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Taking Science to the People

Carolyn Johnsen

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Taking Science to the People

A Communication Primer for Scientists and Engineers

Edited by Carolyn Johnsen

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Introduction

Carolyn Johnsen

In July 2008 Rush Limbaugh, the conservative talk-show host, called the lead scientist at NASA's Goddard Space Institute "an idiot."

The epithet fit comfortably in the context of Limbaugh's daily rants against liberals, environmentalists, Barack Obama, and what Limbaugh has called the global warming "hoax." More than six hundred radio stations nationwide broadcast Limbaugh's show for three hours every day. So Limbaugh's opinion of James Hansen and his efforts to inform the public on the science of global warming reached hundreds of thousands of listeners. It would be repeated in coffee shops, subway stations, and offices nationwide.

On the other hand, Hansen's quiet defense of his science was carried, if at all, in ten-second sound bites on radio and TV programs that infrequently covered science news or in an inch or two of print in wire stories in the nation's newspapers.

In fact the Bush administration had tried to silence Hansen, who told Andrew Revkin of the *New York Times*: "In my 30-some years of experience in government, I've never seen control to the degree that it's occurring now. It's just very harmful to the way a democracy works. We have to inform the public if they're going to make the right decisions and influence policymakers."[1]

Protecting our democracy may be the most important reason for scientists and engineers to explain their work clearly to non-experts—whether to the press, the public, or policymakers.

Important public-policy debates on topics as diverse as global warming, stem-cell research, autism, health care, biogenetics, energy, and food safety call for the expert insight of scientists and engineers. Timely, accessible information from these experts can encourage policymakers to consider evidence along with ideology while making decisions. In fact, ideology untempered by empirical evidence can too easily lead to misguided policy related to human health and even to the health of the planet.

The changing role of the media also places a duty on scientists and engineers to provide expertise and clarity in policy debates related to science. In a limited and sometimes uneasy partnership with scientists, journalists have traditionally translated scientific and technical information for the public. But both print and broadcast media are cutting their coverage of science news, leaving a void of information at a time when we need it most.

Boyce Rensberger is the former director of MIT's Knight Science Journalism Fellowships and a contributor to this book. In Harvard's *Nieman Reports*, Rensberger wrote, "The impacts of science, including technology, and its effects on individuals and on society, are becoming more powerful and less predictable. It is more important than ever that the public be informed of what's happening in science."[2]

And yet traditional news media, which would typically be the conduit for this information, are showing less commitment to this role. An analysis from the Project for Excellence in Journalism, titled "The State of the News Media 2008," cites a study by Christine Russell of Harvard's Shorenstein Center that "estimates that of the 95 newspapers that published special science sections in the 1980s, only about 35 still do so today."[3]

The report also says that in watching five hours of cable news in 2008, a viewer would have seen at least twenty-six minutes on crime, ten minutes on celebrity and entertainment, and less than two and a half minutes on science, technology, and the environment.

The proliferation of Web sites and blogs dedicated to science offer one way for scientists and engineers to pick up the slack. Motivation to do even more comes from a major funding agency.

Many researchers rely upon National Science Foundation (NSF) grants that pay for important elements of research, such as laboratory space, equipment, graduate students, and travel. The NSF now requires researchers applying for grants to include plans for reaching beyond the laboratory to explain their work. Leslie Fink of the NSF elaborates on this obligation in her essay, in addition to giving advice on how to meet that obligation.

The NSF, in turn, feels pressure from Congress to expand the public's access to information about science. In 2007 Congress passed the America COMPETES Act, which urged the NSF to do more to teach science graduate students how to communicate more clearly about their work to "nonscientist audiences."

The Act arose from a practical need for policymakers to have clear information on how researchers spend the tax money that supports them. But the public has a stake in this process as well.

In the NSF's periodic reports on public opinion about science and technology, the authors always observe that good citizenship relies, in part, on a knowledge of science: "Knowing how science works—how ideas are investigated and either accepted or rejected—can help people evaluate the validity of various claims they encounter in daily life."[4] Obvious examples include the competing claims of manufacturers of pain remedies and children's car seats.

But when politicians sort out competing points of view on such topics as food safety or coal mining's effects on the environment, their decisions affect us all. So researchers who build the foundations of science and technology have a critical role to play in bringing clarity to the discourse on both personal practice and public policy.

In his inaugural address, President Barack Obama vowed to "restore science to its rightful place."

The rightful place of science in a democracy is at the center of policymaking on many of the most pressing issues of our time.

In an essay for the *New York Times*, science writer Dennis Overbye pointed out the similarities between the values of science and the values of a democracy: "honesty, doubt, respect for evidence, openness, accountability and tolerance and indeed hunger for opposing points of view."[5]

These values—which echo those that drive good journalism—offer a further rationale for researchers in a democracy to communicate more clearly about their work.

Taking Science to the People is primarily for scientists and engineers who acknowledge these opportunities and obligations and who want to improve their communication skills. The essays published here should also persuade some skeptics to polish their communication skills and to provide the means for their graduate students to do so. Accordingly, the authors offer both the rationale and some tools for communicating about science and technology to nonexperts.

This book grew out of a conference with the cumbersome title "Communicating Science to Broader Audiences" held at the University of Nebraska–Lincoln in 2007. Speakers from the NSF and from university information offices, and journalists and "popularizers" of science who are, themselves, scientists, offered compelling evidence of the need for researchers to take on this outreach role.

The conference drew more than a hundred people, primarily from university public-information offices nationwide. Only one reporter attended—a troubling but unsurprising fact, given current trends in news coverage. But about one-third of the attendees were scientists or science graduate students who recognized the need to communicate about their work to the public.

In an effort to reach a wider audience of scientists and engineers, this book picks up the thread spun out at the 2007 conference. To that end, several speakers submitted chapters reflecting and expanding upon their comments at the conference. They include Leslie Fink, David Ehrenstein, Sidney Perkowitz, Stacey Pasco, Boyce Rensberger, and Margaret Wertheim. Some of those authors are either scientists themselves or have received graduate education in the sciences.

Three other authors—Georgia Tech science writer Abbey Vogel, journalist Warren Leary, and Gene Whitney, a government scientist—did not speak at the conference but were invited to contribute because of the perspective they could offer from their own experiences.

I hope scientists, engineers, and graduate students in the sciences and engineering will read this book and find the authors' insights and advice convincing and useful.

Although some of the authors have abandoned full-time scientific endeavors to write about science, none of them suggests that researchers must abandon either their work or their specialized language. Instead these writers urge researchers to become equally fluent in the plain English needed to communicate about their work to the public and policymakers.

While the news media sort out the future of science news and of journalism itself, this book may also remind journalists of the critical role they have played in effectively communicating to the public about science and technology.

Indeed, because journalists still offer a common route for information about science to reach the public, scientists can benefit from learning a thing or two about how journalists do their work. Several essays offer that information.

I add one thought not covered by any of the authors in this book: If scientists and engineers are to spread the word about their work to nonexperts (people other than peers), institutions who employ scientists—primarily universities—should develop a system of incentives and rewards for that effort.

Too often, scientists who "popularize" their work are rewarded not with praise but with their peers' scorn or indifference. One exception is the annual AAAS Award for Public Understanding of Science and Technology recognizing "scientists and engineers who make outstanding contributions to the 'popularization of science.'"[6] To further efforts to communicate to the public, the AAAS even offers "Communicating Science: Tools for Scientists and Engineers."[7]

W. Wayt Gibbs, a contributing editor at *Scientific American*, told the 2007 UNL conference, "Most scientists see no reward for this kind of work. Until that's part of the job expectations, they're reluctant to do it." Gibbs added that the lack of reward for scientists who tell the public about their research makes such an effort seem more of a charitable activity than a professional responsibility.

Writing in the journal *Science Communication*, Michael Weigold of the University of Florida explained why scientists resist communicating with the public: “Fellow scientists may look down on colleagues who go public, believing that science is best shared through peer-reviewed publications. Scientists may also believe that . . . scientists should be humble and dedicated to their work, that scientists should have neither the time nor the inclination to blow their own trumpets.”[8]

In contrast, science journalists have many opportunities to receive recognition for excelling in their work. Here are three examples of annual awards: The Society of Environmental Journalists gives cash awards to reporters for the best environment coverage aired, printed, or posted;[9] the National Association of Science Writers, Inc., gives the Science in Society Award to outstanding science journalism;[10] the Metcalf Institute for Marine and Environmental Reporting at the University of Rhode Island awards the $75,000 Grantham Prize to honor outstanding reporting on the environment.[11]

Some of the most prestigious awards for science journalism come from scientists themselves — from the American Association for the Advancement of Science and the National Academies of Science.[12]

Although the role and the very shape of news media are in flux, citizens in this democratic society still need information about science and technology. The authors collected in this book urge scientists and engineers to do their part to fill that need.

Margaret Wertheim, a distinguished science journalist educated in physics, mathematics, and computer science, issues this call to action: “It is time to get off our high horses and go out to the people.”

Notes

1 "A Conversation with Dr. James Hansen," Erik Olsen, producer, *New York Times*, http://video.nytimes.com/video/2006/01/28/science/1194817097774/a-conversation-with-dr-james-hansen.html.

2 Boyce Rensberger, "Reporting Science Means Looking for Cautionary Signals," *Nieman Reports* (Fall 2002), http://www.nieman.harvard.edu.

3 "The State of the News Media 2008," Project for Excellence in Journalism, Pew Research Center, http://pewresearch.org.

4 The NSF's "Science and Engineering Indicators" can be found at http://www.nsf.gov/statistics/seind. The cited material was taken from chapter 7 of the 2006 survey.

5 Dennis Overbye, "Elevating Science and Elevating Democracy," *New York Times*, January 27, 2009.

6 AAAS Award for Public Understanding of Science and Technology, American Association for the Advancement of Science, http://www.aaas.org/aboutaaas/awards.

7 "Communicating Science: Tools for Scientists and Engineers," American Association for the Advancement of Science, http://communicatingscience.aaas.org.

8 Michael Weigold, "Communicating Science: A Review of the Literature," *Science Communication* 23, no. 2 (December 2001): 164–93, http://scx.sagepub.com/cgi/content/abstract/23/2/164.

9 SEJ Awards for Reporting on the Environment, Society of Environmental Journalists, sej.org.

10 National Association of Science Writers, http://www.nasw.org/awards/society.htm.

11 Grantham Prize, http://www.granthamprize.org.

12 AAAS Kavli Science Journalism Award, http://www.aaas.org/aboutaaas/awards/sja. For science journalism awards, such as the Keck Foundation Award, given by the National Academies of Science, see nas.org.

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Taking Science to the People

Leslie Fink is a science communicator at the National Science Foundation. For twenty-five years, she has been involved in communication programs for federal research agencies in the Washington DC area.

Fink established and led the communications office of the Human Genome Project at the National Institutes of Health. She later led communications for the National Institute of Allergy and Infectious Diseases, the NIH component in charge of research on HIV, global infectious disease, and biodefense.

Recently, Fink has been producing multimedia Web pieces and exploring opportunities to include science and engineering themes in popular-culture venues, especially in movies and on TV.

She holds a bachelor's degree in biology, carried out cancer research at the University of Wisconsin–Madison, and completed the graduate program in science communication at the University of California at Santa Cruz.

In this opening chapter, Leslie Fink explains the obligations that federal law and policy set for researchers to communicate about their work to nonexperts. She also offers methods that researchers can use to avoid "Tower of Babel" consequences.

1

“The Difficulty of Nubbing Together a Regurgitative Purwell and a Superaminative Wennel Sprocket”

Leslie Fink

> We’ve arranged a global civilization in which the most crucial elements . . . profoundly depend on science and technology. We have also arranged things so that no one understands science and technology. This is a prescription for disaster. We might get away with it for a while, but sooner or later this combustible mixture of ignorance and power will blow up in our faces.
>
> Carl Sagan, *The Demon-Haunted World*

Perhaps the best-known story of the untoward consequences of bad communication is the biblical account of the Tower of Babel, in which God is said to have created the world’s different languages in order to prevent the tower’s builders from understanding one another. As intended, the babble that erupted among them brought the project to a halt.

In modern times, the Tower of Babel metaphor may aptly apply to communication between scientists and the public, with similar consequences to the support of research through funding and social acceptance.

Like most specialists, scientists have refined a way of communicating that operates effectively in the halls of academia and in professional societies but falls short in popular parlance. This chapter's title—"The Difficulty of Nubbing Together a Regurgitative Purwell and a Superaminative Wennel Sprocket"—provides a humorous but very real example.[1]

The history of science tells us that the communication difficulties between scientists and nonscientists are a relatively recent occurrence—one that may be related to the shift in funding sources that occurred in the last sixty years.

Until at least the mid-nineteenth century, theorizing, research, and exploration were carried out by "men of science"—mostly savants supported by wealthy patrons or private foundations.

In fact support of science as a public investment, particularly at universities, did not gain a foothold in the United States until after the end of World War II. Then, as the Cold War escalated, most federally funded research taking place at universities was supported by military contracts, not by the system of grants awarded by peer review that is common today.

In 1954, for example, the Department of Defense and the Atomic Energy Commission supported 96 percent of academic research outside of medical and agricultural studies. From "V-J Day to Sputnik," those funds were concentrated at a few of the nation's elite campuses and supported very directed, applied research on weapons and other military technologies.[2] Working to outsmart real or perceived Soviet threats, academic scientists reasonably kept conversation about their projects to themselves.

When the Cold War ended, emphasis in science-funding policy in the United States shifted toward an increasingly diverse portfolio of peacetime pursuits to improve quality of life and economic growth. Today the public is both benefactor and beneficiary of those policies, as applications of federally funded science-and-engineering research have made their way into nearly every aspect of American life.

Still, most tenured research faculty in university labs today were Cold War scientists themselves (or were trained by someone who was) who instilled the culture of the period in their students. In contrast to the mum culture of the Cold War years, scientists have a responsibility now more than ever to participate in dialogues about their work directly with citizens who will, in the voting booth, ultimately decide its intellectual, practical, or even moral value.

Citizens are being called upon to make decisions about increasingly complex scientific and technological issues, such as climate change, stem-cell research and its applications, energy policy, green technologies, evolution, genetically modified foods, privacy issues related to surveillance, computer and medical technologies, space exploration, defense technologies, education, and end-of-life decisions, to name a few.

The Public as Benefactor and Beneficiary

> The most important things happening in the world today won't make tomorrow's front page. . . . They'll be happening in laboratories — out of sight, inscrutable and unhyped until the very moment they change life as we know it.
>
> Joel Achenbach

In a 2008 *Washington Post* article, journalist Joel Achenbach went on to say, "We vaguely understand that this stuff is changing our lives, but we feel as though it's all out of our control. We're just hanging on tight, like Kirk and Spock when the Enterprise starts vibrating at Warp 8."[3]

Indeed years of public surveys conclude most people know relatively little about science and technology. A National Science Foundation (NSF) survey showed that nearly half of the U.S. adults questioned did not know how long it takes Earth to orbit the sun. About half did not know that electrons are smaller than atoms, and only one-third knew that the universe started with the Big Bang.[4]

Nevertheless, the same surveys show that all segments of the American public overwhelmingly support scientific research and the federal government's funding of it. About 80 percent of survey respondents said the federal government should support research "even if it brings no immediate benefits."

By 2006 the federal government provided the majority of funding for academic research and development—63 percent. Six agencies supplied about 95 percent of the $25 billion spent in 2007. NSF is the lead federal agency for funding academic research in the physical sciences, mathematics, the computer sciences, and earth, atmospheric, and ocean sciences.[5]

By law, NSF and other federal agencies now establish periodic strategic plans and annual mechanisms to report progress to Congress and the administration's Office of Management and Budget.

One such mechanism is the requirement that researchers who receive federal funds regularly notify their agency program managers, who are themselves scientifically trained, of their progress. Such transmittals come in the form of published research papers, annual progress reports, and other technical documents. NSF also asks for brief lay summaries, called "Highlights," from its investigators.

First and foremost, these would-be simple statements fulfill requirements of the Government Performance and Results Act (GPRA, pronounced "gippra") of 1993. A key GPRA objective is to "improve the confidence of the American people in the capability of the Federal Government, by systematically holding Federal agencies accountable for achieving program results."[6]

Highlights help NSF leadership account for the agency's management of funds to congressional appropriators. Highlights also serve to make a persuasive case for increases in future funding to budget officials in the executive branch, who parse the scarce tax dollars in the very competitive budget the president submits to Congress each fiscal year.

Besides contributing to bureaucratic reporting requirements, well-thought-out and well-written research Highlights can serve a number of other useful purposes. They can be especially valuable in articulating to stakeholders important research problems or knowledge gaps and in bringing distinction to institutions trying to solve them.

Scientists who can present their research "Highlight-style" are assets in communities seeking to parlay local intellectual talent into better schooling or business and economic benefits and better healthcare, for example, or simply a more enriched life for citizens.

Finally, those scientists are blue-chip commodities on the "Good Will Exchange" when the inevitable and widely chronicled misadventure threatens an institution's reputation.

Scientists can practice these short, clear explanations of their work by developing a so-called elevator speech—a good way to organize information about their research and why it's important.[7] Succinct elevator speeches can hone scientists' skills in framing highly technical work in words that have meaning to all—a benefit not just for conveying the significance or importance of individual research projects to the public but also to management and for garnering new resources.

NSF has partnered with the Center for Public Engagement at the American Association for the Advancement of Science to provide online resources including Webinars, how-to tips for media interviews, strategies for identifying public outreach opportunities, and more to help scientists and engineers develop public communication skills.[8]

In August 2007 President George W. Bush signed the America COMPETES Act into law. Included as a "Sense of Congress," the law says that NSF should "train graduate students in the communication of the substance and importance of their research to nonscientist audiences." It directs NSF to report to Congress within three years the details of those training programs.[9]

The mandate originated from a bill called the "Scientific Communications Act of 2007," which Doris Matsui (D-CA) and Bart Gordon (D-TN) introduced in the House of Representatives "to help bridge the communications gap between scientists and the rest of us." Matsui said, "If scientists can't tell the rest of us what they've discovered, we are not fully realizing the benefits of our investment in scientific research."[10]

Ample anecdotes indicate that Gen-X graduate students are not only willing and enthusiastic to talk about their work with nonscientists, many are also quite good at it. Formal training in communication can enhance and reinforce those skills.

In a letter to the journal *Science*, a group of scientists and communications experts at Cornell University reported on a course they designed to teach science communication to graduate students. Their goal was to improve students' abilities "to discuss our research with both the general public and the professionals writing and reporting on science in the media."

The authors made three suggestions. First, they said, involve people from multiple fields, especially those from the campus media-relations office, but also other scientists experienced in communicating with the public as well as journalists themselves.

The authors also recommended visiting a newspaper or a radio or television station and sitting in on editorial meetings in which editors and journalists pitch stories. That way, scientists can learn which findings are considered newsworthy and gain a better understanding of what journalists need when preparing a story.

Finally, the Cornell group suggested graduate students get hands-on experience by writing news releases, conducting interviews, being interviewed, and taking advantage of other opportunities to communicate with nonspecialists.

The letter concluded, "Starting public communication training at the graduate level will increase the frequency and confidence with which scientists communicate, with positive feedback for both science and public understanding."[11]

The Scientist in the Public Square

> All mankind is divided into three classes: those that are immovable, those that are movable, and those that move.
>
> Benjamin Franklin

Even technical journals have begun to express the point of view that increased communication between scientists and the public is a life-or-death matter for the research enterprise. Alan Leshner, chief executive officer of the American Association for the Advancement of Science, which publishes the journal *Science*, likens the current relationship between science and society to the Dickensian best of times, worst of times.

Alongside unprecedented advances in science and technology, society is "exhibiting increased disaffection," Leshner says, fostered by cases of data fraud and financial conflicts of interest. Worse, public skepticism and concern are increasingly aimed at scientific issues that appear to conflict with basic human values, religious beliefs, or political or economic agendas.

"The ensuing tension," Leshner says, "threatens to compromise the ability of the scientific enterprise to serve its broad societal mission and may weaken social support for science."

Leshner acknowledges that encouraging graduate students to communicate better directly with the public may come at some risk: "Many young colleagues are enthusiastic about discussing their work with the public, but they are also under tremendous pressure to stick to the bench, secure hard-to-get research grants, and publish rapidly in high-quality journals. Many even feel that the culture of science actively discourages them from becoming involved in public outreach, because it would somehow be bad for their careers."

In the end, public understanding of scientific facts is not sufficient because even (or especially) people who have command of the science may still have trouble embracing it in a societal context.

Leshner says, "We must have a genuine dialogue with our fellow citizens about how we can approach their concerns and what specific scientific findings mean."[12]

Former NSF director and White House science adviser Neal Lane defined the "civic scientist" as "one who uses his or her special scientific knowledge and skills to influence policy and inform the public." Lane considered Benjamin Franklin to be the model civic scientist owing to his command of three important qualities: wisdom, science, and communication.

Franklin was indeed a wise man—early to bed and early to rise. Lane attributes Franklin's wisdom, in part, to his older age compared with his Revolution-era contemporaries. Franklin was also a scientist who was elected a fellow of the Royal Society of London and of France's Royal Academy of Sciences. For his discoveries in electricity, Franklin received recognition equal to today's Nobel Prize. Both scientists and the public read his book, *Experiments and Observations on Electricity*.

Franklin's skill as a public communicator was perhaps most evident when, under the pseudonym Richard Saunders, he published *Poor Richard's Almanack*. From 1732 to 1758, Franklin filled yearly almanac pages with sprightly accounts of weather, astronomy, and even astrology, as well as poetry, math problems, aphorisms, proverbs, and other musings. The *Almanack* was reportedly the second-best-selling book in the colonies behind the Bible.

According to Lane, Franklin "would not be timid about convening town meetings where community leaders and other citizens could candidly discuss with scientists the moral, ethical, and practical implications of cloning, stem cell research, genetically modified crops and foods, nanotechnology, nuclear energy, missile defense, and so forth. And he would encourage scientists to listen as well as talk. No doubt Franklin, who taught by example nearly everywhere he went, would ask scientists of all disciplines to become more personally involved in their communities."[13]

Along those lines, NSF now requires funding applicants to address two equally important criteria in their proposals. The first, *intellectual merit*, addresses, among other things, how important the proposed activity is to advancing knowledge and understanding within its own field or across different fields. The second, *broader impacts*, addresses how well the activity advances discovery and understanding while promoting teaching, training, and learning; broadens the participation of underrepresented groups; and describes what the benefits to society may be.

Today, it is NSF policy to "return without review proposals that do not separately address both merit review criteria."[14]

Public Understanding of Scientists

> Everything should be made as simple as possible, but not simpler.
> Albert Einstein

Despite the difficulty scientists may think they have communicating with nonscientists, surveys show that researchers enjoy an admired position of prestige and credibility among the public.

A survey by Research!America reported that scientists topped a list of admired professions with 57 percent of respondents saying scientists had “very great prestige.” In contrast, only 15 percent said journalists did. Thirty percent said members of Congress did.[15]

Communicating with an interested, intelligent (but not expert) public requires the same considerations as communicating with colleagues in a different, but equally rigorous, profession. Most members of the public certainly will not have the same knowledge an expert does. But they can and do understand the information when that knowledge is communicated effectively.

Making understanding possible requires the expert and the nonexpert to connect in a shared, neutral space in which neither party is in control, but in which both parties stretch beyond their comfort levels. It is never a matter of “dumbing down.” The goal is to make understanding happen by taking into account different experiences and points of reference in the communication process.

To accomplish this goal, scientists often rely on journalists, who have long been the primary purveyors of science to the public. The Internet has modified that role, but scientists still have to talk to journalists. Scientists and journalists, however, are trained to present information differently. Scientists begin with ample history and background followed by the facts and their context—what the finding means in the bigger picture. Journalists and members of the public, on the other hand, consume information in the opposite order, with the most important questions being, What is the discovery? and What does it mean? The details will be interesting to some, but in journalism and other public communication, the news comes first. Other authors in this book explain in more detail the benefits that accrue when scientists and journalists communicate with each other.

Communicating Science in the Digital Age and Other Opportunities

> The clashing point of two subjects, two disciplines, two cultures—of two galaxies, as far as that goes—ought to produce creative chances.
>
> C. P. Snow

The federally funded research enterprise in the United States has become an endeavor carried out by a diverse group of people in the sunshine of public scrutiny and accountability. Now we urge scientists to leave their comfort zones to communicate with the public at a time when communication technologies have never been so daunting.

The handful of major national newspapers that once reported science has largely given way to countless cable programs, Internet news sites, blogs, personal-device downloads, wireless transmissions, and the like.

The endless media formats now available, combined with the pervasive role of science and technology in everyday life, give scientists and their research institutions unprecedented opportunities to communicate directly with the public.

Today, popular culture, including art, music, sports, television, and movies—even video games—are "the current vernacular" and offer myriad opportunities to engage the public in interesting and relevant ways.

Opportunities lie elsewhere, as well, in an age where academics are encouraged to collaborate across disciplines.

For example, many universities support humanities programs that can enrich the presentation of science and engineering when invited to partner in broader-impact activities. A research theme may lend itself just as easily to a dramatic film or play, musical performance, or art exhibit as to the now-traditional Web site.

Experience tells us that students and faculty in creative, nonscience departments are eager to take on intriguing technical topics, particularly those with complex societal implications. Experience also tells us the "two cultures" are not as different as they may once have been.

Creative chances abound.

Notes

1 J. H. Quick, "The Turbo-Encabulator in Industry," *Student's Quarterly Journal*, Institution of Electrical Engineers, London, 1944. A video version of the complete article can be found at http://www.youtube.com/watch?v=PtuqjFf7-N4&feature=related/.

2 Roger L. Geiger, "Science, Universities, and National Defense, 1945–1970," *Osiris*, 2nd ser., 7 (1992): 26–48.

3 Joel Achenbach, "It's heading right at us, but we never see it coming," *Washington Post*, April 13, 2008, "Outlook" section.

4 National Science Foundation, "Science and Technology: Public Attitudes and Understanding," in *Science and Engineering Indicators 2008*, 2: appendix table 7-5.

5 National Science Foundation, "Academic Research and Development," in *Science and Engineering Indicators 2008*, 1: chapter 5.

6 *Government Performance and Results Act of 1993*, Public Law 103-62, 103 Cong., 1st sess. (August 3, 1993), Sec. 2(b)(1).

7 An "elevator speech" is a way to practice briefly and clearly explaining to nonexperts what you do. Imagine yourself with one or more strangers on an elevator. None of them is an expert in your field. They may include people who finance your research, lawmakers considering withdrawing funding from your lab, your department chair, who has his own narrow specialty, or some of the 102 freshmen in your survey class. You have the time it takes to go from the first to the fourth floor to explain to your captive audience what you do and why it's important to them. For more on the elevator speech, see Christian Daughton, "Emerging Pollutants, and Communicating the Science of Environmental Chemistry and Mass Spectrometry: Pharmaceuticals in the Environment," *Journal of the American Society of Mass Spectrometry* 12, no. 10 (October 2001): 1067–76.

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10 Doris Matsui, "House adopts Congresswoman Matsui's amendment to provide communications training for scientists," press release, May 2, 2007, http://matsui.house.gov/SupportingFiles/documents/070503_-_Science_Communications_amendment_passage.pdf.

11 Dana R. Warren et al., "Lessons from Science Communication Training," *Science* 316 (May 25, 2007): 1122. All the quotes from the Cornell group come from this source.

12 Alan I. Leshner, "Outreach Training Needed," *Science* 315 (January 12, 2007): 161. All preceding Leshner quotes come from this source.

13 Neal Lane, "Benjamin Franklin, Civic Scientist," *Physics Today* 56 (October 2003): 41–46. All preceding Lane quotes come from this source.

14 Rita R. Colwell, "Implementation of New Grant Proposal Guide Requirements Related to the Broader Impacts Criterion," *Important Notice to Presidents of Universities and Colleges and Heads of Other National Science Foundation Grantee Organizations*, notice no. 127, July 8, 2002.

15 Cristine P. Brown et al., "Report: Helping Researchers Make the Case for Science," *Science Communication* 25, no. 3 (March 1, 2004): 294–303.

Margaret Wertheim is an internationally noted science writer whose work focuses on the relations between science and the wider cultural landscape. She is the author of *Pythagoras' Trousers*—a history of the relationship between physics and religion, and *The Pearly Gates of Cyberspace: A History of Space from Dante to the Internet*.

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In addressing those attending the 2007 science-writing conference at the University of Nebraska–Lincoln, Margaret Wertheim offered this advice: "Don't report science as something that happens in test tubes but as a deeply human activity that has happened throughout history." This advice reflects her own efforts to engage readers by telling the stories of science. In this essay, she argues that work remains to be done to reach a wider audience with those stories. Wertheim presents evidence showing that magazines intended to inform the general public about science are reaching only about half the possible audience.