audiences such as students, teachers, policy makers, and science-interested adults.

A key success of the program was its low cost and consensus building approach.

Steps to Homepage Harmony

NIST's centrally managed external Web servers hold more than 300,000 individual Web pages, while additional tens of thousands of NIST Web pages reside on servers maintained directly by NIST departments and program offices.

The task of converting such a large volume of information to a single format was daunting, especially given the Institute's long-standing decentralized approach to Web page management.

Several important decisions made early in the project helped to ensure its success. While primary design and management of the project resided with the Public and Business Affairs Division, a committee representing all NIST departments was actively involved from the earliest stages of the project.

Communication goals, content needs, and navigation approaches were determined first. With agreement on

these issues in hand, a design was created to implement them. The design and the templates to implement it were simple enough so that non-designers could be taught to use them.

Research and Evaluation

Surveys of NIST stakeholders in 1998 and 2000 found that respondents had trouble finding things on the NIST Web site and were confused by the different formats for NIST's 12 different laboratories and other major units. They wanted faster loading pages, crosslinked by topic areas, in plain English.

In 2001, a focus group tested the new Web design. Among other things, they suggested a "three click" standard for finding most information, multiple pathways for finding the same information, and that the credibility of a Web page owner is just as important as the design of the site for predicting usage. The study results were used to make changes to the new NIST site prior to its public launch.

Key Lessons Learned

Start by adopting a uniform format for top-level pages and work your way down to interior pages. Don't demand 100 percent compliance before launching a more uniform Web site. Half a band in uniform is better than no uniforms at all.

Create a "Web Style Guide" and post it on an internal site as an organizational reference. The guide should include "customer service standards" like "All Web pages will list a contact e-mail." Use this central location to post downloadable HTML templates. Provide both written directions and hands-on training for implementing the new design.

Evaluate Web sites based on tasks successfully completed—information successfully found. Don't just ask for opinions.

The Eye Site—A Traveling Exhibit on Low Vision for Shopping Centers



Sponsor

National Eye Institute (NEI), National Institutes of Health (NIH)

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Budget

\$200,000 (development cost)

Web Sites

Program: www.nei.nih.gov/nehep/eyesite
Poster: www.nist.gov/public_affairs/Posters/eyesite.htm

Communications Goal

NEI created The Eye Site—A Traveling Exhibit on Low Vision for Shopping Centers to provide information for the approximately one of every 20 Americans with low vision, their families, caregivers, and friends.

Target Audience

Low vision primarily affects people over 65. Hispanics and African Americans of any age are also at higher risk. Defined as a visual impairment not correctable by regular eyeglasses, contact lenses, medicine, or surgery, low vision interferes with the ability to perform everyday activities. It can result from a

variety of diseases and disorders such as age-related macular degeneration, cataract, glaucoma, or diabetic retinopathy, or from injuries.

Research

NEI conducted focus group research among individuals with low vision in 1997, which resulted in the creation of the Low Vision Education Program. The program includes community education programs, public service campaigns through the mass media, and The Eye Site exhibit.

The exhibit has undergone extensive pilot testing and evaluation, including interviews and observations during a pilot test; telephone interviews with the sponsoring organizations; focus groups to obtain feedback on the appearance and content of the information presented in the exhibit; and a suitability assessment by individuals with expertise in health communication, low vision, interactive technologies, and marketing.

Description of the Program

The Eye Site provides information in English and Spanish and consists of five colorful kiosks, which display booklets and local resource information, feature assistive devices, and tell the stories of people with low vision. An innovative interactive multimedia touchscreen program explains the causes of low vision, offers personal video accounts, and provides a low vision self-assessment.

Two exhibits will tour shopping centers around the country for several years. NEI determined that shopping centers—America's new town halls—provide an ideal venue for communicating health information to a wide audience.

Program Implementation

NEI staff has expertise in health education, communications, and public outreach. Institute staff came up with the initial concept and developed the format and all content for the exhibit. NEI guided contractors in the fabrication of the exhibit kiosks and the design and programming of the interactive touchscreen program.

In most communities, the exhibit will be sponsored by a local Host Committee composed of members from NEI grantee institutions and community organizations and groups interested in low vision. At each mall, the Host Committee will sponsor education programs featuring local experts.

Lessons Learned

Preliminary planning, strong local Host Committees, and the assistance of a professional tour management company are essential to the success of each tour.

Program Evaluation

While on tour, the exhibit will be evaluated through onsite surveys; data collected by the touchscreen program, which will report the age range and gender of users, track visits to each section of the program, and report how many users select the Spanish or English versions; ongoing referral tracking by local Host Committees organizations that provide low vision services; and tracking of media coverage in each community.

The Weather Discovery Center



A school group creating their own wind to propel and steer a sailboat on the "high seas."

Sponsor

The Mount Washington Observatory

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Budget

- a) Cost to build infrastructure and exhibits in existing building: \$800,000
- b) Cost to build related and connected exhibit on the summit of Mount Washington: \$100,000
- c) Staff to run Weather Discovery Center when fully staffed: About \$105,000 for director of museums, two full-time floor staff, two part-time floor staff (16 hours a week), full-time exhibit fabricator/maintenance worker
- d) All financial administration including accounting, book keeping, postage, development, and Board of Trustees is shared with rest of Observatory and is currently incalculable.
- e) Annual operating expenses after opening: \$75,000

Web Sites

Program: www.mountwashington.org
Poster: www.nist.gov/public_affairs/Posters/weather.htm

The Weather Discovery Center (WDC) is the latest educational effort of the Mount Washington Observatory (MWO), a weather observatory located on the summit of the highest peak of the Northeast. Mount Washington hosts what many believe is the worst weather in the world and it is a perfect venue for the continuously staffed observatory that has existed there since 1932. For decades the MWO has sought to augment its scientific endeavors with outreach and education, and the WDC was a natural extension of this effort. The initial exhibit planners wanted to teach visitors about weather, wind, the sciences of meteorology and atmospheric, the MWO, and other related topics using high-tech exhibits. It was the planner's intention to reach school age children and general tourists, especially families. The Weather Discovery Center opened on May 1, 2000 in the Mount Washington Valley.

The MWO conducted focus groups and other formative evaluations before the WDC opened. Findings indicated a strong interest in the public to learn more about the weather and meteorology. The most striking finding was the desire of the test group to learn more about what meteorologists do, especially MWO meteorologists, and to see and work with real time weather data and maps. Using this information the Observatory created exhibits that connected the visitor as directly as possible to working meteorologists and developing weather patterns and weather forecasting, including:

- Two computer terminals that continuously update themselves with developing weather data.
- A telecommunications link with the staff at the Observatory on the summit for direct discussions on conditions and projects.

■ A camera set on top of Mount Washington whose image can be seen and manipulated at a console in the WDC to monitor conditions on the summit.

■ A blue screen exhibit that invites visitors to role play being a television weather forecaster using up to the hour weather maps.

■ An exhibit on Groundwinds—the Mount Washington Observatory's highest profile research project.

The Observatory conducted surveys and traffic studies to judge the effectiveness of the exhibits in the Weather Discovery Center. Several lessons were learned quickly and often:

■ People love weather and love viewing real weather data, but these are hard to dependably provide with a fickle Internet connection.

■ A diversity of technologies should be used in any exhibit area to deliver content.

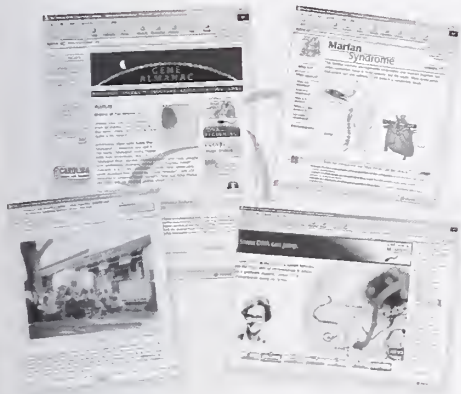
■ Don't promise real-time scientific data unless you know you can provide it reliably.

■ People love meeting the observers via the teleconference exhibit. It seems to be the scientific version of "a piece of the true cross" phenomenon history museums know so well and know how to exploit to garner interest in historic topics.

■ Never underestimate the public's, including children's, interest in arcane scientific data and information, but never overestimate their prior knowledge.

■ People seem to enjoy more, learn more, and spend more time at exhibits that involve another person. A second person is needed to bounce ideas and questions off of while exploring difficult information.

Dolan DNA Learning Center Web Sites



Sponsor

Cold Spring Harbor Laboratory

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Estimated Annual Budget

\$500,000

Web Sites

Program: www.dnalc.org
Poster: www.nist.gov/public_affairs/Posters/dna.htm

The Dolan DNA Learning Center (DNALC) is the world's first science center devoted to public genetics education. It is an operating unit of the Cold Spring Harbor Laboratory, a world-renowned basic research facility. The DNALC develops and runs hands-on laboratory courses for middle and high school students and provides teacher training workshops.

In recent years, to broaden their audience, the DNALC started developing educational material for the World Wide

Web. *Gene Almanac* (<http://vector.cshl.org>) is DNALC's Web portal to all of the other major content sites produced by the Biomedica staff. Key among these content sites are:

DNA from the Beginning: the animated primer to genetics and molecular biology. www.dnafb.org

Your Genes, Your Health: the multimedia guide to genetic disorders. www.yourgenesyourhealth.org

Digital Archive of the American Eugenics Movement: the online archive chronicling the American eugenics movement of the 1900's.

www.eugenicsarchive.org

These and other DNALC Web sites cover the field of genetics and molecular biology, highlighting the science, history, social implications as well as the promise of current and developing technologies. The Web sites are meant to provide information to the interested public, teachers, and students. Professionals from other fields can also use the Web site to learn or update their knowledge about topics that impinge on their specialties. The Web sites are all free and have been used for teaching and other research projects by teachers and students all over the world.

The DNALC Web sites are supported by a number of grants, which helped establish the Biomedica Group: a small staff of scientists, writers, artists and designers, and computer programmers. There are currently seven full-time employees augmented by part-time staff and interns. The Biomedica Group has regular meetings to decide on design, style, and content for our Web sites.

Everything on the Web sites is produced inhouse.

Before each Web site was built, either an Internet assessment meeting (DNA from the Beginning), an internal board review meeting (Digital Archive), or a focus group meeting (Your Genes, Your Health) was convened. These meetings provided us with contacts, information about current and upcoming technologies, and important feedback from other professionals in the field. An important insight that can be distilled from these meetings is the importance of flexibility and adaptability. New software and technology change quickly; Web sites have to accommodate the largest number of users without being slow and dated.

Statistics on Web site usage have been collected every month since the DNALC's Web sites have been online. Some of the things we track with statistics are user sessions, parts of the sites accessed, as well as time spent on the site. As the Web sites grew, so did the numbers. In addition to the ability to compile numbers, each Web site has its own feedback function, which allows users to email their opinions, problems, and questions. An online survey was added six months ago to DNA from the Beginning to solicit more specific information about the user's needs and level of knowledge. We plan to expand the online surveys and add them to other DNALC Web sites in order to identify and target user needs.

Major Funding:

The Josiah Macy Jr. Foundation
National Institutes of Health, Ethical, Legal, Social, Implications of the Human Genome Initiative Program (NIH ELSI)

USGS Western Region Center, Open House 2000



Sponsor

U.S. Geological Survey

Contact

Leslie C. Gordon
Geologist/Education Coordinator
U.S. Geological Survey
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Menlo Park, CA 94025-3591
Phone: (650) 329-4006
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lgordon@usgs.gov

Budget

\$100K materials and operating
expenses plus 13,800 staff hours

Web Sites

Program: openhouse.wr.usgs.gov
Poster: www.nist.gov/public_affairs/Posters/usgs.htm

The U.S. Geological Survey's Western Region Center in Menlo Park, Calif., has held public open houses every three years since 1985. Our most recent Open House 2000 was a multi-media event that attracted approximately 14,000 people over a period of three days, May 12, 13, & 14, 2000. May 12 was a special VIP and school preview day, and May 13 & 14 were open to the general public.

Multiple audiences were targeted. The event, open to the general public, attracted children and families, college students, teachers, neighbors, USGS cooperators, and scientists from nearby universities. The San Francisco Bay Area is not only a very large metropolitan area, but it's also home to Silicon Valley, the

high tech-industry, two major universities, and a highly educated, well-informed populace. Bay Area residents typically seek out information and are tuned into science and nature issues. We are filling a large demand for timely and accurate natural science information. The first day of the open house (Friday, 5/12/00) was by invitation only to local school groups, Congressional representatives, local government officials, and our own employees.

We wanted to show who we (USGS) are, what we do, and why we do it. This is our regular triennial event to give back to the community in a fun and educational manner. Our local community has not forgotten the 1994 threat to abolish the USGS, nor the 1997 threat to move us out of Menlo Park. Years later we still get regular inquiries about our continued existence. The open house is one visible reminder of our commitment to the community.

The USGS Western Region Center is on the leading edge of a major tectonic plate, and in a geologically active area. People have a need and desire to understand the natural processes at work all around us. The open house is a way for the USGS to share unfiltered information about local earthquakes, landslides, water pollution, and numerous other critical issues affecting the 9 million people living in the Bay Area.

We used every medium we could think of in order to reach the widest audience possible. This multi-media extravaganza had something for everyone. During the event, there were hands-on activities and crafts for kids, poster displays (technical and non-technical), a video theater, laboratory tours, and music and dance performances. American Sign Language interpreters were available

throughout the event and led guided tours. The open house is a rare opportunity for the public to see behind the scenes in a large government facility, and speak to research scientists face-to-face in a friendly informal setting. It is a way for the taxpayer to see first-hand what we do.

The event included more than 250 exhibits, a printed program, passport, poster, a companion Web site with most information online, and included both the presentation of A/V materials and the creation of them as a record of the event.

The concept of a USGS open house began in Menlo Park, Calif., in 1985, and we've held them every three years since then. The successes of early open houses led to the establishment of similar events in other USGS regional centers in Denver and Reston, Va. Questionnaires distributed to the attendees beginning in 1985 greatly influenced later open houses. Starting in 1997, we distributed a questionnaire to our own employees. Responses to the questionnaires, and countless anecdotal stories, led to the continued improvement of subsequent open houses. With little advertising, almost 20,000 people attend each three-day open house, many of them repeat visitors from past open houses. All year long we receive calls asking when the next open house is scheduled, and school groups are disappointed they have to wait three years for the next one.

Our success has become an enormous burden in recent years. The huge amount of work involved in an event of this size has led us to reconsider doing another one of comparable scale. Instead, we are considering conducting much smaller open-house-like events more frequently.

Science, Technology and Society Resident Scholar Program (STS/RSP)



Sponsors

Institute for Science, Engineering and Public Policy (lead organization) Oregon Public Broadcasting (PBS/NPR), Oregon University System (seven campuses), a dozen private colleges, a Community College Consortium (six colleges), statewide K12 schools, Oregon Museum of Science and Industry, Oregon Coast Aquarium, a number of corporations including Mentor Graphics, ESI, InFocus, Intel, Tektronix, CH2M Hill, Precision Castparts, the high-tech PR firm Waggener Edstrom, and many more, plus several banks and law firms.

Contact

Terry Bristol, President and CEO
Institute for Science, Engineering
and Public Policy
The Linus Pauling House
3945 SE Hawthorne Blvd.
Portland, OR 97214
Phone: (503) 232-2300
Bristol@isepp.org

Budget

\$350,000 (typical year breakout below)

Revenue

Co-sponsors: \$150,000

Ticket sales: \$200,000

Expenses

Speakers \$125,000

Marketing \$50,000

Staff \$100,000

Overhead \$75,000

Web Sites

Program: www.isepp.org

Poster: www.nist.gov/public_affairs/

Posters/STS.htm

Audience targeted: Success has depended heavily on an active coalition of business, educational, media, and government organizations. As a result there are multiple target audiences (academics (K12-graduate schools), business, other non-profits, professional and trade organizations, government, and general public. There was a successful effort to achieve ethnic diversity as well as gender and age equity.

The problem, as we see it, is not to convey more scientific and technological information to the public. Rather it is to develop a multi-disciplinary, cross-sector dialogue on issues of science, technology, and society.

A broad range of key citizens in modern societies are inadequately informed about recent scientific and technological advances. However, the problem is symmetrical. The science and technology communities have an equally poor understanding of the nature of the larger human enterprise, and their place in it.

Critical self-reflection is required, where we seriously consider: What is science? What is engineering? What is the aim of the social enterprise? There is a need to reconsider assumptions about inquiry, innovation, and problem-solving. An essential premise is that we are in a position to change the course of events.

People want to understand the implications of advances in science and technology. What does it mean to me, for us?

What: The STS/RS Program, begun as a Public Lecture Series, evolved—as the coalition evolved—into a Resident Scholar Program with scholars interacting with the community over a period of several days. The niche, unfulfilled by existing institutions and programs, is multi-disciplinary, cross-sector dialogue. The strategy is not to educate as much as to

excite natural curiosity, create a sense of intellectual community, and foster “formative experiences” for students.

Who: ISEPP invited celebrity scientists and engineers as well as a mix of relative unknowns. Among the scholars: Carl Sagan, Jane Goodall, David Suzuki, Stephen Jay Gould, Philip Morrison, and Stephen W. Hawking. The year 2001-2002 line-up: James Burke, Brian Greene, Robert Ballard, Jill Cornell Tarter, David Albert, Lee Hood, Richard Leakey, and Lawrence Krauss.

When: The Series runs on the academic calendar. Scholars arrive on Tuesday evening, allowing for several classroom visits, radio and television interviews, and special breakfast/dinner events for trade or professional groups. The main presentation is to a large audience (1,200-3,000) on Friday evening.

Advice: The STS/RSP is conceived as parallel to local theater and symphony. This defines the genre as part of the cultural milieu. Price the events similarly, and seek underwriters and co-sponsors support as do theater and music groups.

Use a cooperative marketing strategy. Work with other local cultural entities, national science magazines like *Scientific American*, *Science News*, etc., and national science organizations like AAAS, Sigma Xi, etc.

Seek publicity through newspapers, radio, and TV media co-sponsors, as well as contacting numerous professional and trade newsletter editors. Each scholar was asked to submit a “policy essay up to 1,500 words.” Interviews were arranged, both prior to and when visiting.

Use aggressive direct mail campaign; creative, award-winning posters; newspaper space ads; radio/TV public service announcements; and so forth.

Bridging the Gap Between Scientific Research and the Public

Sponsor

Adler Planetarium & Astronomy Museum

Contact

Dr. Doug Roberts, Adler Planetarium & Astronomy Museum
300 S. Lake Shore Drive
Chicago, IL 60605,
Phone: (312) 322-0529
doug-roberts@northwestern.edu

Budget

We describe two programs with very different budgets.

- Cosmology Gallery: total of about 35 person-months of staff (astronomer, historian, educator, project manager)
- CyberSpace Gallery: total of about 100 person-months of staff (astronomers, educators, information technicians, production personnel, exhibit designers).

Web Sites

Program: www.adlerplanetarium.org
Poster: www.nist.gov/public_affairs/Posters/adler.htm

A key ingredient in successfully developing exhibits, shows, and programs for a museum whose mission is "to engage and educate a diverse audience in the exciting quest to understand our evolving Universe" is the integral involvement of research scientists.

Working with professional education and exhibit staff, the scientists bring into the process a broad understanding of the science, current knowledge of the field, contacts with colleagues, and the excitement and passion for science that are an essential part of the scientific process.

However, development of these exhibits and programs requires a significant commitment of time on the part of the scientist and also entails learning a new skill set for most. This is simply not possible for most research scientists, who are already balancing the demands of an active research program with significant teaching responsibilities (at the undergraduate and graduate level).

Adler Planetarium & Astronomy Museum has taken the lead in establishing an astronomy and astrophysics research group in a museum setting. Adler currently has eight Ph.D. astronomers and astrophysicists on staff, including four who have joint appointments on the research faculty at the University of Chicago and two with joint appointments at Northwestern University. The nature of these joint

appointments strengthens the integration of the Adler and its educational mission with the world-class Chicago research community (including Fermilab), as well as with the international research community. These positions are analogous to faculty positions at more traditional research institutions, with a requirement that an active program of research be maintained. However, instead of becoming experts in undergraduate education, these scientists become expert in the area of public education. They contribute directly to the development of museum programs and exhibits, and also serve as translators between research colleagues and museum professionals, facilitating the integration of new discoveries and technologies into the museum and its programs.

In addition to close relationships with active researchers, Adler carries out evaluation of exhibits and shows at various stages in order to access and improve their effectiveness. Generally, this process involves a front-end evaluation to determine the level of knowledge and familiarity that typical visitors have on a particular subject for a planned exhibit. The development team then creates prototype exhibit components and carries out evaluation of their ability to communicate key concepts. The evaluation of the prototype is then fed back into the final design.

Border Health Information and Education Network (¡BIEN!)



Sponsors

New Mexico State University Library—lead agency
¡BIEN! is a partnership of 17 academic and public libraries, hospitals, clinics, and other public health organizations in three southern New Mexico counties.

Contact

Sylvia Ortiz
New Mexico State University Library
P.O. Box 30006
Las Cruces, NM 88003
Phone: (505) 646-7481
sortiz@lib.nmsu.edu

Budget

\$204,000, including \$60,480 for salaries; 1 full-time librarian, 1 half-time librarian

Web Sites

Program: www.bienhealth.org
Poster: www.nist.gov/public_affairs/Posters/bien.htm

Southern New Mexico has an ethnically diverse population, a high poverty rate, and has been designated as medically underserved. The need for biomedical information is great. ¡BIEN!'s mission is to contribute to improving the health behaviors of residents in this region by providing increased access to quality health information in English and Spanish, in multiple formats, for health professionals, educators, and consumers.

An extensive feasibility study was conducted by means of a planning grant received from the Paso del Norte Health Foundation in El Paso, Texas. ¡BIEN! partners and personnel also conducted focus groups, trainee questionnaires, and needs assessment surveys to ensure that health information and related technology needs would be met.

Our goals:

1) Identify and provide quality consumer health information in electronic and other formats to targeted populations; 2) provide timely, quality health-related research information to health professionals, educators, librarians, and students; 3) develop an information network for participants; and 4) provide information literacy training for health professionals/educators and consumers.

Our accomplishments:

- Developed a technology infrastructure, including installation of Internet accessible computers and printers at ¡BIEN! locations.

- Created a ¡BIEN! Internet Web site accessible at www.bienhealth.org.

This site includes links to reliable consumer health information Web sites in Spanish and English as well as links of interest to health providers and educators.

- Purchased various Web-based health databases for ¡BIEN! partners.

- Purchased print and audiovisual materials to facilitate the creation of consumer health information centers at each site.

- Conducted electronic health information access training at ¡BIEN! partner sites by project librarians.

- Provided training sessions that included presentation of ¡BIEN! Web site features and instruction on navigating the site to locate and retrieve valid and authoritative health information.

Training/instruction was also provided on searching selective biomedical databases. Each training session included time for "hands-on" practice. Response to the sessions by participants and trainers has been very positive, as documented by the evaluation forms completed at the end of each session. Project staff have also responded to numerous information requests via e-mail, phone, and in person.

Two critical lessons were learned:

1. A project of this scope was difficult to accomplish within the grant established, one-year timeframe. Even with a planning grant, infrastructure had to be developed before goals and objectives could be accomplished.

2. The need for marketing was underestimated. Marketing is crucial to the success of such a project and should be initiated early on.

Evaluation has been ongoing based on "Best Practices" and "Continuous Quality Improvement" models. Changes have been made to the project upon review of data acquired through surveys, user feedback, and internal evaluations of procedures. An external evaluator will provide a final examination of the goals and objectives developed for the original National Library of Medicine proposal.

Live@Exploratorium:Origins



Sponsor

Exploratorium

Contact

Melissa Alexander, Project Director
3601 Lyon Street
San Francisco, CA 94123
melissaa@exploratorium.edu

Budget

Staff and fringe: (includes planning, oversight and production for Web site, Webcasts, public programs, and internal evaluation) \$300,000

Production Supplies \$90,000

Travel and Transportation \$30,000

Telephone and connection \$20,000

Consultants \$10,000

External evaluation \$65,000

Web Sites

www.exploratorium.edu/origins/cern

www.exploratorium.edu/origins/hubble

www.exploratorium.edu/origins/antarctica

Poster: www.nist.gov/public_affairs/Posters/exploratorium.htm

Live@Exploratorium:Origins is a pilot project that mixes live, Internet broadcasts (Webcasts), and streaming media with interactive presentations held in the museum's Wattis Webcast theater. Our efforts are designed to take visitors on virtual field trips to laboratories throughout the world where scientists are examining what we know about the formation of the universe, the creation of matter, the shaping of the Earth, and the origins of life.

Origins goes beyond the science to showcase the settings where some of the most advanced technological achievements occur and the extraordinary people who bring these achievements to reality. We go into research institutions with a collaborative spirit, involving the researchers in the idea generation and creation of the programs. Using Exploratorium staff scientists and educators as mediators, we invite our audiences into the process of scientific discovery—taking them to laboratories where specialized instrumentation is created, into the field where experiments are performed, and into the hearts and minds of scientists who do basic research. In collaboration with staff at each facility we design additional Web site resources about the people, places, tools, and the scientific ideas for each location.

We look over the shoulders of scientists in real time as they perform their research. Using low-cost, two-way video conferencing technologies designed for business-to-business communications, we host live Webcasts from the research facilities that are then archived at www.exploratorium.edu/origins. Webcasts are accompanied by museum-based presentations that include hands-on

activities. When appropriate, museum exhibits and specially designed interactive media augment the presentations in the Webcast studio. Webcasts are two-way, enabling staff scientists and staff interpreters to be both on location and at the museum, fostering a conversation between the research environment and the museum environment.

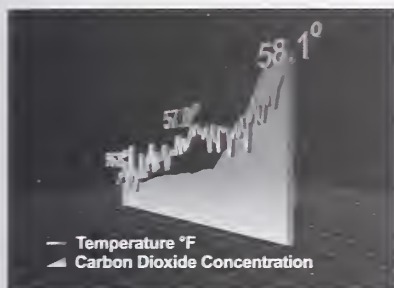
Evaluation is performed by the Center for Children and Technology (CCT), part of the Education Development Center. There are three questions that we hope to elucidate for informal educational Web projects: Who exactly is the audience? What are they doing online? How does this material contribute to their learning?

Because of the remote and distributed nature of the audience and the knowledge about users that Web data provides, we rely on a mixture of surveys of existing data sets, web site analysis, online questionnaires, and interviews. We also seek to identify and disseminate promising evaluation practices relevant to this new type of learning experience.

On-site interviews with audience members provide rapid feedback to staff, allowing us to modify our scripts and shows before the following day's production.

In collaboration with CCT we are conducting ongoing Web site reviews of material with online audience members. We expect that the project will give insight into effective strategies for engaging remote viewers in the content and subject matter, preparing viewers for Webcasts and determining the number of follow-up contacts or deeper engagement with the material.

Climate Stock



Sponsor

University Corporation for Atmospheric Research
U.S. Environmental Protection Agency
UCAR Communications

Contact

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Boulder, CO USA 80307-3000
Lucy Warner
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Bob Henson
(bhenson@ucar.edu, 303-497-8605)

Budget

\$100,000, including contracted animation and production services, studio time, and satellite uplinks
Staff time: Roughly 800 person-hours from UCAR Communications staff over three years.

Web Sites

Program: www.ucar.edu/climatestock
Poster: www.nist.gov/public_affairs/Posters/climatestock.htm

TV weathercasters are the single most visible representatives of science in U.S. households. Yet by and large, they focus on day-to-day weather events rather than the larger-scale, longer-term processes that make up climate. In their role as scientific emissaries, TV weathercasters have a unique opportunity to convey the facts and uncertainties about global climate change to the public. With support from the U.S. Environmental Protection Agency, UCAR Communications produced a series of B-roll videos from 1997 to 2000 to help weathercasters understand global climate change issues and address them in their programming. These packages included:

- interviews with leading scientists from UCAR/NCAR and other institutions;
- visualizations of weather and climate concepts, produced in-house or acquired from other sources;
- stock footage of major weather events, such as the Montreal ice storm of 1998 and the 1997 Red River flooding; and
- suggested scripts that index the appropriate ClimateStock segments and provide additional narration.

Each B-roll was made available free via satellite uplink at the time of release and afterward at nominal cost in Beta or VHS format. Weathercasters were notified of each uplink through fax and e-mail. Suggested scripts and shot lists were placed on the ClimateStock Web site: www.ucar.edu/climatestock.

ClimateStock topics included El Niño and La Niña, global temperature and human-induced climate change, hurricanes, extreme weather events such as winter storms, and pollution. The timing of the releases was determined largely by

news value (e.g., the hurricanes package was released during the hurricane season).

Over 200 weathercasters on a national e-mail listserve were polled informally at the outset to find out what topics were of most interest and what type of B-roll would best suit their needs. We also took into account the findings of Kris Wilson (University of Texas), who had surveyed TV weathercasters to determine their level of knowledge on global warming and related science. After each of several uplinks, a ratings service was employed for 30 days, reporting the station and viewership of any ClimateStock segment more than one second in length. More than 20 million viewers saw portions of at least one ClimateStock package. In addition, more than 100 Beta tapes have been ordered since fall 1998, many by documentary producers, a group not targeted by the ClimateStock plan. Some of the greatest visibility of ClimateStock products—particularly animations—has occurred in such documentaries as “What’s Up with the Weather?” (*NOVA/Frontline*, April 2000) and *Hot Planet* (The Weather Channel, October 2000).

Overall, the greatest interest from viewers and producers has been in dramatic weather and climate events, while pollution was one of the least popular topics. The use of B-roll and suggested scripts allowed us to emphasize key points and control important aspects of the scientific message, while granting weathercasters the flexibility to tailor and localize their stories as they saw fit. This model could easily be transferred to other large institutions carrying out research that is highly relevant to society yet difficult to translate.

Flying into the Future: Global Hawk Down Under



Sponsor

Defence Science & Technology
Organization

Contact

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Science Communications DSTO
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Canberra ACT 2600 Australia
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jimmy.hafesjee@cbr.defence.gov.au

Budget

AU\$40,000 plus staff time

Web Sites

Program: www.dsto.defence.gov.au
Poster: www.nist.gov/public_affairs/Posters/globalhawk.htm

In April 2001 the U.S.-developed Global Hawk high-altitude, long-endurance surveillance aircraft flew non-stop from California to South Australia, setting a Guinness World Record for the "longest flight ever by a full-scale unmanned aircraft."

Research had shown public concern that Australia may not have up-to-date defence technology for coastal surveillance against people smuggling, drug trafficking, and illegal fishing. Following an agreement between the U.S. authorities and the Defence Science & Technology Organization (DSTO) of the Australian Defence Department, Global Hawk arrived in Australia to test its surveillance

capabilities during defence trials from 24 April to 7 June. This was an opportunity to capture the public imagination, reinforce Australian-U.S. collaboration and promote public confidence in Defence by highlighting Australia's scientific contribution to a high-technology project.

To meet these goals a public awareness campaign was conducted by an international team of public affairs communicators representing the Australian Defence Department, U.S. Air Force, and aircraft builder Northrop Grumman. Displays, talks, a dedicated Web site, and targeted media activities were used to make the event an aviation landmark. The communications campaign included a crisis management plan to minimise negative coverage in case of a mishap.

The media was used to reach a much broader community audience not usually interested in Defence issues. Messages were also targeted at the Australian Defence Organisation and government decision-makers because Defence was likely to purchase such an aircraft if it tested favorably in Australian conditions.

The key messages highlighted Australia's technological enhancements to Global Hawk's capabilities—a DSTO-redesigned sensor suite for more efficient maritime surveillance and a DSTO-developed ground station for imagery analysis in near real time.

To provide an Australian angle, Global Hawk's trans-Pacific crossing was compared to the 1928 San Francisco-to-Sydney flight by Australian aviator Charles Kingsford-Smith and his American colleagues flying the three-engine Southern Cross. Global Hawk was re-badged Southern Cross II for its Australian deployment.

Media events were organized before the aircraft's departure, during its take-off from California, on its arrival in South

Australia, and at a subsequent VIP function. The involvement of the Defence Minister, his Parliamentary Secretary, Australia's Air Force Chief, U.S. Air Force personnel, and Northrop Grumman executives gave these events a high profile and credibility. A Global Hawk exhibit at the Australian International Air Show, a lecture during National Science Week, a commemorative postage stamp, and images of Australian landmarks taken by Global Hawk from 55,000 feet for regular release to the media helped to sustain public interest.

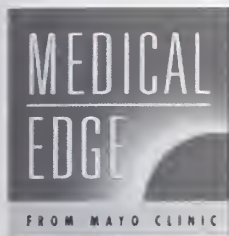
The Global Hawk coverage was the most extensive recorded by Defence for a comparable single event, generating 445 positive items in all Australian media, including 154 items in mainstream media.

International usage of the Web site was very high, including 70% from the United States. Between 9 April and 30 June 128,000 page views were recorded, significantly surpassing the international average monthly benchmark. Average user session was 10:05 minutes, i.e., one-third the usual surfing time.

The campaign's success can be attributed to effective teaming between the Australian and U.S. communicators, advance planning, coordinated implementation, an Australian theme, proactive, honest dealings with the media, responsiveness to media requirements, trained spokespersons, and an up-to-date, information-rich Web site packed with streaming audio and video.

The Australian government has decided to purchase a Global Hawk-type aircraft by 2007.

Medical Edge: Regular News Insert for Local Television



Sponsor

Mayo Clinic

Contact

Chris Gade
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Rochester, MN 55905
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cgade@mayo.edu

Budget

One-time start-up costs were \$150,000 (camera, editing bay, and animation work stations). Annual costs are approximately \$250,000 (consultative and talent producer fees; staff salaries; travel; promotion; videotape duplication; and market research).

Web Sites

Program: www.mayo.edu/edge/
Poster: www.nist.gov/public_affairs/Posters/medicaledge.htm

Medical Edge is a weekly, 90-second television medical news insert that is made available at no cost on a market-exclusive basis to local television news stations in the United States, Canada, and other international locations. The segments regularly air on 121 local television affiliates in the United States and Canada, along with stations in Turkey, the Middle East, and Croatia.

Communications goal

The communications objectives of *Medical Edge* include:

- Provide reliable information for the public on medicine and health.
- Increase awareness about Mayo Clinic in national and international locations, including news media coverage.
- Increase awareness of Mayo Clinic locations in Jacksonville, Fla., and Scottsdale, Ariz.
- Increase awareness of Mayo Clinic specialties, expertise, and research activities.
- Increase awareness among minority populations.
- Drive traffic to Mayo Clinic's health information Web site.

Target audience

The ultimate audience is women, age 25 and older, the primary health care decisionmaker in most U.S. households.

Research before launch

Before the product was launched, focus groups were conducted among a sampling of potential viewers that closely matched the potential audience.

Some specific findings included:

- Health reports hold strong interest for many local news viewers.
- Viewers' expectations for health/medical reports center on relevance and credibility.

Description of the program

Each segment includes a full package, nat sound version, animation and graphics, promos, b-roll and sound bites. Custom outcues for affiliates are made available on request. The reports are people-focused, reflecting a mix of medical breakthroughs and the latest in general health information.

How is the program carried out?

The primarily in-house production team includes an executive producer;

talent/producer; videographer/editor; illustrator; two animators; medical editor; and affiliate relations representative. In most cases, *Medical Edge* constitutes one-half or less of the individual's overall job responsibilities.

Lessons learned

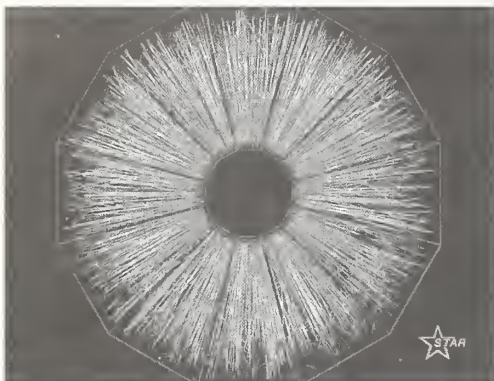
- Develop a product that carries credibility with journalists.
- Develop an in-house team, if at all possible, that is responsible for production and affiliate relations.
- Ensure that your production team meets with some frequency in order to stay on track with program objectives.
- Produce a product that includes high-quality video and animation.
- Include patients in the stories.
- Develop tools that make it easy for local television stations to respond to inquiries from viewers.

Program evaluation

A variety of measurements evaluate project success, including:

- Quarterly surveys of affiliate stations to track usage and feedback on the product.
- Track total number of viewers based on when the segments air during November 2000; January, June, and December 2001.
- Pre- and post-implementation awareness surveys in two markets.
- Page views on the Mayo Clinic health information Web site.
- For procedure-based stories, surveying patients to determine how they became aware of the procedure.
- Tracking time per segment contributed by physician subject experts to ensure that physicians' time with patients is not compromised.

Going for the Gold: The Collider Communications Program



Tracks of thousands of particles produced in one of the first collisions at Brookhaven Lab's Relativistic Heavy Ion Collider, as viewed by the STAR detector. This image has since been featured in countless newspaper stories, on posters, brochures, booklets, a calendar, and has even been recreated as an artwork of silk embroidery featured at an international exhibit.

Sponsor

U.S. Department of Energy's
Brookhaven National Laboratory

Contact

Karen McNulty Walsh
Senior Public Affairs Representative
Brookhaven National Laboratory
Media and Communications Office
Bldg. 134
PO Box 5000
Upton, NY 11973-5000
Phone: (631) 344-8350
or (631) 344-2345
kmcnulty@bnl.gov

Budget

Four full-time staff and \$30,000 for collateral materials

Web Sites

Program: www.bnl.gov/rhic/
Poster: www.nist.gov/public_affairs/Posters/collider.htm

The year 2000 was a major milestone for Brookhaven National Laboratory, where the Relativistic Heavy Ion Collider (RHIC) was expected to become operational and produce its first scientific results.

As with any complex, publicly funded scientific endeavor, keeping RHIC in the public eye in a positive way was and is essential to its success. After all, taxpayers foot the bill. They have a right to understand the project's goals, feel safe in its operation, and be in on the exciting atmosphere of discovery.

We wanted these messages to reach the science-attentive public; local community members; educators and school children; local, regional, and national elected officials; and Lab employees, who could help spread news and enthusiasm about RHIC.

But communicating about RHIC posed a few unique challenges. For starters, the science isn't an easy sell: RHIC's research goal—to create a state of matter that last existed billions of years ago—will offer insight into the evolution of matter and atomic-scale forces, but might never yield practical applications. Furthermore, the collider had been under construction for nearly a decade, with eight prior years of engineering studies and an ongoing struggle for funding. During construction, a radioactive leak from an unrelated Brookhaven facility stirred up local environmental fears, followed by replacement of the Laboratory management. Then, just as RHIC was about to go online, a news story ignited an international media frenzy focused on the possibility that RHIC might destroy the world, triggering a deluge of e-mails accusing scientists of playing God.

Fortunately, our multifaceted communications strategy helped us meet these challenges with success. We listened

to questions and fears to identify key issues and gauge the level of explanation needed. We selected and trained scientists to communicate RHIC's goals and used these "spokespeople" for media interviews, talks in schools and at community meetings, and as guides for tours of RHIC.

We also prepared news releases, Web pages, photos, fact sheets, brochures, and video to reach our various audiences directly and via the news media. We especially targeted reporters focused on science, and even pitched to reporters from scientists' hometowns to encourage coverage of the RHIC story nationally and from a "local" angle around the country and world.

Commemorative T-shirts, pins, and postcards also helped spread enthusiasm beyond our gates.

We learned to adjust the science content to match the audience—and helped the scientists do the same. We also learned to manage the competing interests of scientists from RHIC's four detector collaborations, and strengthened our relationships with top-level science reporters.

These efforts paid off with more than 200 print, Web, and TV news stories in the year 2000 alone, attendance by some top-level science writers at the Quark Matter 2001 conference, and a new sense of good will with our neighbors. We even turned interest in speculative disaster scenarios into additional opportunities to tell the physics story.

Of course, the most exciting part of RHIC's story is just beginning. We look forward to sharing more milestones as the science unfolds.

Research to Prevent Blindness Biennial Science Writers Seminar in Eye Research



Sponsor

Research to Prevent Blindness

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Budget

Approximately \$185,000.
During 4-day Seminar: 5 staff; 2 for 8-10 hours a day; 3 for 10-16 hours a day.

Also Program Director and Seminar Moderator.

During Seminar year: Director of Public Information and assistant fulfill regular departmental responsibilities and integrate full slate of Seminar activities into the work flow. Two other staffers devote time as well. One negotiates hotel arrangements and is involved in planning; another coordinates hotel booking. A Program Director is retained.

Web Sites

Program: www.rpbusa.org
Poster: www.nist.gov/public_affairs/Posters/preventblindness.htm

The Research to Prevent Blindness (RPB) Science Writers Seminar acquaints science, health, and medical writers with advances in basic and clinical eye research. We seek to increase support for eye research by informing the public about threats to vision and about scientific progress in combating blindness. The

target audience includes the public, 17,000 eye doctors, and 2,200 vision scientists. We reach all three groups through the press. We reach the latter two directly by sending them a book of complete seminar proceedings.

How did we determine the best ways to reach the target audiences? We rely on past experience and whatever flexibility and ingenuity we can muster on a limited budget. It helps to start with a bucket of elbow grease and to season it with humor.

Our approach has yielded international coverage in print, broadcast, and electronic media.

To earn that, you must build a good program and attract writers to cover it.

To create the program, recruit a Program Director who knows science and who knows news. The RPB program includes 30 presentations by leading vision scientists over four days. Topics include all major and various other eye diseases.

At the conclusion of one seminar, scouting begins for the next. We monitor journals, trade press, and general media reports. We seek nominations for speakers from past presenters, departments of ophthalmology, the National Eye Institute, and associations of vision scientists. As many as 300 nominees are considered for 30 spots on the program. The Program Director interviews finalists. Many are pleased that we distribute the seminar monograph to their peers.

We hold the seminar only when we find enough news to justify asking a writer to spend four days to absorb it. Each day's slate includes a story with a news edge sufficient for reporters who file daily. We open the seminar to press, presenters, and selected guests only. We provide reporters ample access to scientists.

The moderator adheres to a strict timetable. Scientists present 7- to 10-

minute talks followed by 15-minute "Question and Answer" sessions. To avoid delays, further Q & A and interviews spillover to the press room. To achieve that delightful scenario, you need plenty of reporters.

To publicize the meeting, we affix "Mark-Your Calendar" notes to selected communiques within a year of the seminar. We post the meeting on EurekAlert!, in the NASW newsletter and on our Web site. Four months prior to the meeting, we launch a series of four increasingly detailed press alerts.

We prune and build our media lists continually. We monitor news and write to reporters interested in the eye. We offer a limited number of Traveling Fellowships to help writers who would otherwise lack the means to attend. With the Seminar imminent, we increase contact with wire services and local press.

Year round, we stay in touch via press releases, newsletters and research reports; attend meetings of writers (NASW, CASW) and of scientists (AAAS, vision researchers); strive always to be available for the press whether or not a story is likely to mention RPB; and provide reliable information and references to experts.

We try to be good hosts. As one reporter from the West said, "You put on a good feed!"

We seek to earn and to maintain the interest of a core group of reporters. We build an extensive press kit that contains the text of all presentations, updated statistics, eye dictionaries, and other materials. Weighing in at 4 pounds, the kit has proven ideal for aerobics workouts between sessions to work off the good feed!

EurekaAlert! News Site



Sponsor

American Association for the Advancement of Science

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Budget

Approximately \$600,000

Web Sites

Program: www.eurekaalert.org
Poster: www.nist.gov/public_affairs/Posters/eurekaalert.htm

EurekaAlert! is a public service project of the American Association for the Advancement of Science (AAAS). The site was established in 1996 as a vehicle through which organizations could bring word of their scientific achievements through reporters to the public.

By targeting journalists and public information officers (PIOs) at universities, medical centers, associations, and other research organizations, EurekaAlert! has attracted a large and diverse audience. More than 400 organizations distribute news through EurekaAlert!, and more than 4,000 journalists from over 45 countries use EurekaAlert! as a source of story ideas. Thousands of researchers, students, educators, and others interested in science also visit the site regularly.

EurekaAlert! is divided into three main sections: one for reporters, PIOs, and the public. The reporter-only section is designed to provide journalists with all of the information they need to publish or broadcast breaking science news stories, including embargoed news releases, press packets for scientific journals, and a searchable database of experts. By providing qualified journalists with access to embargoed news, or news that has not yet been released to the public, EurekaAlert! helps them research and write timely, well-informed stories for release at the moment an embargo lifts.

The PIO-only section provides qualified users with an online interface through which they can submit press releases, experts, and other items; monitor the traffic their news items receive; and keep up to date with scientific news from other organizations. In order to distribute news through EurekaAlert!, a PIO must belong to an organization that has purchased a EurekaAlert! subscription.

The public section of the site highlights the wealth of news available on EurekaAlert! Elements include a searchable archive of more than 25,000 press releases, a Breaking News section featuring recently released news items, and a News by Subject section, which breaks down news by topic.

EurekaAlert! began as a very small operation, with technical support and hosting services provided by Stanford University and a few staff working at AAAS. Technological and staff needs have increased over time. Current day-to-day operations require technical support, both from an in-house technical specialist and a private Web hosting company, a three-person editorial team, a marketing specialist, and a program associate. A director manages the project and guides EurekaAlert! policy with the help of an advisory panel.

Creating a product that is secure, reliable, international in scope, rich in content, and editorially consistent has been a challenging task. Despite the obstacles, the numbers show that EurekaAlert! has come to be a widely used resource among the scientific community. During a typical month, the site receives nearly 3 million hits. Other evaluation methods, such as online surveys, show a heavy degree of reliance among users. In the most recent survey, nearly 90 percent of journalists surveyed reported visiting EurekaAlert! at least once a month for story ideas, and more than half said that they publish or broadcast items based on information found on EurekaAlert! several times each week.

The Internet and Stakeholder Outreach: The Transportation Resource Exchange Center



Sponsors

U.S. Department of Energy National Transportation Program
ATR Institute at the University of New Mexico

Contact

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Budget

\$2.5 million over five years to develop, maintain, and continually improve the Web site

Web Sites

Program: www.trex-center.org
Poster: www.nist.gov/public_affairs/Posters/trex.htm

The Transportation Resource Exchange Center (T-REX) at www.trex-center.org is the first Virtual Library dedicated to providing information about the transportation of radioactive materials (RAM) to stakeholders. The U.S. Department of Energy (DOE) National Transportation Program (NTP), which coordinates transportation activities for all DOE non-classified shipments of radioactive and mixed wastes and provides information about these shipments to stakeholders, recognized the need for greater outreach and responded. In June 1998, through a cooperative agreement,

the DOE NTP authorized the ATR Institute (ATRI), at the University of New Mexico, to develop and maintain a Virtual Library that would serve as a "one-stop-shop" source of information about RAM transport for non-DOE and DOE stakeholders.

The ATRI identified five primary goals for the T-REX:

- supply pertinent information to diverse audiences,
- build relationships that promote user assistance in developing and maintaining the T-REX,
- develop training for utilizing the T-REX,
- improve the management and dissemination of needed information, and
- provide reference and research services without charge.

The ATRI created the T-REX to serve as a national clearinghouse for information. The overarching goal for the Center is to become the permanent repository and principal distributor of documents and information on the transport of RAM. Positioned as a public interface for public outreach, the T-REX is a vital conduit linking those stakeholders who are in need of information and those who produce the public information.

Three formative research tools were developed by the T-REX Center. "The T-REX User Needs Assessment" and "The National Transportation Information Resource Survey," were completed *before* the T-REX Web site was created. "The Content Analyses of U.S. Department of Energy Environmental Impact Statements (EISs) Comments and Questions," was begun shortly after the

Web site was launched. These tools were developed to identify the gaps between potential users' questions and the information that was available regarding stakeholder issues. In the most basic sense, the results produced by the research tools informed the T-REX designers of what information related to radioactive material transport is available and which information is the most highly prized by the users. Information specialists at the T-REX Center have worked collaboratively with the Virtual Library's database developers throughout the life of the Web site.

The T-REX Center also created an internal questionnaire for evaluative research to ensure that diverse multiple users can easily find the information they need. Because patrons of T-REX Center vary greatly in knowledge and expertise, the T-REX Center offers information reference and referral services to assist stakeholders in finding for themselves or obtaining for themselves the information they need, without charge. The subject categories include: Carriers, Education/Training, Emergency Management, Health, International, Laws/Regulations, Packaging, Public Participation, Routes, States, Students/Teachers, and Tribal. The Center has online searchable databases for documents and contacts, and an annotated bibliography series.

The T-REX Program Manager, Nancy Bennett, has an education background in art, art history, and library science. Mary E. White has an undergraduate background in public relations and advertising. Her master's thesis is studying the Internet as a communication tool.

Health Behavior News Service & HABIT



CENTER FOR THE
ADVANCEMENT OF HEALTH

Sponsor

Center for the Advancement
of Health

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Budget

Approximately \$500,000/pa

Web Sites:

Program: www.cfah.org/
Poster: [www.nist.gov/public_affairs/](http://www.nist.gov/public_affairs/Posters/healthbehavior.htm)
Posters/healthbehavior.htm

The Health Behavior News Service (HBNS) of the Center for the Advancement of Health informs the public of the latest research about the impact of psychological, sociological, behavioral, economic, and environmental factors on health. The mission is to make the Center the "go-to" organization for journalists and the public interested in the unique niche we have carved out—translating health research into effective policy and practice.

The Center provides clear, concise analysis of research findings across academic and professional disciplines by disseminating embargoed news releases to about 1,300 media contacts on behalf of 22 social science journals. Distribution is

by e-mail and fax to individual reporters and to a general journalism audience through EurekaAlert! and Ascribe. Non-deadline writers receive a packet of the month's news releases by postal delivery.

In 2000, HBNS issued 189 press releases, received 509 placements from those releases, received 71 mentions of the Center itself, and placed op-eds or letters to the editor 21 times. It also handled more than 200 requests from reporters. From the *Abilene Reporter* to the *Wall Street Journal*, from *wired.com* to *Good Housekeeping*, the Center has become a credible source of information for the notion that when it comes to health and illness "behavior matters."

The Center also publishes *Facts of Life* 8 to 10 times a year, providing background information, fact sheets, interviews, and sidebars on recent research findings on specific topics. In addition, the Health Behavior News Service refers news inquiries from ProfNet, from individual calls, and from our own Web site to a network of the nation's leading behavioral scientists.

The Center also has been successful in uniting more than 4,000 health care researchers from around the world by means of the *Health and Behavior Information Transfer* (HABIT), an electronic newsletter published every three weeks. HABIT reports on federal research policy and funding opportunities across disciplinary boundaries. It builds bridges among disciplines that otherwise do not communicate with one another. The Center serves HABIT's diverse audience as an impartial, responsive advocate while challenging science's narrow focus.

A fourth element of the Health Behavior News Service is *Good Behavior*, a monthly newsletter for 2,200 stakeholders and friends of the Center. The double-sided one-pager, in addition to announcing Center initiatives and news, is known for pungent essays and pithy "disconnects" about research findings that don't get put into day-to-day medical practice.

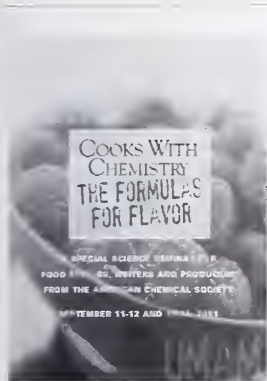
The news releases and *Facts of Life* are handled by a single science writer (with freelance support) and an in-house assistant, both under the supervision of the public affairs director, who edits *Good Behavior*. HABIT is edited by a program associate. A second science writer may be added.

Evaluation is difficult because most of the media's attribution is to the journals and individuals that we promote and not the HBNS. A lesson learned is the need to blow our own horn by branding each release with our name as a byline and using the initials and full name in every e-mail proffer of experts or background. We count clips through a limited subscription to Nexis and a full subscription to Luce. In another year's time, we expect to choose one or the other.

HBNS is adaptable by other small organizations armed with:

- a targeted press list,
- quick access to their field's experts,
- understanding of news media needs for timeliness and clarity, and
- a reputation for disseminating only the highest quality research.

Cooks with Chemistry: The Elements of Chocolate (2000) and the Formulas for Flavor (2001)



Sponsor

American Chemical Society

Contact

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Budget

Per workshop, \$38,000 to \$40,000, including invitation design, printing, and mailing; facility rental, all meals, and accommodations for two days; speaker honoraria and travel; video archiving; and staff time.

Web Sites:

Poster: www.nist.gov/public_affairs/Posters/cooks.htm

The American Chemical Society, the world's largest scientific society, has sponsored two workshops, collectively called the Cooks with Chemistry series, to introduce food journalists and writers to our rich array of resources on food chemistry.

The Office of Communications recognized that an increasing number of food writers were covering food chemistry research emanating from ACS journals and meetings—so much so that, by the end of 2000, ACS-generated news

about food chemistry reached a greater potential audience through media coverage than any other single subject category, more than 80 million people. Research on topics such as chocolate, flavor chemistry, wine and beer, and antioxidants were especially popular.

The ACS Office of Communications, with input from a group of prominent food scientists, journalists, and authors, evaluated these findings and decided to hold a workshop that would offer food writers a new perspective on the science of food. The resulting seminars—the Elements of Chocolate (2000) and the Formulas for Flavor (2001)—were designed to provide journalists with background information on topics that would appeal to their audiences and introduce the American Chemical Society as an objective, authoritative resource.

We invited prominent experts to present sessions on topics ranging from the history of chocolate to its health benefits. We prepared comprehensive lists that included print, radio, and television media and created an attractive invitation that appealed to reporters' visual and olfactory senses. Reporters eagerly registered, later citing the quality of the presenters and the original, innovative program as some of the main reasons they were interested in attending.

The workshop was held at Belmont Conference Center, the Society's world-class facility conveniently located just minutes from Baltimore-Washington International Airport. The center, with its outstanding culinary and meeting services, offered attendees an intimate, relaxed atmosphere. To accommodate the busiest of schedules, the workshop started in the evening and ended in the early afternoon on the following day. Reporters had access to top experts, participated in

hands-on activities and tastings, and were sent home with materials—such as recipes and other background information—that they could use to develop future stories.

We measured the program's effectiveness in several ways. Speakers enthusiastically accepted our invitation to participate and were generous with their time and resources. Reporters from some of the nation's highest circulation newspapers and magazines attended the Elements of Chocolate seminar, including *Prevention* and *Good Housekeeping* magazines and daily newspapers such as the *Portland Oregonian* and the *Albany Times-Union*. Coverage inspired by or about the workshop has reached a potential audience of more than 3 million readers. Although the Formulas for Flavor workshop was disrupted by the events of September 11, we had enough interest to fill two workshops, which boasted registrants from prestigious media outlets such as *Cooking Light* magazine and the *New York Times*.

Among our lessons learned: Food writers, generally lacking experience in science coverage, need more interpretive materials and respond well to experts who can bridge the food and science worlds. An orientation to basic terminology and concepts of food chemistry was added to the start of the flavor workshop and proved to be useful in defining terms that would be used throughout the session, allowing more in-depth questioning. Finally, interest level in providing scientific information with accuracy is high in this journalistic area, suggesting promise for more outreach to food writers.

Building a National Newswire for Scientific, Educational, and Nonprofit Institutions

AScribe

The Public Interest Newswire

Sponsor

AScribe - The Public Interest Newswire

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Budget

\$1.5 million

Web Sites:

Poster: www.nist.gov/public_affairs/Posters/ascribe.htm

The University of California (UC) system faced increased difficulty in the mid-1990s getting its news into major daily newspapers. One problem: Papers had gone digital but the university was still distributing news by mail and fax. In addition, the media landscape was becoming more complex. UC knew it also needed to distribute its news widely on the Internet and through the principal research database services.

A small group investigating this situation at Berkeley determined that higher education and scientific institutions needed nothing less than their own dedicated wire service. This service would deliver releases directly to the computers of major news organizations. And, the wire also would handle the technical and legal arrangements to get news into the myriad Internet channels and major research databases.

No one institution acting alone could create such a service, but many institutions actively collectively could support a new national wire.

The group that designed the AScribe service included journalists, public affairs professionals, newspaper publishers, and computer systems specialists.

Key goals were to develop a system that would allow public information specialists to: 1) cut through the incredible volume of news delivered daily to news organizations; 2) respond to around-the-clock news cycles; 3) explore new opportunities for coverage; 4) enhance credibility by sending releases across a trusted wire in the company of other credible information; 5) take advantage of distribution technology that has worked well for corporate news; and 6) extend the shelf life of news through inclusion in electronic databases. The service also had to be easy to use and affordable.

The wire was launched by four people working full-time using personal funds and outside investment by individuals involved in the media and higher education. It was created with the assistance of the *San Jose Mercury News* and The Associated Press.

Initially, the wire operated only within California, connecting the UC system and other universities to the state's major daily papers. After functioning for a year within the state, AScribe began to offer service to research institutions and media outlets across the country. The wire now moves news on behalf of 500 organizations and agencies and reaches top media organizations across the country.

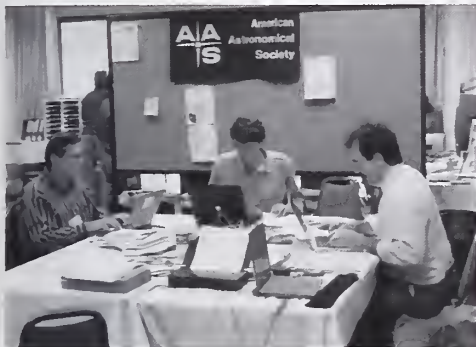
AScribe cannot evaluate performance of the wire in accomplishing the diverse goals of over 500 separate organizations. Therefore, AScribe relies upon several indirect measures to determine the service's effectiveness.

Key measures include: 1) anecdotal reports—users often report that they receive additional media contacts and broader coverage; 2) renewal rate—organizations renew their annual contracts with AScribe at rates above 95 percent; 3) usage rate—the average daily and annual usage of the newswire has risen steadily since inception; and 4) news outlet adoption rate—additional newspapers and publications continue to request AScribe's newsfeed for news-gathering purposes following their review.

AScribe Newswire has become an important tool that public-interest organizations rely on to effectively deliver news to both traditional and new media channels. AScribe provides a vehicle for collaboration and collective action that demonstrates its value to the organizations that send news via the wire every day.

American Astronomical Society

Press Services



Internet hub in press room at on AAS meeting. Reporters filing stories are Charles Petit (left, *U.S. News and World Report*) and Bos den Hond (center, *Trouw* newspaper, Amsterdam). A PIO from the Smithsonian Astrophysical Observatory, David Aguilar, works at right. Two unattended laptops hold positions for other journalists. AAS photo by Richard Dreiser, (c) 2001 American Astronomical Society.

Sponsor

American Astronomical Society

Authors

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Budget

\$17,654 in 2000

Web Sites:

Poster: www.nist.gov/public_affairs/Posters/astronomical.htm

Since 1985, the American Astronomical Society has systematically increased services to the media to foster greater coverage of astronomical research. We have upgraded press activities at our meetings and initiated an electronic press release distribution service for cooperating observatories, universities, and other organizations. We developed written guidance on how to write press releases and how to present press conferences for scientists participating in our meetings, and offer counsel to institutional PIOs on embargo and "story-marketing" issues. We operate a referral service to put inquiring journalists in immediate touch with specialist experts. During this period, press attendance at our meetings has increased from a handful of reporters to as many as 204 registered journalists and PIOs. An Internet hub in our press room facilitates efficient filing of stories. Coverage of findings reported at the meetings has been sufficiently extensive that on occasion newspaper editorials and journalist trade-paper stories have been devoted to the coverage itself. Our press activities are entirely separate from the Society's programs in education.

Our electronic press release distribution service is for journalists and is not offered to the public or to our fellow scientists. We are serving the media, not competing with them. As of February 7, 2002, there were 1,163 persons in the news media and 216 PIOs on this distribution. PIOs are sent releases separately, as some material cannot be sent to them in advance of the respective embargo times.

We find that the most effective way to obtain coverage of our field in all media is to direct our planning toward

best satisfying one media component: daily newspapers and wire services. Wide coverage in magazines, broadcast media, and other outlets, we learned, is reliably attained when there is heavy coverage in the dailies.

Some specific aspects of our program are: (1) press officers are working scientists with undergraduate teaching experience; (2) we feature stories we think reporters will want to cover, not stories that scientists think are deserving of coverage; (3) we select the roughly 10 press conference topics and 60 other press release topics per meeting according to perceived newsworthiness, not presumed scientific significance; (4) there is no preference for invited speakers, prize lecturers, etc., in press activities.

Several Divisions of our Society also have press officers. The embargo policies, briefing formats, etc. of their meetings differ from procedures at national Society meetings. Divisional policies reflect perceived ease or difficulty in attracting journalists. Reporters at the well-attended national meetings receive releases not sent to absentee journalists and national meeting press conferences are not available by telephone, webcast, etc., to absentees. In contrast, at Divisional meetings where low press attendance is expected, briefings may be by conference call, with illustrations posted on protected Web sites, and embargoed press releases may be distributed widely beforehand. Two Divisions have also initiated science journalism awards to foster excellence in reporting on their disciplines.

Science Communications Curriculum: Communications Tools and Best Practices

Sponsor

Environment Canada

Authors

Alex T. Bielak, with Geoff Howell, Jon Stone, Philip Enros, and Paul Hempel

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Budget

For communications training pilot course: Environment Canada (EC) invested \$50,000 (Canadian) plus costs of participants travel. An organizing committee spent a substantial part of their time, over and above their normal duties, organizing the course and producing a final report. Total amount included translation costs (English to French) and report production. Cost per participant of subsequent risk communications training course—delivered by external contractors—is about \$1,200 (Canadian) per participant.

Web Sites

Program: www.ec.gc.ca
Poster: www.nist.gov/public_affairs/

Canadians have a strong interest in science and technology, and there is an increasing interest in science topics associated with nature and the environment. Interpreting and communicating scientific information is vital to EC's mandate. In the context of a rather open communications policy in EC, the Department needed to foster communications skills for scientists and also develop better links between communicating scientists and departmental communications staff. With input from both the science

community and communications specialists, EC has emerged as a leader in the science communications field.

An external Advisory Board has focused on science communications as a priority area for advice to the Department. They developed a Science Communications Framework and concluded there was a "need to make popular communications a high priority." Among their recommendations was that EC should act on lessons learned from the communications pilot project described below.

A Communications Curriculum and Toolkit:

According to public opinion polling, scientists are EC's most trusted spokespeople. In December 1998 we developed a ground-breaking pilot training course for a dozen up-and-coming scientists with an interest and aptitude for communications. Communications personnel from across EC were also fully involved to build linkages between the two constituencies.

The course included media training, mentorship by EC Communications "Masters," and a media panel. An intensive evaluation of the course allowed us to build a "road map" for future training sessions, including various logistic considerations. A proposed three-day curriculum was developed based on Core sessions (the Communications Environment, Science and Communications, Science and Media/Panel Discussion, Science and the Written Media, Media Relations Training) complemented by suggested Auxiliary Presentations.

Our approach—which included development of an extensive toolkit for future use—provided a baseline for applying the lessons learned in other science-based institutions with a goal of fostering collaborative communications

of science. Building on concepts developed by EC, further pilot courses in "Risk communication media training"—intended as a basis for a co-ordinated training program—were developed co-operatively by a group of federal science departments in early 2001. Furthermore, EC-Atlantic staff have been active in helping develop training courses involving students in the fields of journalism, public relations, and science.

Other Best Practices:

A number of other "best practices" across EC are emerging. EC's National Water Research Institute requires scientists to provide a public summary with all scientific manuscripts. EC-Atlantic staff have developed a variety of targeted multi-media products to better disseminate science results, including innovative methods for making presentations to aboriginal groups (see "The Ashkui Project" poster).

At the national level, EC's communication teams have developed four diverse products to bring science and technology to Canadians. They are targeted, using different media, to both general and specialized audiences, and include the news media as a message multiplier. (Each product is available on our *Green Lane*—Environment Canada's link to the World Wide Web (www.ec.gc.ca). The materials produced nationally are tracked as to the media pickup resulting from each of them.

Also, in collaboration with other federal natural resource departments, EC has taken a leadership role in a partnership with the (Canadian) Discovery Channel to produce *Earthtones*, a series of vignettes showcasing science activities. These can be accessed at www.durable.gc.ca/radio-video/video/index_e.phtml).

Appendix A

Conference Program

Wednesday, March 6

- 5:15 p.m. Bus service from Gaithersburg Holiday Inn to NIST
- 5:30 p.m. Poster setup begins
NIST Administration Bldg. (101) Hall of Flags
- 6 p.m. Welcoming Reception for all conference attendees
Hosted at the *NIST in Your Community* interactive public exhibit
Administration Bldg. lobby
- 8 p.m. Bus service to Gaithersburg Holiday Inn
Dinner on your own

Thursday, March 7

- 7:45 a.m. Bus service from Gaithersburg Holiday Inn to NIST
- 8-9 a.m. Registration/Continental Breakfast
- 9 a.m. Welcome from NIST/DOE
William Ott, Deputy Director, NIST Physics Laboratory
William Valdez, Director, Office of Planning and Analysis, Office of Science, U.S. Department of Energy
- 9:20 a.m. Introduction—Conference Co-chair
Earle Holland, Ohio State University
- 9:30 a.m. Keynote Address: Sense, Nonsense, and Science
Joseph Schwarcz, Professor of Chemistry and Director of the Office of Chemistry and Society, McGill University
- 10:30 a.m. Break/Refreshments
- 10:45 a.m. Putting Communications Research and Evaluation into Practice
Susanna Hornig Priest, Associate Professor, Texas A&M University Department of Journalism
James Grunig, Professor, University of Maryland Department of Communication
- 12 noon Panel Discussion: Case Studies in Successful Evaluation of Communications Programs
Jon Miller (moderator), Director, Center for Biomedical Communications, Northwestern University Medical School
- Kathy Geiger, Brookhaven National Laboratory, "Restoring Public Trust: Community Affairs Evaluation"
 - Chris Gade, Mayo Clinic, "Medical Edge: Distributing Health News Through Local Television"
 - Cindy Ferch, Orange County Water District, "Groundwater Replenishment Community Outreach Project"
 - Terry Devitt, University of Wisconsin, Madison, "The Why Files"
- 1 p.m. Lunch
- 2:30 p.m. Topical Lecture—The Future of Broadcast Journalism
Peggy Girshman, Assistant Managing Editor, National Public Radio News
- 3 p.m. Poster Session
- 4:30 p.m. Adjourn
Bus service to Gaithersburg Holiday Inn
- 6:30 p.m. Reception at Gaithersburg Holiday Inn

- 7:30 p.m. Dinner at Holiday Inn—"Live from the Field: Observing Science in Its Natural Habitat"
Hannah Holmes, freelance writer; reporter and columnist, Discovery Online; and author, *The Secret Life of Dust: From the Cosmos to the Kitchen Counter, the Big Consequences of Little Things*

Friday, March 8

- 7:45 a.m. Bus service from Gaithersburg Holiday Inn to NIST
- 8-9 a.m. Late Registration/Continental Breakfast
- 9 a.m. Introduction—Conference Co-chair
Earle Holland, Ohio State University
- 9:10 a.m. Research Roadmap for Communicating Science and Technology in the 21st Century
Rick Borchelt, Director, Communications and Public Affairs, Whitehead Institute
- 9:45 a.m. Topical Lecture: How Science Books Drive Public Discussion
Bruce Lewenstein, Associate Professor of Science Communication, Cornell University
- 10:15 a.m. Break/Refreshments
- 10:30 a.m. Graphic Science: New Venues for Science Communication
Frank Burnet, Faculty of Applied Science, University of the West of England
- 11:15 a.m. Panel Discussion: Broadening the Audience for Science and Technology
Frank Burnet, University of the West of England (moderator)
- Yolanda S. George, American Association for the Advancement of Science, "Science Linkages in the Community"
 - Jan Tyler, U.S. Department of Energy Thomas Jefferson National Accelerator Facility, "BEAMS: Becoming Enthusiastic about Math and Science"
 - Sylvia Ortiz, New Mexico State University, "Information at the Border: BIEN Health Network"
 - Alex Bielak, Environment Canada, "The Ashkui Project: Knowledge, Culture, and Landscape"
- 12:30 p.m. Lunch
- 2:00 p.m. Keynote Address: Sex, Lies, and Science Television
Paula Apsell, Executive Producer, NOVA, WGBH Public Television
- 3:00 p.m. Poster Session
- 4:30 p.m. Audience Discussion: Next Steps (open microphone)
- 5:30 p.m. Adjourn
Bus service to Gaithersburg Holiday Inn

Appendix B

Communicating the Future

Best Practices for Communication of Science and Technology to the Public

Call for Papers

Communicating science and technology to the public has become an essential enterprise for research universities, national laboratories, science museums, foundations and granting agencies, other nonprofit scientific organizations and corporations. To advance the state of the art, a national conference on Best Practices for Public Communication of Science and Technology to the Public will be held Sept. 23-25 in the Washington, D.C., area.

Co-chaired by Joann Rodgers of the Johns Hopkins Medical Institutions and Earle Holland of Ohio State University, the conference aims to assemble a comprehensive set of "best practices" in communicating science and technology through an open call for papers. Entries will be judged by a panel of reviewers comprising distinguished science writers, educators, and researchers. Judging criteria will include the suitability of an entry to be adapted for use by a variety of research and education institutions. Individuals whose papers are selected will be expected to present their "best practices" at the September 2001 [later postponed till March 2002] conference and will receive a travel stipend and complimentary conference registration.

During the conference, distinguished communicators will lead discussions on fundamental issues and challenges for science communicators, and selected participants will be asked to develop and interpret poster presentations describing their entries. The best-practice poster presentations also will be archived electronically for wider distribution following the conference.

The conference is held under the auspices of the Department of Energy's Office of Science, and is co-sponsored by the National Institute of Standards and Technology. The meeting will be held at the NIST campus in the Washington, D.C., suburb of Gaithersburg, Md.

General Criteria

Best practice entries will describe programs implemented by research and education institutions designed to communicate scientific and/or technological advances and/or research in general to a variety of lay audiences. Individual communications vehicles or products such as news releases or videos will not be accepted. Rather, the reviewers will evaluate entries that describe programs for communicating science and technology, and for fostering strong public outreach. Processes and methods must be included, and entrants are encouraged to provide details of their program's "toolkits," such as print materials, interactive/electronic media, videos, animation and graphics, radio, slide shows, exhibits, events, and so on.

Best practice entries may describe the following:

- targeted direct-to-public campaigns,
- programs for general and special media,
- museum-style exhibits,
- innovative use and training of scientists or other technical spokespersons,
- campaigns to inform political debate or change health behaviors,
- programs to reach non-traditional or special audiences,
- entertainment projects,
- innovative use of advertising and other paid media,
- public relations and earned-media projects, and
- news-based endeavors.

Entries should include best practices that are adaptable with minimal modification by other research institutions and science-based organizations and enterprises; should strategically target one or more audiences; should include measures of effectiveness through evaluation and review; should clearly involve scientists/technical experts in the program; and should illuminate both the product and process of scientific research.

Categories

Entries will be accepted from all areas of science and technology, including but not limited to biomedical science, environmental science, social sciences, biotechnology, and physical sciences. All entries must include substantive scientific content.

Entries may include public information and earned (free) media programs, paid media (advertising, infomercials) and/or special projects as components.

Lastly, entries should fit into one or more of the following six categories:

1. Direct to Consumer Programs
2. Scientist-based Programs
3. Programs for General Media
4. Programs for Specialized Media
5. Programs for Legislators and Opinion Leaders
6. Programs intended for Children (outside of classroom instruction)

Eligibility

Entries will be considered from research-sponsoring institutions such as universities, government agencies, corporations, or non-profit organizations, from public education institutions such as museums or non-profit web-based enterprises, or from third parties engaged by these entities in their communications efforts. International entries are welcome.

Submissions

Deadline for submitting entries is 16 July 2001. For instructions and an entry form see the conference web site at <http://www.nist.gov/bestpractices>. For additional information contact: Rick Borchelt at DOE (rick.borchelt@science.doe.gov) or Gail Porter at NIST (gail.porter@nist.gov)

Registration

The registration fee of \$100 will cover conference materials, coffee breaks, lunches, a reception, and a dinner. Further agenda and registration information will be forwarded in July.

Electronic registration will be available at: https://sales.nist.gov/conf/secure/CONF372/conf_register.htm

A block of rooms has been reserved at the Gaithersburg Holiday Inn, (301) 948-8900, at a special rate of \$95 single or double, plus 12 % tax. Reservations must be received by 7 Sept. 2001.

Program Information

Rick Borchelt
DOE, Office of Science, SC-5
1000 Independence Ave., S.W.
Washington, D.C. 20585
Phone: (202) 586-6702 FAX: (202) 586-7719
email: rborchelt@nasw.org

Registration Information

You may also mail your information to:
Kimberly Snouffer
NIST
100 Bureau Dr., Stop 3461
Gaithersburg, MD 20899-3461
Phone: (301) 975-2776 FAX: (301) 948-2067
email: kimberly.snouffer@nist.gov

Entry Form

[A-Z subject index](#)[Search NIST webspace](#)[Contact NIST](#)[Home](#)

Communicating the Future: Best Practices in Communicating Science and Technology to the Public, March 6-8, 2002

[Download Adobe Acrobat/EXE](#)

Submission deadline extended to July 16, 2001

You can electronically submit the form below or download a [PDF file](#), and fax or mail this form to:

Rick Borchelt
Director of Communication
Office of Science, SC-5
U.S. Department of Energy
1000 Independence Ave., S.W.
Washington, D.C. 20585
Fax: (202) 586-7719

Please mail any supplementary materials to the above address and include the project coordinator's name and phone number.

All submissions and any supplementary materials must be postmarked by July 16, 2001.

Project coordinators selected to present their "best practice" at the conference will receive a \$750 travel/lodging stipend, free conference registration (\$100 value) and publication of their paper in the conference proceedings and on the Best Practices website. All submitters will be notified by email if their paper has been selected or not by August 1, 2001.

Title of project, campaign, or ongoing communication program	
Name and contact information of coordinator or organizer	
First Name	Last Name
Address	
City	
State/Country	Zip Code
Phone	
Fax	
E-mail	
Duration of the project, campaign, or program	

Cost (include an annual cost if on-going)

Audience targeted

Entries should fit into one or more of the following six categories (Click and hold the Ctrl key for multiple selections.)

Direct to Consumer Programs
Scientist-based Programs
Programs for General Media
Programs for Specialized Media
Programs for Legislators and Opinion Leaders
Programs intended for Children (outside of classroom instruction)

Name of organization(s) that sponsored this communications project, campaign, or program

Type of organization(s) (check all that apply) Click and hold the Ctrl key for multiple selections

University/college
Government agency
Corporation
Web-based enterprise
Museum
Other non-profit organization
Other

Please provide a narrative description of the project, campaign, or ongoing program (500 words or fewer). Your description should answer all the usual journalistic questions – who, what, when, where, and why – as well as highlight those elements of the project, campaign, or program that you believe are easily adaptable to other organizations. The communications effort described must include substantive science or technology content.

Supplementary materials

Additional material such as news releases, videos, newsletters, web site addresses, photographs, summary reports or other items associated with the project, campaign, or program may be attached or sent separately to accompany the submission. (Please be reasonable. If it won't fit in a medium-sized Fed Ex box it's probably more than we need.) Entries, including supplementary materials, will not be returned.

Was there a systematic effort to collect information about audiences or communications media (formative research) prior to the start of the project, campaign or program? If so, please describe this effort.

Was there a systematic effort to evaluate the effectiveness of the project, campaign, or program (evaluative research)? If so, please describe this effort.

Please Wait a few moments for your Confirmation

Submit

Reset Form

The information you provide in this entry form will be used by the Best Practices steering committee to choose 50 presenters for the Best Practices in Communicating Science and Technology to the Public conference on September 23-25, 2001. Entries selected for the conference will be published in the Best Practices conference proceedings and on the conference web site. Information from all entries, both selected and not selected, may be used by the steering committee in preparing a summary of the conference.

Addresses, phone numbers, faxes, and email addresses will not be shared with any other organizations. This information will only be used to send a tentative program for the conference and to allow the committee to contact you with questions. We will keep your information on file so that we can notify you if any subsequent conferences on this topic are held. We will remove your information from our files if you no longer wish to receive these materials. For additional information, see the [NIST Privacy Statement/Security Notice](#).

