Worlds Apart

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HOW THE DISTANCE BETWEEN SCIENCE AND JOURNALISM THREATENS AMERICA'S FUTURE

JIM HARTZ AND **RICK CHAPPELL, PH.D.**

FIRST AMENDMENT CENTER
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Worlds Apart:
How the Distance Between Science and Journalism Threatens America's Future
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Foreword

"The public have an insatiable curiosity to know everything—except what is worth knowing ...."

—Oscar Wilde, 1854-1900

Among multiple public complaints about newspaper and television news content in this tabloid-tainted, media-saturated society is an odd criticism, laced with irony and loaded with contradiction: Readers and viewers of mainstream media assert that they are overfed with an information diet they don't want and starved for news they need.

Still, responsible editors and news directors note with natural interest and professional regret the great gobs of tabloid news about O.J., Princess Di, Marv and Jon-Benet that have been consumed and digested by many millions of their customers.

They know, of course, that intellectual junk food sells. And they are entitled to wonder once in a while, despite the public's complaint about its diet, whether Wilde was right. Looking back on the news coverage of recent years, it's obvious many editors and news directors believe he was.

When celebrity fills every inch and second of news space and air time, something else must be omitted, perhaps something more important, something the public needs, perhaps something even as entertaining—if not as titillating.

This yearlong study, by a veteran science journalist and a physicist who has spent years in NASA's space-science program, considers something that has been left out of most mainstream news coverage in recent years. *Worlds Apart* analyzes media coverage and media attitudes as they relate to science and technology.

Science and technology?

Can these topics really compete with celebrities for news space?

Jim Hartz, former host of NBC's *Today* show, and Dr. Rick Chappell, trained as a space-shuttle payload specialist, would argue that this competition is fair. With straight faces, they would assert that science should win.

Their study makes a compelling case that they are right and Wilde was wrong.

If you are a taxpayer, you should know and care that $73 billion of your money last year went to scientific and technological research and development. If you are a stockholder in any of a number of major corporations, you should know that another $100 billion-plus was spent by the private sector.

If the nation's health fight—whether the enemy is cancer or heart disease or AIDS—is your fight, it's a human-interest story, a multibillion-dollar economic story and a science story.

If crime concerns you, you should know that DNA testing has made police investigative procedures more effective by proving—in ways that lie detectors and fingerprints never could—whether a suspect is likely to be implicated in certain major crimes.

Genetic engineering, cloning and fertilization techniques: all of these are science stories.

So is global warming. So are all the new technologies that drive our computers and cell phones.

Science is literally a life-and-death news story that threads its way through every aspect of American culture—and the media leave the public mostly ill-informed about it, contend Hartz and Chappell.

With extensive interviews, detailed research, a public-opinion survey and anecdotal reportage, the authors make the case that too many

news organizations give science short shrift, thereby depriving their readers and viewers of information they both need and want.

To read *Worlds Apart* is to understand that some news decision-makers sincerely believe that their readers reject science out of hand as a deadly dull subject. Others are intimidated in the face of a subject they themselves know so little about. Still others insist—and perhaps believe—they are adequately covering science under other names: health, space, technology, the environment.

The evidence the authors present leaves no doubt that adequate coverage of science stories is rare, found in only a handful of news outlets.

It has not been forever thus. Sputnik launched the space race more than 40 years ago, thrusting this nation into a panicked competition with the Soviet Union, our dread enemy. We answered the challenge. When Neil Armstrong took his "giant leap for mankind" onto the surface of the moon, we knew the race was won.

As democratic impulses began to take root and the Soviets' "evil empire" crumbled away, Americans began to relax. The spin-off benefits from the space race flowed into consumer products such as fiber optics, cellular phones, fax machines and home computers, but we began to take our scientific advances for granted. The news media's interest in matters scientific rapidly waned.

Scientists have come to see the loss of media interest in their field as dangerous to the future of the nation. Nobel Prize winners have declared that we are eating our seed corn by failing to understand, promote and support new scientific initiatives.

There is a cruel irony in the fact that journalists, whose own profession has been so radically altered by the technology of the Information Age, are neglecting to explain the transformation affecting their industry and so many others. There is concern on the part of many reporters that even greater changes will shake their news organizations as millions of Americans move to the new media for their information.

In a time of such great transition, the American people need a better understanding of how science is daily altering lifestyles and culture.

In the nation's earliest days, the founding fathers knew that the free flow of information was vital to the sustenance of our democracy. That is why they gave the free press constitutional protection. They anticipated that journalists would use that liberty to create what Thomas Jefferson envisioned as "an enlightened society."

Today, Hartz and Chappell insist, society is hardly enlightened when it comes to science—at the very time when there are dramatic and disturbing legal, moral and constitutional debates surrounding so many scientific breakthroughs.

They call for journalistic leaders to take a new look at science so that the public might be better equipped to understand and participate in the growing debates. They ask it in the spirit of values embodied in the free-press clause of the First Amendment.

The First Amendment Center is indebted to Jim Hartz and Rick Chappell for their dedication and professionalism in researching and writing *Worlds Apart*.

—John Seigenthaler

Introduction

We started and finished this study with a definite bias that we feel is necessary to confess at the outset: Both of us have had a lifelong fascination with and keen interest in science and high technology.

Dr. Chappell comes by his legitimately; he's a space physicist who studies sun-earth interactions above the atmosphere. Hartz is a mere observer who, over a 39-year career as a journalist, has frequently chronicled science matters for NBC News and PBS.

While confessing this bias, we also realize not everyone shares our view of the seductiveness of nature's tantalizing complexities. In fact, we know we are in a minority, as painful as that is. For while a majority of Americans profess a great curiosity about matters scientific, they also confess that they really don't comprehend a lot of what they see and hear.

That is understandable. There has been an outright explosion of new scientific knowledge just in our lifetimes. No one person can know it all. Many scientists themselves say they are hard put to stay up with cutting-edge research in their own specialties.

The elusiveness of perfection, however, should not discourage a workaday familiarity with and appreciation of the scientific basis of contemporary life. One has only to glance at today's factories, farms, hospitals, stores, offices, homes, cars and even entertainment to see the immense changes modern science has brought to our lives. Yet most of us throw up our hands in mock horror when it comes to programming a VCR.

We've become a point-and-click society, rarely considering what goes on behind the screen. One school of thought says you don't need to know what happens back there, just as you don't need to know how a car's transmission works to make it go. True, of course, but this kind of limited thinking, when magnified to encompass larger issues, leaves individuals more bewildered and less powerful in shaping the course of their own lives. If, by habit, we come to prefer—and demand—simple constructions to complex questions, eventually we are bound to get incomplete and ultimately incorrect answers.

As a society, we are, in fact, grappling with such a choice right now. At the heart of the matter is the value we place on science itself.

Since World War II, most scientific research in the United States has been funded by the federal government. And it's a mighty undertaking—$73 billion this year (1997). In the short space of 50 years, such federal support, plus funding from industry, foundations and individuals, has created a scientific enterprise that is the envy of the world. In many ways, it defines America. But the scientific establishment says that, through complacency, budget cuts and plain misunderstanding, it is all in jeopardy.

At the risk of seeming unduly alarmist, we must agree. No, the great citadel will not disappear tomorrow. It's the kind of edifice that will crumble slowly from neglect. Hardly anyone will miss it until it's gone.

Nor will the process of discovery stop. It won't. In a fundamental way, science is a zero-sum game; if U.S. researchers don't make the discoveries, someone else will. Whoever assumes leadership in the scientific and technological realms will eventually assume world economic and political leadership. Throughout history, innovators have dominated their times. The United States is just the latest in a long line of innovators.

The modern roots of America's great scientific establishment go back no further than a half century. Science in this country really has no organized constituency except itself. In a curious way, it created itself; there were no huge lobbies, no street demonstrations, no sit-ins, no strikes, no political blackmail. No small part of the scientific establishment's growth has been in super-secret weapons and related research. In short, the public knows little about its size, operating methods or even its direct benefits, except in the case of a few highly visible aspects such as the space program, medical research and programs that capture the public's fancy—astronomy and dinosaur research, for instance. Big science has thrived in America largely through the enlightenment of a few policy-makers.

With a small natural constituency, no spare cash, feeble organization and little experience in the rough-and-tumble of Washington politics, science is justifiably worried that it is now playing a losing game. At the same time, it is beginning to understand that a big part of the problem is an inability to get its message across to the public.

It is at precisely this confluence of events that we began to examine how the news media interact with and report on the scientific community. This document is the result of a year-long study that included a major survey of the attitudes held by scientists, engineers and journalists, several roundtable discussions, conversations with knowledgeable individuals, and analysis of numerous news stories concerning scientific discoveries.

As it turned out, our time frame coincided with the period during which journalists also were re-examining many of their own principles and methods in reaction to pressures for change in their domain. And it soon became obvious that we could not discuss the cultural and professional tensions between journalists and scientists without touching on some aspects of society at large—specifically, how we prepare the populace to deal with the complexities of modern life.

What has emerged is a document we hope will be helpful to both groups—to the journalists, who might be persuaded to follow the work of this major establishment more carefully, and to the scientists, who want the public to achieve a more profound understanding of their work.

—Rick Chappell and Jim Hartz
January 1998

Overview

Almost everything we in the United States consider a scientific or technological advancement has come from curiosity-driven research. This is basic research, the kind that explores until it sets upon something magnificent, whether microcomputers or the mapping of DNA. It has served this nation well, contributing immeasurably to the U.S. role as world leader.

But support for science and technology in this country has dwindled—in part, it appears, because of media inattention. The American public says it doesn't understand many matters scientific. The proportion of public money allocated for research and development is smaller than at any time since the Soviets' Sputnik launched the space race in 1957.

While the first casualty of this scientific belt-tightening is basic research, there is much more at stake.

Shortly before he died, the great scientist and communicator Carl Sagan warned: "If we were to back off from science and technology, we would in fact be condemning most of the human population of the Earth to death."

Such a retreat is under way.

On Oct. 17, 1996, five American Nobel Prize-winning scientists lamented to a group of journalists gathered at the National Press Club in Washington that public support and understanding of science and technology was in a serious state of decay.

This $180 billion-a-year enterprise is threatened by the declining quality of the people who enter it and by the drop in support for basic research. Less than 9 percent of all basic research is federally funded. Most is financed by universities, whose funding also is declining. Private industry has not picked up the slack; the private sector focuses almost exclusively on applied research, the kind that has creation or improvement of commercial products as its primary goal. This situation is unlikely to change, since private research-and-development funding historically tends to follow the priorities set by public funding, rather than counterbalancing them.

At the root of the problem—and the heart of the solution—are those who control the flow of crucial information about the value of basic scientific and technological research: the scientists themselves and the journalists who communicate their triumphs and failures to the American public.

More than 1,400 scientists and journalists were surveyed for *Worlds Apart*. The journalists said scientists' jargon and the endless qualifications by which they circumscribe their findings make communicating their work to the public an all but impossible task. But 81 percent of scientists said they were willing to take a course to help them learn to communicate better with journalists. Although the overwhelming majority of scientists said that few in the media understand the nature of science and technology, 72 percent said that journalists do not "face a hopeless task in explaining the complexities of science." Knowing the obstacles that have stood in the way of interaction between journalists and scientists, the groups can now work together to communicate science to the public.

Because science in America came of age during the Cold War in a climate of urgent support and ardent secrecy, scientists have grown used to funding that comes without question. They are unaccustomed to explaining the intricacies of their work to the public.

At the same time, the public—including the media—has grown less and less familiar with the basic tenets of science and technology, even as achievement in both areas has become more and more essential to modern life.

"What I'm concerned about," Sagan said shortly before his death, "is that the consequences of these attitudes are much more dangerous today than in the past."

Almost every American newspaper has an astrology column. Very few have a weekly science column. Today, half the American public doesn't know that it takes a year for the Earth to rotate around the sun. Meanwhile, within two short generations, 50 percent of U.S. citizens will depend on science and technology for their living.

Something must change, and soon.

Both science and journalism tend to attract practitioners who are above average in intelligence and education. Both groups are highly motivated and free-thinking. So why the gulf in their communication?

Besides scientists who don't speak English and journalists who don't speak science, there are uncertain gatekeepers—editors who decide which stories will be published or produced—and a public ill-equipped to grasp the nuance and significance of scientific developments. Given these circumstances, it's not surprising that the popular support that science once enjoyed is now eroding.

Another reason for the impasse may be that both scientists and journalists are likely to be egotistical and skeptical by nature. In the past five years, First Amendment Center surveys of clergy, corporations, military, even politicians have shown that none were as distrustful of the news media as the scientists surveyed for *Worlds Apart*. Only 11 percent of the scientists said they had a great deal of confidence in the press. Twice that many said they had hardly any confidence at all. Although two in five scientists said they were afraid of being embarrassed before their peers by news stories about their work, nearly three-quarters said they wanted the public to know about their research. And it is becoming more critical that the public learns what is going on behind the laboratory doors.

Both scientists and journalists have been jolted from complacency by threats to their professional existence. Scientists, whose caste system of language and vocabulary isolates them from the public at large, fear failure in the politically charged funding arena. Journalists, whose increasing tendency to sensationalism has weakened their credibility, fear obsolescence in the fast-changing world of communications technology.

Meanwhile, the public push for science and math education that began when Earth's inhabitants first saw pictures of their planet from space has waned. Today, 40 percent of U.S. eighth-graders lack even basic math skills. American math and science students who score better than 95 percent of their peers in this country would be only average students in Singapore. Leading scientists are increasingly vocal about their fear that the United States will lose its place as the world leader in cutting-edge research.

That was the central issue when nearly three dozen scientists convened for a roundtable discussion at Vanderbilt University in the fall of 1996. The consensus: The United States risks losing its position of leadership, in part because the American taxpayers really don't understand what they're getting when they pay for research and development. Scientists themselves share a large part of the blame because they aren't explaining the ramifications of their work. The inability of researchers to move from the jargon-filled laboratory into the "real" world means most Americans don't understand what's happening in the lab.

Americans want to understand.

A 1997 study by the Pew Research Center for the People and the Press showed a fifth of Americans polled said they enjoyed stories about science and technology. That topic beat out religion, politics, international affairs, entertainment, consumer news, business and finance, famous people, and culture and the arts. About the same time, a survey by the nation's largest newspaper chain, the Gannett

Co., showed that 75 percent of readers were somewhat to very interested in science and technology.

Such figures suggest that editors and producers are underestimating public desire for science news and may be losing readers and viewers by not providing it.

What can be done? Here are some recommendations:

• Scientists and journalists should begin a dialogue to educate each other about the ways in which their needs and the needs of the public can be met.

• The scientific community should train communicators to speak for different scientific disciplines.

• Journalists should increase their understanding of and training in the sciences.

• Publishers of scientific papers should require authors to include summaries of their findings—written in plain English—that put the work in perspective and explain its relevance and importance.

• Journalists should pay close attention to the peer-review process to avoid overplaying potentially questionable work.

• All scientific disciplines should develop web sites operated by the principal scientific associations for the posting of papers, e-mail and phone numbers of scientists and spokespeople, as well as other information geared to the public and—particularly—to the media.

• The American Association for the Advancement of Science or the National Academy of Sciences should maintain a master web site linking these individual sites.

• The media should use the web sites, where major findings would be flagged, as a guide for improving their coverage of scientific and technological topics.

The current First Amendment Center survey reveals that scientists and journalists recognize the widening gap between them and want to bridge it. The time is ripe for action.

CHAPTER ONE

The Unscientific Americans

If a nation expects to be ignorant and free, in a state of civilization, it expects what never was and never will be.

—Thomas Jefferson, 1743-1826

On Oct. 17, 1996, five American scientists appeared before journalists at the National Press Club in Washington, D.C. They had just won Nobel Prizes. By all rights they should have been jubilant. Instead, they were apprehensive, dour and sounded just a little angry. These scientists, who were soon to pocket prize money of several hundred thousand dollars apiece, were worried about the means to carry on—worried not for themselves, but for the U.S. scientific enterprise as a whole.

Dr. Douglas D. Osheroff of Stanford University began to speak of a time not long ago, during the space race with the Russians that followed World War II, when "… the U.S. supported science almost as a religion."

"That seems to be over now," he said. "And, unfortunately, I think that the U.S. public and, in particular, the U.S. Congress, seem to know and appreciate very little about basic science. And I really think that's a problem …."

Dr. Robert C. Richardson of Cornell University picked up the theme: "[A]s far as I can see, the issues that concern us about science have been completely invisible in this political season … And this, for me, seems remarkable in the context of the desire to reach the balanced budget by the year 2002. The reason we want to do that as a country is to make life better for our grandchildren. I do not understand how we can make life better for our grandchildren if we don't provide the environment where new things can be invented, new products made, and the quality of life generally improved …."

Dr. David M. Lee, also from Cornell, seemed genuinely perplexed that anyone could doubt the need for science and technology investment. "[T]he government has a very large program to fund interstate highways systems, and this is a facility which is used by everyone," he said. "The basic research enterprise can be thought of in the same way: It provides a facility for new discovering, and those discoveries are accessible to all industry."

Smalley

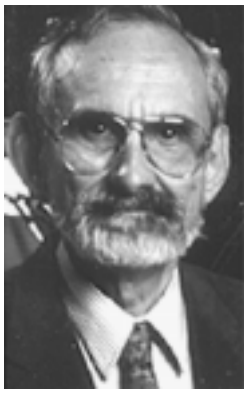
Three disgruntled and ungrateful physicists? Listen to Dr. Richard E. Smalley, a chemist from Rice University, speaking at the same news conference: "I decided to go into science one year after Sputnik [launched in October 1957]. At that time, … science and technology was the most romantic area you could possibly enter. … And during my career, I have watched as the support for this enterprise—science-and-technology development with a long time horizon—has gradually gotten harder and harder to [obtain], for many reasons. The process is in actually somewhat of a state of decay right now—in a rather insidious way that I think we won't know clearly about for another 10 years or so."

Research and development, a vast enterprise that in the United States gathers up $180 billion in public and private funds, in a "state of decay?" How could that be?

While this massive establishment at the moment is working tolerably well, it's the "long time-scale, the true basic research, the frontier work" that is threatened by budget reductions, Smalley said. Even worse is "the quality of the

people coming through the system," he lamented. "That's where I think the insidious decay occurs."

Lee agreed, calling American education in science "abysmal."



Curl

Threatened cutbacks, public ignorance, inadequate education, a failure of vision—all add up to "trouble in this country," said the fifth Nobelist, Dr. Robert F. Curl Jr. of Rice. "… I think that we really need to do something to make sure that basic research continues, because otherwise we'll be in the position of eating our seed corn."

It was a familiar two-part harmony—a dire national problem looming on the horizon, followed by a weighty call to "do something." Did these celebrated scientists represent just another special-interest group "crying wolf"? Or was there something more substantive in what they were saying?

Most media organizations evidently thought that even the newest American Nobel Prize winners were not worth listening to. None of the major networks carried the scientists' remarks. But then, no major network had carried the announcement a week earlier that the men had won Nobel Prizes.[1]

Serious omissions

Granted, this particular press conference was not in itself an earth-shattering news event. But the episode does illustrate an increasingly troubling point: It's becoming more and more difficult for serious matters, especially those involving complex issues, to catch and hold the attention of the American news media. And if the subject concerns a trend or a lapse unlikely to inconvenience the public until some distant and ill-defined future time, forget it.

On the other hand, perhaps there was something missing from the scientists' lament. If a crisis is indeed looming over America, and if, for example, the Congress knows little about the strategic national importance of basic science, the question begs to be asked: Had the new Nobelists ever attempted to rectify the situation by educating their legislators?

"Well, for me, that's a terribly embarrassing question," Curl admitted. "It's terribly embarrassing because I've actually made no effort to influence my legislators or try to get them to do what I want them to do."

Smalley admitted he had had "only brief experiences" with lawmakers. Osheroff said he had to "confess that I've actually never talked to a congressperson in person."

Only one of the five scientists, Richardson, claimed ever to have spoken to an elected official. He had lobbied some in the past, he said. While he found most members of Congress who were directly concerned with science budgets "quite knowledgeable," others were "know-nothings."

"They don't want to know anything about it, because it's too complicated and they're very likely not going to vote for the increases, or even for stabilization, of the science budget," he declared.

Their answers indicated these prominent researchers had stretched their famous scientific detachment to the illogical point of abandoning political reality. In a time of reductionism and retrenchment, it's not likely that anyone will go to bat for scientists if they aren't willing to step up themselves. And while the phrase may indeed characterize many members, calling a member of Congress a "know-nothing" is hardly the way to initiate the enlightenment process. As Will Rogers once said, "Everybody is ignorant, only on different subjects."

The laureates were hardly more inspirational in their personal responses to what they perceived as the second greatest threat to maintaining the U.S. lead in R&D: the state of American science education. They cited anecdotal evidence of declining educational quality.

"… It is my experience," said Osheroff, "having been around to many, many countries, that in fact this country understands less and cares less about what's happening in basic science."

Smalley said he perceived cracks in the science establishment itself. "[W]e do not have the large number of graduate students entering science and engineering," he said. "We can always keep the numbers up, but the quality—that most insidious aspect—I do not believe is what it used to be."

Asked for specific indicators of the decay he saw in the quality of "people coming through the system," Smalley stumbled over the problem of proving a negative. "No. That's the point. Because the question is, what breakthroughs should we have had by this time that we don't have because we don't have that quality? That's why it's insidious."

Finally, the Nobel Prize winners were critical of American private enterprise. Osheroff noted that "… almost all American industry has gotten out of the business of basic research, with, perhaps, the exception of the biological sciences and biotechnology areas." If the nation is counting on the marketplace to provide funding in today's world, Osheroff said, there will be very little because "… the lead time [on results] is simply too long."

But, as with their criticisms of the educational establishment, the scientists could offer no concrete solutions to the problems created by projected industry reductions. "I don't know what the right answer is going to be," said Smalley. "I'm not yet an expert in this area. But I think that the garden right now is not being tended correctly."

Scientists cannot and should not expect the media, the Congress, industry and the public to automatically side with them or to understand their most heartfelt, even demonstrable, concerns for the future without help. There is no such thing as extrasensory perception, as scientists themselves are quick to point out. When scientists and engineers come to the collective arena—in this case, the news conference—they must be armed with numbers, appropriate illustrations and well-thought-out arguments. Most of all, they must improve their persuasive skills.

Mercifully, there was precious little jargon in the Nobelists' news conference. And there was one nearly priceless example of how best to communicate with an alienated public. Osheroff responded to a question about the direct benefits of science and technology with a universally understood metaphor.


Osheroff

"Let me just answer your question by asking one of my own," he replied. "Would you ever consider that, in order to put bread on your table, you would take your children out of school? Or let's make it a broader question and less personal: Should we maybe do without schools because, in fact, they cost a lot of money?

"The answer is clearly 'No,' because the children of today that are being educated are the workforce of the next generation. They're essential, I think, in the same way that the research that we do today will be essential for whatever technologies are developed in the next generation."

Despite the low turnout at this particular news conference and the subsequent paucity of written and broadcast reports, this nation does care about science and high technology. Numerous independent polls indicate this to be so. At this moment in our history, however, there is a profound disjunction between what scientists do in the laboratory and the field and what the public understands. There's a growing gap between two separate and unequal societies—between those who are scientifically literate (and reasonably well-informed) and those who are not.

It's true that, with each advance, science marches deeper into esotericism. But that fact only makes it more imperative for scientists to

think of new ways to explain their work. It also challenges the mainstream media to become and to remain proficient at reporting science.

The U.S. science establishment

Where do scientists work? And who pays them?

The annual research-and-development budget in the United States is approximately $180 billion per year. Of that, in 1997, the federal government provided $73 billion. Of the federal money spent, $40 billion went to defense, the rest to various civilian programs.

The trend in recent years has been for government funding to remain stagnant, or decrease, while industry spending has gone up. Government support is receding to "a junior role in the overall enterprise," according to Daniel S. Greenberg, editor and publisher of *Science & Government Report*, a Washington newsletter. "[This] means that in civilian research, industry outspends government by more than three to one," he observes.[2]

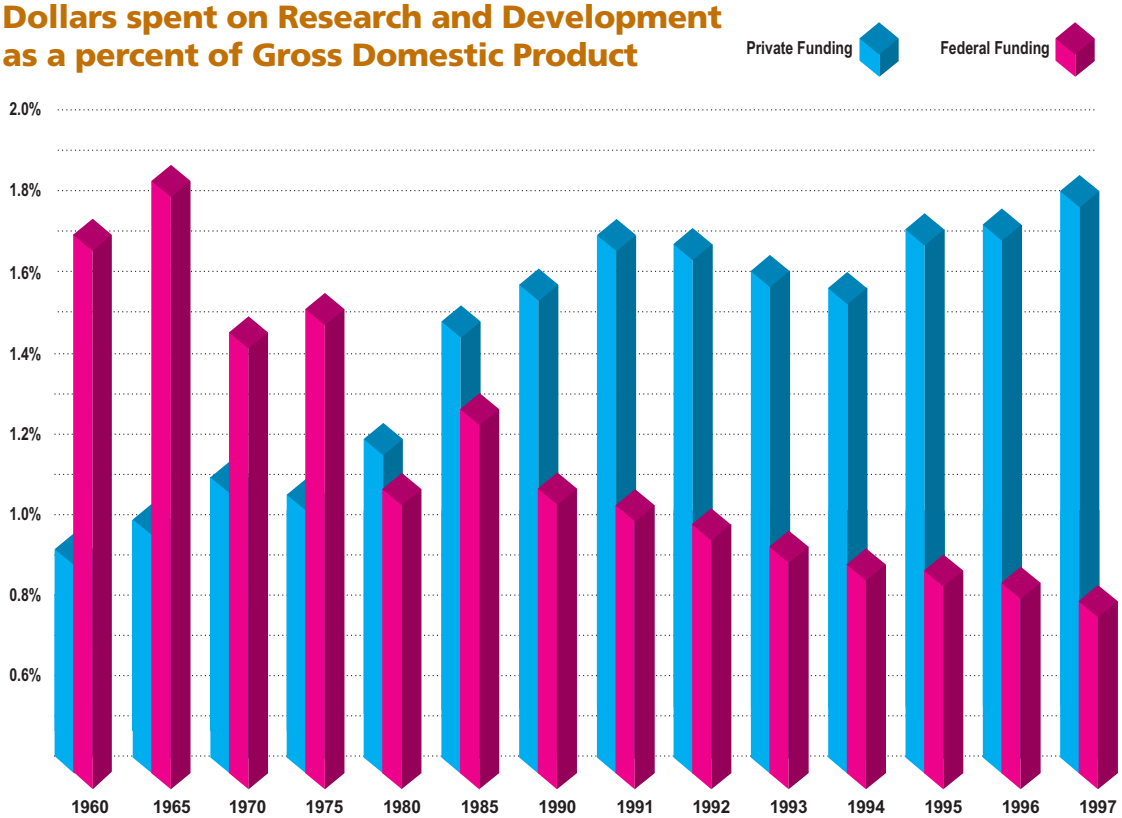
Unfortunately, industry increases don't fully compensate for government cuts. In fact, at least one study indicates that, in the long run, private funding follows the lead of public funding. According to Christopher T. Hill, professor of public policy and technology at George Mason University, a review of the patterns of U.S. R&D funding over the past three decades suggests that, on average, decreases (or increases) in federal funding for R&D are followed by proportionate decreases (or increases) in private funding, one year later.

"Thus, if this historical pattern is followed over the next several years, we should expect to see sharp reductions in private R&D spending following on, and likely stimulated by, the anticipated reductions in federal funding," wrote Hill in the summary of his 1995 study. "The most likely outcome, then, is that industry actions will add to the cuts in federal support for science and technology, not offset them."[3]

The vast bulk of industrial research is "applied science" as opposed to the "basic science" largely carried out in the nation's major universities. Sometimes called "industrial science," applied research is almost exclusively aimed at creating or bettering commercial products.

"Nylon came out of this system," wrote Louis Uchitelle in *The New York Times*. "So did the silicon chip, … cellular phones, color television, modern gene technology, fiber op-

Dollars spent on Research and Development as a percent of Gross Domestic Product



tics and other breakthroughs that eventually created new industries, which in turn helped to expand the national economy at a rapid pace. Much of the effort was concentrated in world-famous laboratories at AT&T, IBM, Eastman Kodak, Xerox, General Electric, DuPont and other giants that dominated their markets and could afford the costly, drawn-out research."[4]

Even though private enterprise outspends the government 3-2 in civilian research, there is no way it will ever take on many vital issues—global warming or ozone depletion, for example. Nor is private enterprise likely to tackle less quantifiable matters such as space exploration, astronomy, archaeology, paleontology and—that favorite with kids of all ages—dinosaur research.

"If we look today at things we regard as important, whether we are thinking about recombinant DNA or microprocessors or any of the important areas of advanced technology, these areas grew out of what was very, very speculative research conducted 20, 30 or 40 years ago," says Sir Derek Roberts, former business executive and now provost of University College London.[5]

This is not to say that industry performs no basic research. However, private investment's share is small and declining. "The shift in emphasis to near-term development is paying off today as American companies excel at turning a generation of good ideas into profitable products," reports Uchitelle. "Yet many corporate executives have decided that basic research for tomorrow is simply too speculative. It should be done, they argue, by university scientists, paid mainly by government."

The problem is that government R&D spending has decreased in real terms by 3.3 percent since 1994. The American Association for the Advancement of Science (AAAS) estimates that a further 14 percent cut is in store over the next five years if the Clinton administration continues on its present course. Other budget analysts say the cut could be as large as 20 percent if Republican plans for a balanced budget by 2002 are enacted. The National Science Foundation, the federal agency that disburses most non-medical basic research money, received a small increase of about 1.5 percent in 1997—up from $3.22 billion to $3.27 billion—an increase that just about kept up with inflation.


Romer

What if spending stays flat or cuts of this magnitude go through? "We are eating our seed corn," says Stanford University economist Paul Romer in the phrase echoed by Nobelist Robert Curl. Romer contends that American private business is still cloning products from the novel discoveries and inventions that came during and after World War II. "If this continues, we will no longer be the nation that is on the cutting edge of new technologies, new products and new markets. For the moment, we still are, but that can't last."[6]

Looking ahead at falling behind

If the United States drops back, others will step forward. Such is the lesson of history.

As has often been the case in recent years, America's stiffest competition may come from Asia. According to Walter Mondale, former vice president and former U.S. ambassador to Japan: "For several years, Japan has invested a larger percentage of its gross domestic product in R&D than has the United States. In July 1996, the Japanese cabinet approved a proposal to spend $155 billion on government science and technology programs over the next five years, of which 95 percent is targeted at civilian technologies. As a result, Japanese government expenditures on civilian R&D have caught up with and will soon exceed U.S. funding in absolute terms."[7]

Closer to home, total Western European spending on research and development is approaching the U.S. total. For example, the

amount of money spent on academic research in Western Europe—about $20 billion in 1992 (the latest figure available)—now equals that spent on U.S. campuses, according to a recent report by the National Science Foundation.

In 1992, Europe graduated almost 300,000 science and engineering (S&E) students, compared to only 173,000 in the U.S. (This compares to 523,000 S&E degrees awarded in Asia in 1992.) Doctoral degrees awarded in S&E fields in Europe totaled 25,310 in 1992, compared to only 18,251 in the United States.

Civilian R&D growth in Europe now exceeds the equivalent United States growth rate by about half a percentage point annually. The total combined R&D investment of Western European countries in 1993 was nearly $104 billion, compared to the $137 billion spent in the United States. This represents about 2.1 percent of Western Europe's combined GDP, compared to the U.S. investment of 2.7 percent.[8]

Performance in individual European nations is admittedly mixed. "Scientists [in Great Britain] are increasingly being forced to get into bed with big business," writes Stephanie Pain in the *UK Guardian*. "The change is partly out of necessity: over the past decade, the Government has cut more than £1 billion from research funding."

The story of Sir Harry Kroto, professor of chemistry at Sussex University and co-winner of the 1996 Nobel Prize for Chemistry with Americans Curl and Smalley, illustrates one of the dangers of starving basic research.

"In 1985, Kroto discovered a new form of carbon, the football-shaped 'buckyballs,'" Pain recounts. "Elongated buckyballs, called nanotubes, have remarkable properties that could make the lightest and strongest materials, and spawn whole new industries—even a revolution in electronics. Britain, however, will not share the winnings from this particular jackpot.

"After the breakthrough, Kroto applied for grant after grant, but got nowhere. In the U.S., meanwhile, researchers had no problem finding backing to delve into this promising new field. Last year, as Kroto picked up Britain's first Nobel prize in almost a decade for his discovery, U.S. and Japanese companies continued to investigate nanotubes with not a single British competitor to worry about."[9]

How ironic if the United States—which stands to profit by transforming the Curl/Kroto/Smalley discovery into new consumer products—should overlook the real moral of this story.

The future of research in America now depends on a complex mixture of opposing forces at work in a society very different from that which put a man on the moon. Some critics say science has had a free ride, especially during the years of the Cold War when almost any project, no matter how far-fetched or unpromising, could get funded. Now that the superpowers are no longer poised on the brink of mutual annihilation, pressures are mounting to make science more applicable, more pertinent, and yes, more profitable.


Brown

"If only one of the funding variables were changing, it would be difficult—but all are changing at once," says Rep. George Brown (D-Calif.), longtime chairman of the House Science and Technology committee and now ranking minority member. "We are now struggling to re-identify something that can replace the security reasoning that guided science and technology over the past 40 years."

Even funding for medical research—which, for the time being, continues to enjoy modest increases—may face closer scrutiny as budget pressures increase. Thirty percent of the nation's civilian research and development budget currently goes toward medical research, as compared to about 5 percent in other industrial countries. And yet the United States has far higher health-care costs and lags behind the other developed nations in infant mortality

and life expectancy at birth.[10]

Nor is the sacred cow of medical R&D—cancer research—exempted from accountability. For over a quarter of a century, cancer spending (currently $2 billion per year) has far outstripped spending on all other diseases. And some experts are starting to raise questions.

"[I]t is reasonable to ask why cancer has been the major exception to our nation's overall progress in improving the nation's health," says Thomas J. Moore, a senior fellow in health policy at the George Washington University Medical Center. "And before we commit still more money to the war on cancer, it is time to ask some searching questions about why we have spent so much on research, screened so many millions of people and invested so heavily in cancer treatment without budging the number that really counts—the overall cancer death rate."[11]

Questions such as these require informed answers and explanations in this new economic climate. Scientists who remain silent do so at their peril. Those who can best explain why their work is important to the nation are those most likely to be funded

"The science and engineering communities will be drawn into this debate or suffer the consequences of its outcome," Brown says. "Researchers must now be able to relate their work to the list of social problems, because these have replaced the threat of communism as a reason for funding."[12]

Out of sight, out of money

Media inattention is being cited by proponents of increased science spending—both inside and outside the science community itself—as a key factor in the reduced outlays that are eroding the nation's scientific stature.

"The Clinton administration," according to David Gergen, "unfortunately, has put a budget forward to the Congress that actually decreases for the fifth year in a row the federal investment in research and education. I would suggest to you that the declines we are seeing are in part a reflection of what's been happening in the media. And that is, in many parts of the country, there has been a declining interest in science in the traditional media."

Shortly before he died, Carl Sagan complained that "almost every newspaper in America has a daily astrology column. Most do not even have a weekly science column."

"When was the last time a scientific topic was discussed on a Sunday morning TV talk show?" Sagan asked. "When was the last time you heard an intelligent remark on science by a president of the United States? You might have to go back to Thomas Jefferson to find one.

"What I'm concerned about is that the consequences of these attitudes are much more dangerous today than in the past," he said. "We have a civilization with immense technological powers. The lives of most of us on Earth are dependent on agricultural technology. The lives of many of us are dependent on medical technology, certainly including me. Science has saved my life; not just that, scientific methods and discoveries of the last five years have saved my life. If we were to back off from science and technology, we would in fact be condemning most of the human population of the Earth to death."[13]

With a few notable exceptions—most recently, the triumphant Mars Pathfinder expedition and the ongoing Mir "deathwatch"—most American newspapers and television news operations basically ignore the accomplishments and failures of science, overlook the nation's investment in science and take for granted the tangible benefits science provides. As Sagan noted, newspapers find space for the daily astrology column and for regular sections devoted to sports, weather, business, entertainment, travel, home decor and any number of other special interests. But only a handful of American newspapers have a regular science section.

Television is a wasteland. While the major networks have science and medical reporters, their allotted air time is measured in minutes per week or less. Of the networks, CNN clearly is superior and devotes the most time to science and technology. Only one cable outlet, the Dis-

covery Channel, is heavy with science. (Incidentally, in national surveys, the Discovery Channel far outpaces the big networks in perceived quality.[14]) Local television coverage of science and technology is almost nonexistent.

Is anybody there?

Less than five months after the Nobelists urged the nation to review its spending on science, their warning was reiterated at an unprecedented gathering of the leaders of 23 of the country's most respected professional organizations, including the American Chemical Society, the American Physical Society, the American Astronomical Society and the American Mathematical Society. The message: Unless reduced spending on research and development is reversed, the nation faces a slow decay.

"When you are on top, the only way to stay there comes through constant effort and diligence," their joint statement said.


Anderson

The president of the American Chemical Society, Paul S. Anderson, put it more bluntly: "We cannot abdicate world leadership on the road to a balanced budget."

The news conference received a small story on page 19 of *The Washington Post.* It was not mentioned in many other newspapers, and the networks completely ignored the scientific establishment's worried plea for increased attention to the nation's future.

And what did the news media fail to tell the American people?

They neglected to report that, according to representatives of more than one million U.S. scientists, the nation's economic competitiveness, health, national security and quality of life are at risk.

"[W]e are in a period of decline," said the leaders of the science community. "This is easily measured by science budgets, which have steadily decreased relative to inflation. We agree with the importance of balancing the national budget. However, to balance the budget, one must ensure future economic growth. The balanced budget and growth are interdependent, just as the sciences are interdependent. On the other hand, the implementation of President Clinton's 1998 budget proposal for science will continue the erosion. It does not even keep pace with inflation, and it is inconsistent with the president's stated national goals."

Those who learned of this unprecedented news conference—media silence notwithstanding—were hard pressed to find more information on it. They were not much helped by the professional organizations that had issued the joint statement. In a clear demonstration of the scientific community's hapless waste of its own resources, the sponsoring societies themselves failed to post the information on their own web sites. Anyone searching for a transcript of the news conference, for background papers or for thoughtful analysis was out of luck. Scientists, quite adept at communicating among themselves on the Internet (it was practically invented for their use), obviously are not yet attuned to using this exquisite tool to reach the public.


Silverstein

The unhappy fact is, very few scientists are any good at talking to the public and/or the news media. "I think we do a miserable job of communicating with the press," says Dr. Samuel Silverstein, chairman of the Department of Physiology at Columbia University. "And I'm not sure why that is."

Until recently, most scientists thought it was superfluous at best and a waste of time at worst to talk to a newspaper or television reporter. In fact, if a scientist talked to the public too much, or too glibly, he would more than likely be despised, even ostracized, by other scientists. Carl Sagan was blackballed at the National Academy of Sciences, almost certainly because of professional jealousy among his peers. There has always been a certain stuffiness in the scientific community with regard to media interaction.

To be evenhanded, there is an historical factor at work here. Many of the nation's most brilliant theorists and experimenters have been engaged in top-secret government work for the majority of their careers. Under such circumstances, talking about their research is a criminal offense. But even outside the cloisters of defense work, scientists have seldom been encouraged to share their discoveries with the general public. The Cold War climate of secrecy still envelops nearly every discipline engaged in the drive toward discovery and creation.

"For 45 years or so, we didn't suggest that it was very important for all these scientists we're talking about to invest much of their time [explaining their work to the public]," says Dr. Neal Lane, head of the National Science Foundation. "In fact, we said quite the other thing. We said: what's critically important, since we are investing taxpayer money for discovery of new ideas about nature and new ways of doing business and new kinds of devices to help humankind, we want you to be in the laboratory, in the classroom—that's what you're capable of doing and that's really where you ought to spend your time."

Now that the Cold War is over, many of the people who built nuclear weapons, rockets, lasers and smart bombs must find their voices. Society has changed, Lane says, and largely for the better. Scientists must change too. Increasingly, they will be required to explain the importance of their work, not only to peers inside and outside their cloisters but to the public as well.

Lane is a leader in the scientific establishment who has taken it as his mission to communicate more effectively with the public. He nudges, cajoles and sweet-talks his colleagues to speak more effectively about the importance of their work.

"I think there is good will there," he said of his fellows during a roundtable discussion about the communications abyss between scientists and the public. "I think there is an understanding that [scientists are now] called upon to do things that they have not been asked to do before. Many of them don't know how to do that, and that's where you who do understand communication can be very helpful."

Lane was directing his remarks to the news-media representatives on the panel: Kathy Sawyer of *The Washington Post*, Ira Flatow of National Public Radio and John Seigenthaler, founder of the First Amendment Center.

"You who do understand communication can be very helpful," he told them.

If that was not a plea, then journalists don't understand communication. Here was the head of the National Science Foundation confronting a national problem and saying to the national media: "Help us."

chapter endnotes

1 CNN did mention the prize announcement. Reuters covered the Washington news conference, and a few newspapers carried the story, including *The New York Times*.
2 Daniel S. Greenberg, "Shortchanging Science," *The Washington Post*, Feb. 19, 1997.
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4 Louis Uchitelle, "Corporate Outlays for Basic Research Cut Back Significantly," *The New York Times*, Oct. 8, 1996.
5 Stephanie Pain, "Did Science Lose its Virtue When it Got into Bed with Big Business?" *UK Guardian*, Feb. 26, 1997.
6 Ibid.
7 Walter Mondale, "America's Challenge," *Science*, Nov. 8, 1996.
8 Laura Vandendorpe, ed., "Research Faces a New Battle," *R&D Magazine*, April 22, 1997.
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10 Tim Beardsley, "Eliciting Science's Best," *Scientific American*, June 1997.

[11] Thomas J. Moore, "Look at the Mortality Rates; The War on Cancer Has Been a Bust," *The Washington Post,* July 23, 1997.
[12] "Research Faces a New Battle," op. cit.
[13] Carl Sagan, quoted in "A Conversation with Stephen Budiansky," *U.S. News & World Report*, March 18, 1996.
[14] In the 1997 EquiTrend Study conducted among 4,000 U.S. consumers by Total Research Corp., the Discovery Channel ranked first among TV brand names. The Learning Channel was second, followed by The Disney Channel (No. 3), CNN (No. 4), PBS (No. 5) and ESPN (No. 6). NBC was ranked No. 9, ABC No. 21 and CBS No. 23.

The 7 Percent Solution

Funding Basic Scientific Research Is Vital To America's Future

By David Gergen

As many of us gazed up at the Hale-Bopp comet this spring, wondrous and serene in the heavens, an angry E-mail ripped through the scientific community below. It was written by Alan Hale, one of the men who discovered the comet two years ago.

Hale, it turns out, earned a Ph.D. in astronomy from New Mexico State University in 1992 and has since had terrible trouble finding decent-paying work. His wife, a nurse, is the family's main source of income. So disillusioned is he with America's "scientific illiteracy" and the drying up of research jobs that he would not encourage today's students to pursue scientific careers.

For many in the field, there is poignant irony in Hale's story. He is one of many younger Ph.D.s who could put their names on new discoveries in science and technology in the years ahead. A recent visit to the California Institute of Technology and the Jet Propulsion Laboratory nearby found scientists bubbling with excitement about prospective breakthroughs. Yet there is a legitimate and growing fear among these same people that the nation really doesn't understand or support their endeavors. Few are as gloomy as Hale, but nearly all share his concerns.

Down, down, down. The clearest form of national support for science is the federal budget, which funds 60 percent of the country's basic research. For decades, expenditures increased. In each of the past four years, however, federal investment in research has declined, and President Clinton's budget calls for yet another drop next year.

Since March, in an unprecedented show of unity, the heads of over 40 organizations representing more than 1.5 million scientists, engineers, and mathematicians have endorsed a joint statement expressing alarm that research investments as a percentage of GDP are approaching a 40-year low. They urge that federal spending on research and development be increased by 7 percent next year—enough to make up for past inflation and to reverse the trend. A growing number of Republicans, led by Texas Sen. Phil Gramm (a deficit hawk), and some Democrats are joining the fight. Gramm wants a doubling of science spending over the next decade.

The arguments for substantial increases are compelling. Some believe the end of the Cold War means we no longer need scientific research to protect our security. What they ignore is that the lag time between basic research and military application is often 20 to 30 years; weapons used in the Persian Gulf war, for example, emerged from research in the 1960s. Who can say with certainty today that we will not need advanced military technology a quarter century from now?

Economists believe research is also essential to growth and keeping our competitive edge. Stanford's Michael Boskin estimates that half of all long-term economic growth since World War II in industrialized nations is due to technological progress—which, in turn, is rooted in basic research. At the University of Pennsylvania, Edwin Mansfield has found that academic research in science has a "social rate of return" in the form of lower prices, better products, and higher productivity that exceeds 20 percent.

Finally, we should understand how science advances our quality of life. Allan Bromley, science adviser to President Bush and now dean of engineering at Yale, points out, for example, that in the past five years "we have learned more about the human brain and central nervous system than in all prior history," thanks to imaging and chemical tests developed by engineers from basic physics, chemistry and mathematics. Since brain-related disorders send more Americans to the hospital than any other disease group, this progress is very good news indeed.

At a time of scarce resources in Washington, it is tempting to see the scientific community as just one more hungry claimant. That's shortsighted. Like public education, serious funding for science is a vital national investment. The men and women in our laboratories stand at the threshold of dazzling new breakthroughs, and the nation should be standing there with them, supporting their work and sharing in their joy of discovery.

CHAPTER TWO

Common Denominators

Curiosity is one of the permanent and certain characteristics of a vigorous mind.

—Samuel Johnson, 1709-1784

If you listen carefully to how they describe themselves, scientists and journalists are alike in many ways. Both groups are highly motivated. Both are above average in intelligence, above average in education, and above all, freethinking.

Both professions view themselves as examiners, analysts and purveyors of reality, in fact willing prisoners of it: to ignore or to compromise any part of the truth is unacceptable. Not only the world but the whole universe—all things visible and invisible—are the proper domain of both scientists and journalists. Attempts to channel the flow of their work into pre-arranged, marketable directions are generally perceived by both as an unwarranted and perilous intrusion into the integrity of legitimate inquiry. Any infringement on the process of pure inquiry, no matter how minor, is regarded ultimately as a denial, or at least a disallowance, of truth.

Competitiveness races in the veins of both. As keen observers of inconsistency, journalists and scientists are equally good players at the game of "gotcha." Most act in accord with George Bernard Shaw's dictum, "You don't learn to hold your own in the world by standing on guard, but by attacking, and getting well hammered yourself."[1]

"You sit in at contentious scientific meetings," Carl Sagan wrote, "You find university colloquia in which the speaker has hardly gotten 30 seconds into the talk before there are devastating questions and comments from the audience."[2]

Stern self-criticism and constant re-examination are also characteristic of both professions. "I don't think there's any profession today or occupation that spends more time looking at its own navel than we do," says Walter Cronkite of reporters.

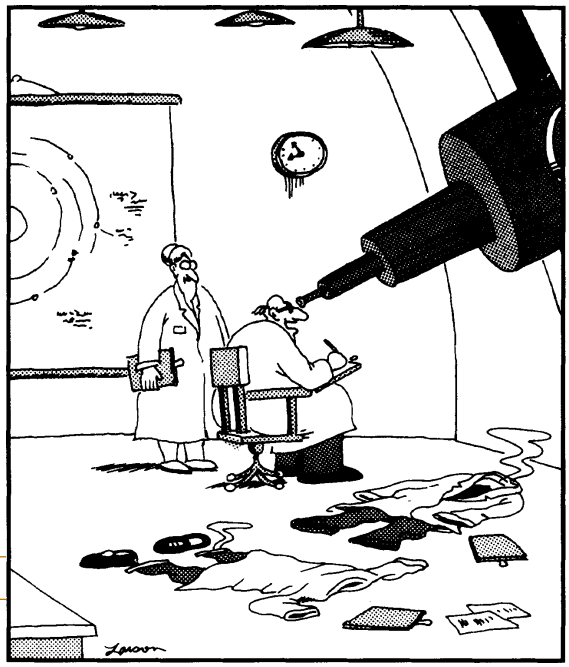
Both journalists and scientists tend to be skeptics who border on the cynical. Both exhibit strong egos. They are generally gregarious among their peers, although some in each camp are better characterized as idiosyncratic loners.

Both must settle for partial truth. The scientist works within parameters set by hypotheses, incrementally adding experimental results to an ever-expanding knowledge base. The journalist works within limitations imposed by a daily deadline, revising each story as additional information is available. Members of both groups are occasionally guilty of selectively interpreting their data.

Unfriendly assessments

How do these not-so-dissimilar groups perceive each other? The scientist sees the journalist as imprecise, mercurial and possibly dangerous—"a man who knows the price of everything, and the value of nothing," to borrow Oscar Wilde's phrase.[3] The journalist sees the scientist as narrowly focused, self-absorbed, cold-eyed and arrogant. Or as Ted O'Brien, news director for Boston's WABU-TV, noted on the survey form he returned to the First Amendment Center: "They are somewhat superior in their attitude to those not of their world."

In fact, most experienced reporters today are well-educated and broad-based in their outlook. Very often they are voracious readers and widely traveled. The best of them keep large personal files, phone books and diaries



"First that cretin Foster and now that jerk Cummings has instantly evaporated! ... I tell you, Ms. Goodman, without a doubt, I'm looking at an authentic full-fledged wishing star!"

and, if they work for the larger, better-funded media organizations, they also have access to enormous databases and excellent research staffs.

Most are excellent listeners and sharp interrogators. If there is a sliver of doubt in a proposition, they will find it; if an argument is possible, they will develop it. They are by nature curious, and by habit good storytellers. If forced to take sides, they will probably go with the underdog. Many consider their work a high calling, a form of quasi-public service.

Reporters come in two basic types: general assignment (who cover any breaking news item) and specialists. In some newsrooms, these roles overlap. Specialists—or beat reporters—are often found covering politics, business, sports, consumer issues, fashion, food, entertainment and science.

Scientists come in as many, if not more, types and temperaments. Theirs too is a world of generalists and specialists, the latter increasingly sub-specialized in modern times. In years past, inspiration alone could propel an experimenter to lofty discoveries, but today a science career doesn't really begin until the Ph.D. is earned. This means "that science is cumulative in a quite special sense," according to J. Robert Oppenheimer, the American physicist who directed development of the atomic bomb.[4] In the minds of many, scientists' scholarly achievements elevate them to a special plane in American society, but this intellectual status is also why "the growing edge of science seems so inaccessible to common experience."[5]

When tortoise meets hare

It is hard to overestimate the value of scientific contributions—most of them now taken for granted—to modern life. Indeed, a new complaint from scientists is that the public no longer appreciates their work, their long years of training and the many blind alleys they must traverse—what Oppenheimer described as a "long tunnel, at the end of which is the light of discovery." The nuclear scientist freely admitted, however, that the complexities of modern science do make this tunnel "discouraging for the layman to enter, be he an artist, scholar, or man of affairs."[6]

Or be he/she a journalist, we might add.

"When we talk about the marriage of science and journalism, our dilemma is clear," says science writer Kathy Sawyer of *The Washington Post*. "Science is slow, patient, precise, careful, conservative and complicated. Journalism is hungry for headlines and drama, fast, short, very imprecise at times."

Many of the misunderstandings between scientists and journalists proceed from the fact that the disciplines demand two completely different standards of evidence. To use a legal analogy: scientists work to meet the standards set for criminal cases (which must be proven "beyond a reasonable doubt"); journalists, because of deadline pressures, more often work at the level of civil cases (where preponderance of evidence is the standard of proof).

Matched against the minute-by-minute demands of journalism, science would seem to be a leisurely calling. But remove the time element, and you find two professions that are quite similar. Both journalists and scientists are data collectors who utilize their experience and insight to bring understanding and order out of uncertainty. The pressures for accuracy, significance and timeliness are roughly equal.

It's the dissimilarity in output that can create tension and anxiety when the two cultures interact. As survey respondent Jim Loy of WOOD-TV in Grand Rapids, Mich., put it: "Scientists and journalists have a lot in common

in the search for knowledge and nothing in common when it comes to reporting results."

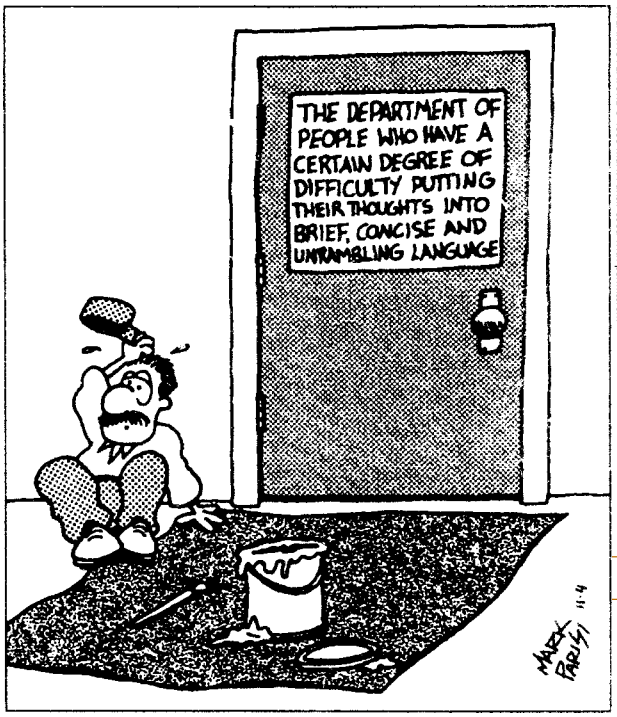
Scientists are notoriously reluctant to state unequivocally that their most recent discovery is a "newsworthy" event, a "breakthrough," which of course is what the journalist needs/wants. By its nature, the work of most scientists proceeds by degrees, step-by-step, not with a "Good-Lord-Mabel-listen-to-this" leap forward. In many cases, the importance of scientific work is not immediately obvious, sometimes even to the scientist. In almost all cases, discoveries are only an incremental part of a larger undertaking. Working within the bounds of the accepted "scientific method"—observe, hypothesize, test, replicate—only the most foolhardy experimenters would make the kind of sweeping claims for their results that headline writers live for.

Journalists, for their part, contend that if they wait for every conceivable issue to be settled and every controversy to be resolved, the story will never be told. Not that reporters and editors don't respect the integrity of facts and interpretation. Like scientists, they must make the best judgment possible based on the information at hand. But journalists are compelled to make such calls on a day-to-day, sometimes minute-to-minute basis, whereas scientists often have months or years to complete and publish their research.

Language barriers

Language use is another key source of the tension between scientists and journalists. The fact that journalists frequently overlook or minimize the precise, qualified language that communicates the tentative nature of research findings angers and dismays many scientists. Scientists in the survey conducted for this report indicated they are often reluctant to talk to the media for fear of having their research mischaracterized and distorted.

The irony is that both journalists and scientists consider themselves fastidious users of language. The problem may lie in the ends to which each uses words and in the fact that identical words may assume different meanings within the differing contexts of science and news.



"Often the very fact that the words of science are the same as those of our common life and tongue can be more misleading than enlightening, more frustrating to understanding than recognizable technical jargon," wrote Oppenheimer. "For the words of science— 'relativity,' if you will, or 'atom,' or 'mutation,' or 'action'—have been given a refinement, a precision, and in the end a wholly altered meaning."[7]

Take the term "theory," for example. Theory is one of those words that scientists define differently from everyone else. To a scientist, a theory is not, in the vernacular of the street, a tossed-off idea or opinion (as in, "Oh, that's just some theory"). A scientific theory is a well-developed assemblage of ideas confirmed by abundant research that has been conducted over a long period of time. In terms of the degree to which it is accepted as fact, a theory is just short of a law. And scientific "laws" are not subject to interpretation.

On the other hand, the single complaint most often expressed by journalists surveyed for this report had to do with scientists' dependence on scientific jargon. It sometimes seems as if the whole scientific establishment has absent-mindedly misplaced English somewhere between high school graduation and the awarding of the Ph.D.

Because the speed at which information moves is now increasing exponentially around the globe, it's important that the language bar-

rier be bridged soon. It's a crucial time for the relationship between scientists and journalists. As Kathy Sawyer notes: "The new technologies are increasing, not reducing, the gap in our perspectives and culture."


Sawyer

The current acceleration of information imposes increasing pressure on journalists to make ever quicker judgments about what the public sees and hears. The rate at which this is occurring is something new. Within the lifetimes of journalists not yet middle-aged, there was a period when deadlines came only twice a day, determined by the morning and evening newspapers and telecasts. In the newsrooms of today's all-news channels, deadlines are virtually continuous. And as more and more newspapers develop web sites, their deadlines also are shifting to meet the demands of Internet surfers as well as the requirements of the nightly press run. It's a truism in news as well as science that, as speed increases, so does the opportunity for error.

Margin of error

This point brings us to yet another difference between science and journalism: the margin of error.

Scientists have an extraordinary advantage over journalists: they usually can (and, indeed, they must) devise valid tests for their hypotheses. Journalists are frequently thrust into exceptionally ambiguous environments in which the outcome is completely unpredictable.

"Knowledge is what we get when an observer, preferably a scientifically trained observer, provides us with a copy of reality that we can all recognize," wrote historian Christopher Lasch a few years ago.[8]

Journalists hardly ever have measurements of such precision; almost always they are forced to depend on notoriously inaccurate eyewitness descriptions, imperfect recollections, and interpretations provided by a second or third party—someone who may have a fallible memory at best and a hidden agenda at worst. By training and temperament, however, reporters and editors are prepared to hone in on what they can confirm and qualify what they cannot. A well-written news story, like a scientific paper, will feature facts and caveats and offer more than one interpretation if the data warrant.

In science, on the other hand, it is a cardinal rule that any experiment must be constructed in such a way that the data can show not only that the hypothesis is true but also that it might be false. In the parlance of science, the hypothesis must be "falsifiable."

Here's an example: In the early part of this century, Albert Einstein postulated the revolutionary idea that light rays could be bent by gravity. Smart guy, Einstein, but the demands of the scientific method wouldn't let him just leave it at that. He had to propose a way to test this hypothesis, one way or the other. And he did.

He proposed that, during the next solar eclipse, when the moon would be blocking nearly all the light from the sun (the largest gravitational object in the neighborhood), scientists should look carefully at the stars that passed behind the sun, stars whose locations were precisely known. If these stars should appear displaced or altered slightly, this would indicate that their light rays had bent slightly as they barreled toward Earth-based observers. If the light rays were bent—and the stars therefore appeared to shift location—the theory would be proved. If the stars appeared in the spots where they were expected, the theory would be falsified. Needless to say, the rays were bent by the gravitational pull of the sun, and Einstein was proved right.

Objective vs. subjective

A fourth major difference between scientists and journalists involves the concept of objectivity. By its very nature, science takes objectivity as its central premise. Research results must be, as noted above, falsifiable, and are, by definition, replicable. Therefore, the vast majority of lab-based and field researchers make every effort to be unbiased, lest they be unmasked and ridiculed by their peers.

This is not to say that every scientist is honest and above temptation. The very fact that the term "junk science" has come into the vernacular indicates that the public knows not all "science" results are objective or legitimate. It's also easy to read many different meanings into the same set of data. But these are exceptions to the rule.

Journalism, on the other hand, is a largely subjective enterprise. In fact, some journalists have given up on the notion of objectivity altogether and adopted instead the concept of journalistic "fairness," which has stirred yet another debate within the profession.

The scientific method—which includes observation, hypothesis, testing, theory, testing, proof, peer-review and, finally, publication—may require months or years to follow its course. It bears little resemblance to the journalistic process practiced at many newspapers and television stations. A comparable journalistic cascade for breaking news would be: identify event or tip (from daybook, briefing or leak), check with sources and files, obtain comment and additional details, check facts, publish or transmit—a process routinely concluded in less than a working day. Indeed, that's why the end product is called "news"—something that is new or different from what was reported in the last edition or on the latest broadcast.

It should be noted that commingled with this sometimes frantic effort to chronicle the immediate is the longer-term commitment of responsible journalists to document fundamental societal movements—health and safety, national defense, education, welfare, economics, government performance, quality of life, business and cultural trends. It is in this arena of internally generated enterprise stories that most Pulitzer Prizes and other prestigious awards are won.

One final divergence between journalism and science concerns the capability scientists have for accurately measuring the effects of their work: Successful vaccines cure diseases. The Hubble telescope photographs a comet crashing into Jupiter. A spectroscope identifies the classic signature of each natural chemical element. Scientific laws are reduced to mathematical expressions that permit results of future experiments to be predicted with various levels of confidence.

On the other hand, journalists can seldom know anything with certitude. The practice of journalism depends on adapting to the vagaries of human unpredictability. Accurate assessments of eventual outcomes are impossible for reporters covering the Middle East peace process, the most recent tax legislation, suburban zoning, official malfeasance, the race for city council, abortion, gay rights or the environment.

Added to this is the multiplier effect of the publicity itself. Does a politician act out of concern for public welfare or because of an embarrassing story? Are the air and water cleaner because a bureaucrat noticed that rivers were catching on fire and children were choking or because the media put and kept these issues relentlessly on the public's agenda? There's no way to know.

Changing times, concurrent threats

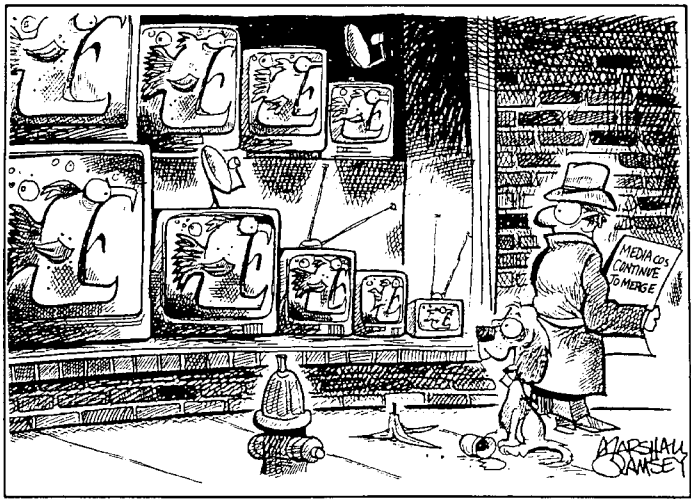
With the dissolution of the Soviet Union, federal R&D funding has begun to dry up. The days of throwing money at problems—no questions asked—in the name of national defense are long gone now, as the nation struggles to bring the budget deficit under control. Science funding is dependent on proof of favorable cost/benefit ratios as never before. Scientists whose research doesn't immediately

translate into new or improved consumer products are at a disadvantage in the current environment. The scientific community is worried that the nation is preparing to cut back on the total dollars spent on pure science—that is, on federal support of research and development—with no prospect that private industry will pick up the slack.

Concurrently, journalists are wrestling with the public's increasing dissatisfaction with their basic product. For years, the public has given the news media very low marks in opinion surveys. As a group, the women and men who report the news are not very highly regarded by most Americans. No one really knows why. One popular "theory" (in the journalistic, not the scientific, sense) is that journalists have become too detached from their audience; they dig up, plow around in and sift through matters most people couldn't care less about.

"In many ways, journalism has become more interesting and more expert than ever," observes columnist William Raspberry of *The Washington Post*. "The people attracted to the business are far smarter on average than they used to be, and from more diverse backgrounds besides. Journalism is as important as it's ever been.

"But at the same time it has become less civic: that is, less concerned about using its power and influence for citizen education and public improvement.



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"It's like hunting. Hunters used to bag deer for a purpose—feeding their families. Now we bag deer—or public figures—for the sheer sport of it. I don't count it an improvement."[9]

In many newspapers and television stations today, reporters and editors are fighting against their own management, who are in turn squeezed by stockholders. Journalists are increasingly asked to select and construct not just intrinsically interesting or important stories, but those that are somehow helpful to the audience—"news you can use," in the current parlance.

The news outlets from which most Americans get their impression of the day's events are largely owned and operated by business conglomerates that put a premium on ratings and circulation with a direct impact on the bottom line. The more people who watch or read, the higher the profits. And profits in the news business these days are very, very good.

All the major networks and most of the major-market TV stations they own are parts of gigantic business enterprises—NBC (General Electric), CBS (Westinghouse), ABC (Disney), CNN (Time-Warner), Fox (Rupert Murdoch's infotainment empire, NewsCorp). Local television stations, especially those in major cities, are often owned by the same companies. Others are parts of smaller, but still influential, chains.

A majority of U.S. newspapers and magazines, with a few notable exceptions, belong to large companies that often have overlapping television interests. How large? In the spring of 1997, the Knight-Ridder newspaper chain, second largest in the country, bought *The Kansas City Star*, *The Fort Worth Star-Telegram* and two smaller newspapers owned by Walt Disney Co. for $1.65 billion. In 1993, *The New York Times* bought *The Boston Globe* for $1.1 billion.

Noting this modern consolidation, Richard Harwood wrote in *The Washington Post*, "Wall Street underwrites the mergers and technology of the industry and exerts great influence dictated by the interests of investors and shareholders in maximizing profits and efficiencies." Further, "it has become neces-

sary in this more placid era to create new agendas and missions that the press is still struggling to define. News priorities are less obvious. Our audiences have new and more personal agendas and many alternative sources of information and entertainment."[10]

NBC News revamped its news agenda by de-emphasizing Washington, foreign and political coverage in favor of stories that, according to *Time* magazine "… are more likely to go for the gut and the pop-cultural hot button." *Time*, which has itself undergone numerous style changes in recent years, noted that "…the NBC Nightly News has had a remarkable makeover: fewer stories per night, moving the broadcast closer to a magazine-show approach; less traditional news from Washington and more on user-friendly topics like health, the family and consumer issues; and a jazzier format, with lots of catchy labels for continuing segments.

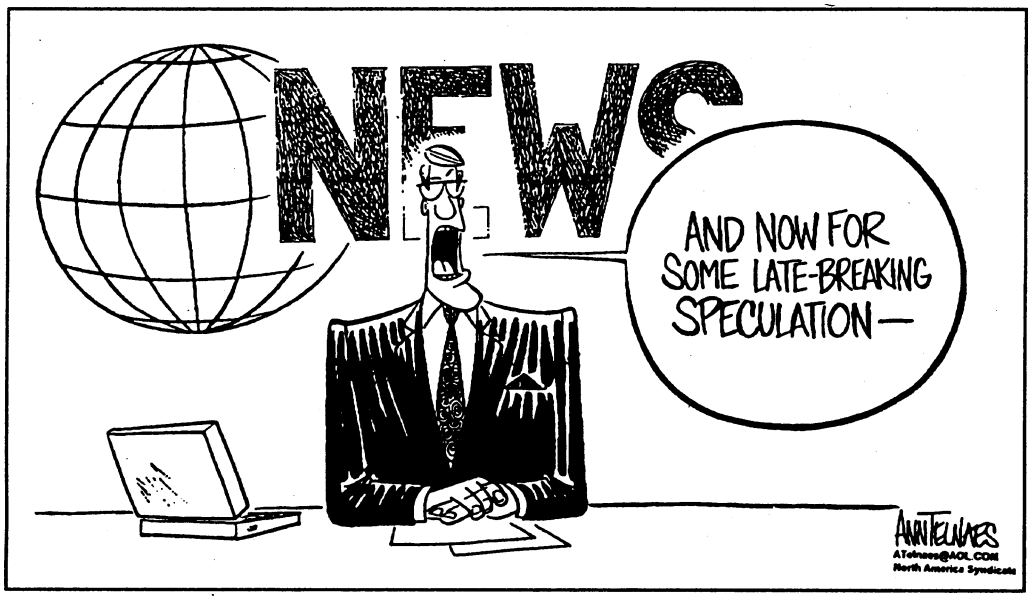
"The success of NBC's new approach," *Time* continued, "has pointed up the problem facing every news organization: how to attract an audience that seems less and less interested in news and yet, at the same time, is bombarded with it from a multitude of reputable and disreputable sources. The mantra among network executives is that the evening news must find a way of standing out in this crowd, offering something viewers can't get elsewhere. Yet if that were really the goal, the nightly news would be steering away from O.J. and JonBenet Ramsey (the very stories that are covered ad nauseam on every local newscast and magazine show in creation) …."[11]

What does the public want?

But if journalists are alienated from the public—not reporting what most people want to read and see—what should they be covering? Surveys are continually being taken to determine the public's appetites. Consultants, with their charts and graphs, abound in the industry. Yet the answers remain elusive.

Moreover, a corollary argument continues among editors and news directors: Do you simply give readers and viewers what they "want," as determined by surveys and focus groups, or do you tell them what they "need" to know, based on the news director's or editor's best judgment?

The range of potential answers is as broad as American society is diverse. A focus group dominated by macho males might want football on the front page each day; a group composed of working mothers might want school



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and day-care stories; a group of retirees might want mutual-fund news. An editor imposing his/her "instincts" might opt for congressional inaction stories, or a wine column or "tits, tots and tears," as one former *New York Daily News* editor put it.

Patently, reporters and news managers are enmeshed in, and often bewildered by, the same uncertainties and contradictions that characterize the larger society. Many, in their most private moments, will say they vastly prefer stories of significance and import—stories in which the public seems to have little interest right now.

If that's the case—and we have no reason to doubt it—a heavy responsibility rests on the shoulders of both journalists and scientists. Their obligation is to make strong and compelling arguments for continued support of the benefits science and high technology have brought and promise to bring to society at large.

The scientific community as a whole needs to help the public understand complicated issues by providing a context for the sometimes contradictory work of individual investigators. Journalists and the public are disconcerted by conflicting scientific claims played up by advocacy groups. Global warming, the value of mammograms, second-hand smoke, toxic substances, breast implants, environmental matters—there is a whole range of issues on which scientists seem sharply divided. Journalists whose job it is to explain various scientific claims to their viewers and readers seldom have time to determine credibility by judging the proof on their own. As a result, they can find themselves "whipsawed by advocates," as journalist Chris Warden of Los Angeles termed it on his survey form.

A new interest in interaction

There is one intriguing new finding in the survey conducted for this report: an apparent willingness among both scientists and journalists to bridge the disquieting gap that separates them. Neither side thinks the issues are too complex to be understood and reported. This means the primary danger ahead is plain old inertia.

At a forum on "Enhancing the Dialogue Between the Scientific Community and the News Media," held several years ago under the auspices of the American Association for the Advancement of Science and the University of Puerto Rico, science writer Boyce Rensberger of *The Washington Post* said, "There are conferences like this that have been going on for a number of years, but it does not seem to solve the problem."

Finally the time is ripe for solution, in large part because both professions perceive their existence at risk, and also because there are obvious ways in which the communication of science to the public can be systematically improved.

The great detective-story writer Raymond Chandler got it about right. "There are two kinds of truth," he wrote, "the truth that lights the way and the truth that warms the heart. The first of these is science, and the second is art … Without art, science would be as useless as a pair of high forceps in the hands of a plumber. Without science, art would become a crude mess of folklore and emotional quackery."[12]

Substitute "journalism" for "art."

chapter endnotes

[1] George Bernard Shaw, *Getting Married*, 1908.
[2] Carl Sagan. *The Demon-Haunted World* (New York: Random House, 1996).
[3] Oscar Wilde, *The Picture of Dorian Gray*, 1891.
[4] J. Robert Oppenheimer, *Science and the Common Understanding* (New York: Simon and Schuster, 1953).
[5] Ibid.
[6] Ibid.
[7] Oppenheimer, op. cit.
[8] Christopher Lasch, "Journalism, Publicity, and the Lost Art of Political Argument," *Gannett Center Journal* (New York: Gannett Foundation, Spring 1990).
[9] William Raspberry, "Good News That Works," *Washington Post*, April 21, 1997.
[10] Richard Harwood, "So Much for the Scoop," *The Washington Post*, April 7, 1997.
[11] Richard Zoglin, "Newscast in Overdrive," *Time* (Feb. 17, 1997).
[12] Raymond Chandler, *Notebooks of Raymond Chandler* (New York: Ecco, 1976).

CHAPTER THREE

Dams, Diversions & Bottlenecks

… The scientist is wiser not to withhold a single finding or a single conjecture from publicity.

Johann Wolfgang von Goethe, 1749-1832

It would be inappropriate to say that the nation is wholly deprived of science news. In fact, there is a great deal available to those who know where to find it.

Several major newspapers, most prominently among them *The New York Times*, *Los Angeles Times*, *The Washington Post*, and *The Wall Street Journal,* seldom miss or fail to develop an important science story. Likewise, the national magazines stay on top of major discoveries. In addition, specialized publications such as *Scientific American*, *The Sciences*, *Science* magazine and several score trade publications and other peer-reviewed journals offer the latest in research news.

The question is: Why, except for these publications, which reach only a fraction of the American populace, do most of the American news media largely ignore science? What prevents the television networks, the local television news operations, the radio news services (National Public Radio notwithstanding) and other newspapers—the sources from which most Americans get their news—from covering this key aspect of American life?

There seem to be four major barriers to the effective communication of new scientific knowledge, each of which will be treated at length in later chapters. The first impediment is imposed by scientists themselves.

Scientists who don't speak English

To begin with, scientists as a group are not efficient or effective in explaining their work to a lay audience, primarily because they are oriented and focused on the research itself, and are not trained particularly well to communicate that knowledge to the general public. They tend to be wordy, unnecessarily detailed and overly technical. They fall into jargon that is incomprehensible to anyone outside their disciplines.

"Traditional scientific training," says Dr. Neal Lane, "does not prepare its graduates very well … to talk plain English!"

Goldin

NASA top executive Daniel J. Goldin is waging a campaign in his own agency to cut down on science and tech-speak. "I am a rocket scientist," he says. "I go into our NASA laboratories and I talk to our people. … I say, 'Stop, I don't understand what you're talking about.' Now, I have the luxury of doing it as the boss. But could you imagine: I don't understand because they make up words. They literally invent words."

The ability to focus narrowly on the scientific work at hand is an admirable quality when a Cold War threatens to heat up or when human survival is at stake in the race to conquer a dangerous disease. At such times, society forgoes explanations concerning its investment in science in exchange for quick results. But challenges to survival having been met, society once again focuses on issues like tax cuts, downsizing and devolution—and expects simple answers from scientists about the basic value of the work it is asked to support.

These expectations are further complicated by the public's tendency to expect scientists—

because they are held in such high esteem—to be all things to all people, to snap Walter Mitty-like from their burners, beakers and computers and transform themselves into fluent guides who can explain the mysteries of the universe.

Reality, of course, is quite different. While some scientists and engineers are extremely gifted in their fields, the vast majority are no more skilled at communicating with the masses than anyone else.

"Of course scientists are people," said Carl Sagan. "Who ever imagined anything different? And of course scientists are subject to all of the failings and the vulnerabilities and weaknesses that politicians and theologians and everybody else among us are." [1]

Not only are many scientists and engineers isolated, unskilled communicators, they also tend increasingly to specialize in fields that are simultaneously growing narrower in scope and greater in number.

"We are, of course, an ignorant lot," observed physicist J. Robert Oppenheimer at mid-century. "Even the best of us knows how to do only a very few things well; and of what is available in knowledge of fact, whether of science or of history, only the smallest part is in any one man's knowing."[2]

There is something else as well. Scientists are often punished by their colleagues if they go public. According to Ira Flatow, host of *Science Friday* on National Public Radio, many scientists "… are fearful of speaking out because of the [threat of] ruination from their colleagues. There are a lot of scientists who would like to talk to you, and would like very much to talk about their work, but they will become anathema in their laboratory. I've found this in 25 years that I've been covering scientists. Over and over and over again it's been told to me, 'I can't speak to you because I won't be able to walk down the hallway the next day without people coming up to me and saying, "How dare you talk to the press?" ' "

Whatever the reason, the vast majority of scientists rarely ever talk to journalists. This is one of the key findings from the survey conducted for this report. Twenty-six percent of the scientists who responded said they had never been interviewed by a reporter; 45 percent said they are interviewed only "every few years." Just 4 percent said they talk to journalists once a month or more often.

The inability of scientists and engineers to communicate clearly and regularly with those outside their disciplines all but dams the massive cascade of new knowledge at its source, reducing the flood to a lesser flow that is funneled toward reporters.

Reporters who don't speak science

Many otherwise well-educated writers and reporters have never taken the time to become familiar with the culture of science, its language and its methods.

Cleghorn

According to Reese Cleghorn, president of the *American Journalism Review* and dean of the College of Journalism, University of Maryland: "Reporters and editors may still have the hang of politics and government and certainly the yen for covering the textures of lifestyles, but they remain largely ignorant when it comes to the sciences, for instance, where many of the new frontiers are to be found."

Certainly, reporters aren't expected to have a handle on all the esoterica associated with research and engineering. But journalists tend not to have even a liberal-arts background in the sciences. Few understand the scientific method, the dictates of peer review, the reasons for the caveats and linguistic precision scientists employ when speaking of their work.

No less a journalistic luminary than Walter Cronkite discussed his own insecurities as a science reporter in his book *A Reporter's Life*.

To report accurately on the U.S. space program required many long hours of study and research into such arcane topics as "the idiosyncrasies of the physics of moving bodies in the weightlessness and atmosphere-free environment of space," Cronkite wrote. He tried his best to experience the training of the astronauts. He rode centrifuges and a converted Boeing 707 that could simulate weightlessness, the latter known as the "Vomit Comet."


Cronkite

"I have often wondered," Cronkite wrote in retrospect, "if my late University of Texas physics professor, wherever he resides in his immortal reward, was aware of my CBS space broadcasts. It was that same Professor Boner who failed me in first-year physics because, among other things, I couldn't understand why a pulley works. If he heard me explaining orbital mechanics to an audience of trusting millions, I'm afraid the good professor would spin in his grave."[3]

Gatekeepers who are uncertain

Information funneled through journalists soon meets a third obstacle: the editors and producers who decide which stories will be printed or aired. These gatekeepers determine the amount and type of science and technology news that will ultimately reach the public. They must decide the relative importance of each new scientific discovery or technological development.

Few editors feel qualified to make sound judgments about the merit of science stories. And others, according to John Noble Wilford of *The New York Times*, underestimate the ability of their readers to understand well-written science stories.

"I think a lot of editors do that all over the country," Wilford says, "partly because editors, by and large, rose in the organization through covering politics or business or, in a few cases, sports—the triumvirate of journalism, as it has been practiced over the years—plus a good crime story every so often."

One of the most experienced science journalists in the nation, Wilford urges editors to expand their thinking. "Science is really a latter-day part of the journalistic menu. It really began as a regular thing with World War II, particularly in the aftermath of World War II."

Editors, however, resent being told what to put in their papers, even by respected big-city writers.


Gartner

"Maybe those stories are of tremendous interest and importance to the readers of *The New York Times*," says Michael Gartner, Pulitzer Prize-winning editor (and owner) of the *Ames* [Iowa] *Tribune*, "but maybe [they're] not of such importance to the readers of the *Omaha* [Neb.] *World Herald*. Maybe [those readers] have interests that are more important."

Gartner, the former president of NBC News, says, "I live in Iowa now, and the biggest story in Iowa is hog lots. That is a science story. It is not basic scientific research, maybe, but it sure is a science story."

Gartner feels science is adequately covered and that those who lobby for increased coverage "sound like the chamber of commerce or the PTA"—just another special-interest group complaining of neglect.

Columnist and commentator David Gergen profoundly disagrees. He sees a new division developing in American society, one based not on money or ethnicity, but on where one lives and which paper he or she subscribes to—or can afford to subscribe to. The issue is access to knowledge.

"The top newspapers are very good [at reporting science and technology]," he says, "but there's a very definite class bias in the way that information is shared in society. Just as we are separated out in our society by income, we are increasingly separated out by information and understanding. And our growing issue is: whether the people who are not in that top segment [that is getting] a chance to read *The New York Times* or [subscribing] to the *Los Angeles Times* or *The Wall Street Journal* … can share and participate in their own futures."

National Science Foundation Science Survey

The quiz given by researchers for the National Science Foundation as part of a larger survey to determine how much American adults know about basic science issues, as well as what their attitudes are towards science and technology. The survey was conducted for the National Science Board's *Science and Engineering Indicators 1996.* Answers are below, along with the percentage in the survey who answered correctly.

1. The center of the Earth is very hot. *true or false*
2. The oxygen we breathe comes from plants. *true or false*
3. Electrons are smaller than atoms. *true or false*
4. The continents on which we live have been moving their location for millions of years and will continue to move in the future. *true or false*
5. Humans beings, as we know them today, developed from earlier species of animals. *true or false*
6. The earliest human beings lived at the same time as the dinosaurs. *true or false*
7. Which travels faster: light or sound?
8. How long does it take for the Earth to go around the sun: 1 day, 1 month or 1 year
9. Tell me, in your own words, what is DNA?
10. Tell me, in your own words, what is a molecule?

Answers, along with the percentage who had correct responses:

1. True. *78%*
2. True. *85%*
3. True. *44%*
4. True. *79%*
5. True. *44%*
6. False. *48%*
7. Light. *75%*
8. One year. *47%*
9. DNA, or deoxyribonucleic acid, is a large molecule in the chromosomes that contains the genetic information for each cell. *21%*
10. Molecule is the smallest unit of a chemical compound capable of existing independently while retaining properties of the original substance. *9%*

Note: The survey was conducted by researchers at the International Center for the Advancement of Scientific Literacy at the Chicago Academy of Sciences for the National Science Foundation. The sample size of the survey quiz was 2,006. The people were selected by random digital dialing from among American adults who have telephones. The survey was conducted by telephone in October 1995. The margin of error was plus or minus 3 percent.

An ill-equipped public

When the once-mighty cascade of scientific and technological information finally reaches the American public, it's not much more than a trickle. Sadder still, many Americans don't know what to make of the information that gets through. They're ill-prepared to receive it.

Still, in survey after survey the American public says it wants to know more about science and technology.

Inspirational, yes. But it's also quite possible that people respond to pollsters' questions with what they think are the "correct" answers. Editors bring this up, because there is evidence that few newspaper readers (outside of those who take *The New York Times* and a few other publications) are avid and faithful readers of science stories. (Whether the science stories ignored by such readers are poorly chosen and/or written is another issue.)

Still, there is little question that the American educational system has failed to produce a reading and viewing public prepared to grasp the nuance and significance of scientific developments. In one survey, only about a quarter of Americans considered themselves well-enough informed about the "nature of scientific inquiry" to make adequate judgments about reports they might read or see in the media.[4] Such a statement reinforces the views of some editors that the public is not really hungry for science stories, because it won't understand them.

Dr. Gerald Wheeler, executive director of the National Science Teachers Association, agrees that "the issue with the general public is an indifference or an insecurity." A nuclear physicist who also has been involved in producing educational science television programs, Wheeler says the public loves the Wheeler sound of science-related words.

"They love 'Einstein,' 'superconductor', 'super' this, 'super' that. But there is something of a reluctance to stay with a particular article" long enough to understand it, he observes.

Public insecurity, gatekeeper bias, reportorial uncertainty and scientific insularity have combined to produce a swaggering national population proud to lead the world in science and technology but woefully unable to understand or appreciate much more than flash and gadgets.

"Our willingness to be ignorant seems to know no bounds," says Cronkite.[5]

chapter endnotes

1 Carl Sagan quoted in "A Conversation with Stephen Budiansky," *U.S. News & World Report*, March 18, 1996.
2 Oppenheimer, op. cit.
3 Walter Cronkite, *A Reporter's Life* (New York: Knopf, 1997), p. 280.
4 Dennis Normile, "Global Interest High, Knowledge Low," *Science Magazine* (15 Nov. 1996).
5 Cronkite, op.cit., p. 284.

CHAPTER FOUR

Analyzing Current Attitudes

"Science is built up with facts, as a house is with stones. But a collection of facts is no more a science than a heap of stones is a house."

—Jules Henri Poincaré, 1854-1912

The yearlong study leading to publication of *Worlds Apart* began with a survey of scientists and journalists to probe their attitudes toward each other and their views on transmitting and translating new scientific information through the media to the public.[1] Among the survey findings:

- Scientists complained that reporters don't understand many of the basics of their methods, including the proper interpretation of statistics, probabilities and risk.
- Journalists complained that scientists are much too wrapped up in esoteric jargon and fail to explain their work simply and cogently.
- Scientists said the news media oversimplify complex issues.
- Reporters said scientists don't understand that "news" is a perishable commodity that must be made relevant to the reader and viewer.
- Both groups said the American public is often confused and gullible, due largely to the low level of scientific literacy in the population at large.

In its broadest terms, the survey indicated that both groups recognize serious shortcomings in the reporting of science stories, and it highlighted what were viewed as the impediments. Many of the views were strongly held. In fact, in First Amendment Center studies of other institutional entities covered by the news media—the clergy, corporations, the military, even politicians—nowhere has the distrust toward journalists been so pronounced or so pervasive as in the science/technology community.

The good news: a large majority of both scientists and journalists feel there is no fundamental reason why the process cannot be significantly improved. The flaws are viewed as technical and reparable rather than institutional and irreconcilable.

How scientists view journalists

Only 11 percent of the scientists surveyed expressed a great deal of confidence in the press, while 22 percent said they have hardly any. Two-thirds said "only some." As for TV, 48 percent of the scientists said they have hardly any confidence in it.

Scientists were asked to rate the news sources they watch, read or listen to most often. Most rated national television newscasts as only good or fair; less than 10 percent said excellent. When it comes to reporting science stories, 30 percent said national TV does a poor job, and nearly half said the quality is fair.

Scientists gave their favorite national newspapers much better marks for general coverage—nearly one-third ranked the national papers as excellent and another 49 percent as good. Nearly half the scientists said the national newspapers they read do a good to excellent job of covering science and technology.

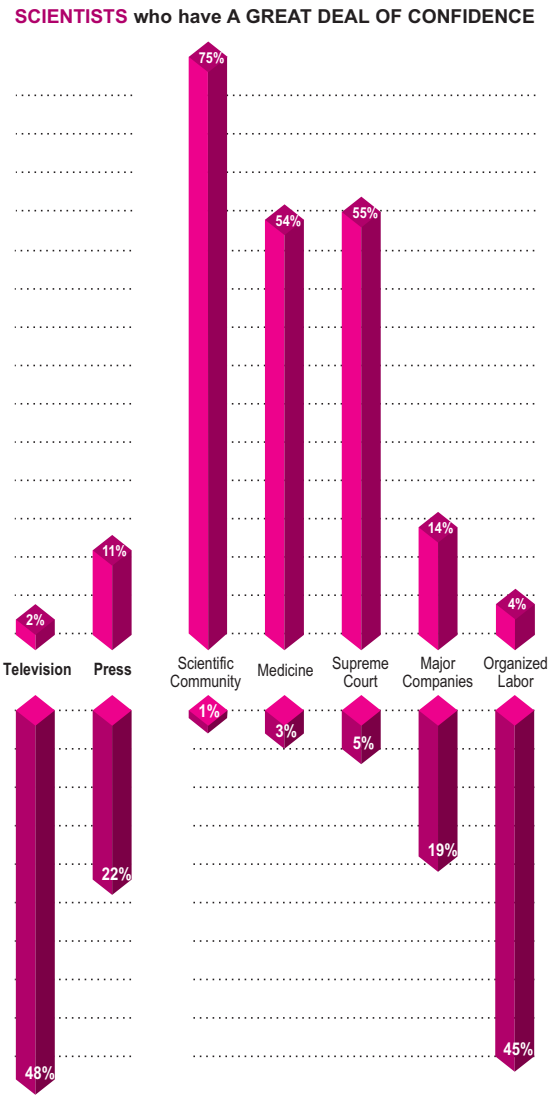
"The coverage of science and technology in the printed press varies tremendously," noted Dr. Peter Rosen, a physicist at the University of Texas at Arlington, on his survey form. "Isolated newspapers like *The Dallas Morning News* and *The New York Times* have really good science sections and publish them on a regular weekly basis. Most other newspapers have little or no coverage, and what they do have does not reach a high, professional level. News magazines are a bit better. Regular network television gives significant attention to medicine and health, but not to other scientific issues on a regular basis."

Scientific esteem for local TV newscasts was dramatically lower. More than one-quarter of the scientists and engineers (28 percent) termed local TV news poor, and another 42 percent said it is only fair. When it comes to covering science, 51 percent said local TV news does a poor job, and 37 percent said fair; only 11 percent said good, and 1 percent excellent.

Dr. B.K. Dicter of Acton, Mass., termed radio and television coverage of science "abominable," complaining that reports are dumbed down to "try to make [the information] personally 'relevant' to the viewer or listener."

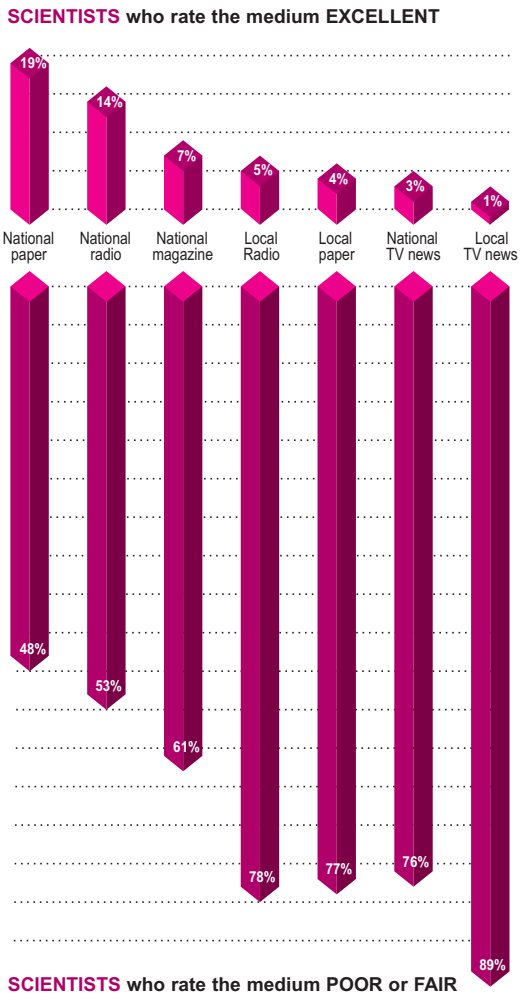
Scientists' confidence in various institutions

(Fig. 1)



Scientists' ratings of *science & technology coverage* by various news media

(Fig. 2)



Nor were local newspapers highly regarded. Twenty-one percent of the scientists termed their general coverage poor, 39 percent said fair, 33 percent said good and only 7 percent said excellent. Science reporting in local papers was termed poor by 37 percent, fair by 40 percent, good by 19 percent, and excellent by 4 percent.

More than 50 percent of the scientists surveyed disagreed with the statement: "There is a professional code among the news media that ensures high standards of journalism."

Negative perceptions

Asked whether they agreed strongly or somewhat—or disagreed strongly or somewhat—with a series of negative statements about the news media, scientists indicated their complete lack of confidence in the competence of journalists.

By an overwhelming margin (91 percent), scientists agreed that few members of the news media understand the nature of science and technology, such as the "tentativeness of most scientific discovery and the complexities of the results."

Eighty-eight percent of the scientists said the news media's top managers are more interested in sales than in telling the public what it needs to know. According to 79 percent of the science respondents, the media are more interested in trendy discoveries than in basic research. And 76 percent felt sensationalism is of more interest to the media than scientific truth. Many of the scientists who wrote comments on their survey forms used words such as "sensational," "flashy," "quirky" and "spectacular" to describe media coverage. And 42 percent of our science respondents said they prefer to avoid the news media altogether because they are "suspicious of their motives."

Most scientists (75 percent) said the media do not cover science better because they are interested in instant answers and short-term results. A large number (69 percent) said most members of the media have no understanding of the process of scientific investigation. Another sore spot with scientists: 61 percent said the media have overblown the risks associated with various substances and activities.

When asked whether the news media underestimate the public by assuming that readers, listeners and viewers want stories about scandals instead of stories about major challenges to science and technology, 71 percent of the scientists said yes.

Are the news media just as important as scientists in maintaining U.S. technological superiority? Half the scientists said no. Perhaps part of the reason for this view is that more than half the scientists polled felt the news media have "no appreciation of the need for funding of basic scientific research and development."

Scientists look at themselves

Self-doubt is not an issue for most scientists and engineers; 77 percent of those surveyed have a great deal of confidence in themselves and their colleagues. An overwhelming 80 percent of them disagreed with the statement that they waste taxpayers' money.

Most scientists (72 percent) said they do want the public to know about their work, but nearly 40 percent said they are afraid of being embarrassed before their peers by news stories about their work.

Most scientists and engineers are willing to talk with the media, but many said they seldom do. Only 4 percent said they talk to the media as often as once a month. Forty-five percent said they talk to reporters every few years. One respondent said the last time he talked to a reporter was in 1959. About one-fourth (26 percent) said they have never been interviewed or written about in a science story during their entire career!

Scientists were also asked if they would be willing to take a course that would help them communicate better with journalists. The scientists reported that they are "very willing"(31 percent) and "somewhat willing"(50 percent).

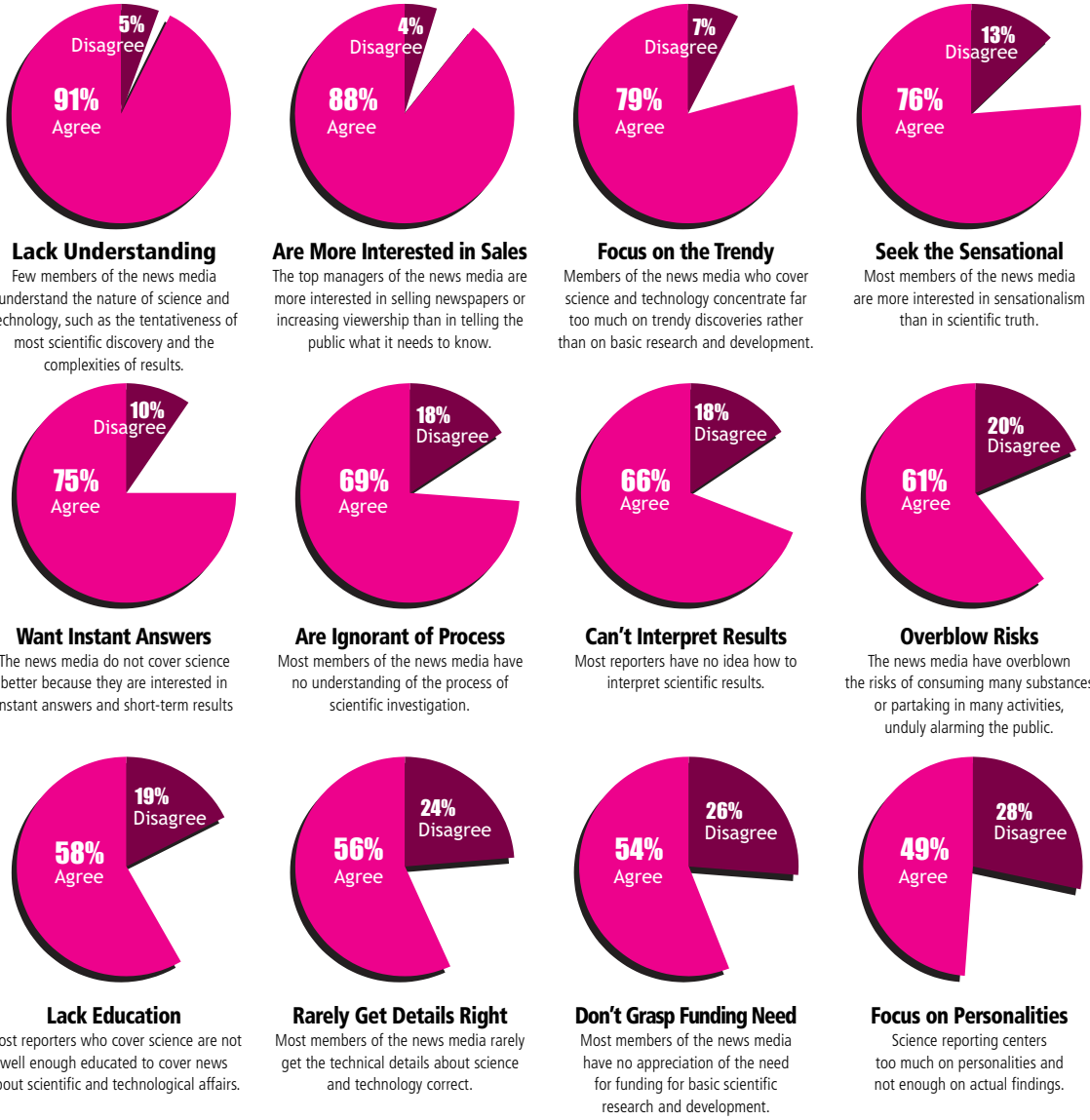
For those scientists whose work had been written about, a plurality (42 percent) said that

they had never been allowed to read a story for which they had been interviewed before publication. Nearly one-third (31 percent) however, said they were allowed to do so "always" or "sometimes." A plurality (43 percent) of scientists rated the journalists involved in reporting science as "somewhat knowledgeable," but 39 percent scored them "not very" or "not at all" knowledgeable.

Even so, 49 percent of those who had been the source or subject of a news story found themselves at least somewhat satisfied with the coverage.

Scientists' agreement with various negative statements about the news media

(Fig. 3)



"In general, I have been very pleased with my interactions with the press, TV and radio," wrote Dr. Roscoe O. Brady of Maryland. "The interviewers have been courteous, quite well-informed and appreciative of my work."

"I have always made myself available to the media and have found it useful and worthwhile for the most part," reported Dr. John States of Rochester, N.Y. "We need more journalists with technical backgrounds, but the media probably can't afford them."

How journalists view scientists

Journalists have a great deal of confidence in scientists (51 percent). In fact, their survey responses indicated a higher level of confidence overall in the scientific community than in their own professional community.

Journalists strongly disagreed (80 percent) that scientists who allow themselves to be interviewed are publicity-seekers. A majority of journalists (63 percent) said they feel scientists want the public to know about their work. Eighty percent of the journalists surveyed found scientists "somewhat accessible," but only 15 percent found them "very accessible." Seven percent reported them "not at all" accessible.

The one complaint heard most from journalists was that scientists are "so intellectual and immersed in their own jargon that they can't communicate with journalists or the public." Sixty-two percent of journalists agreed with that statement—as did about half the scientists.

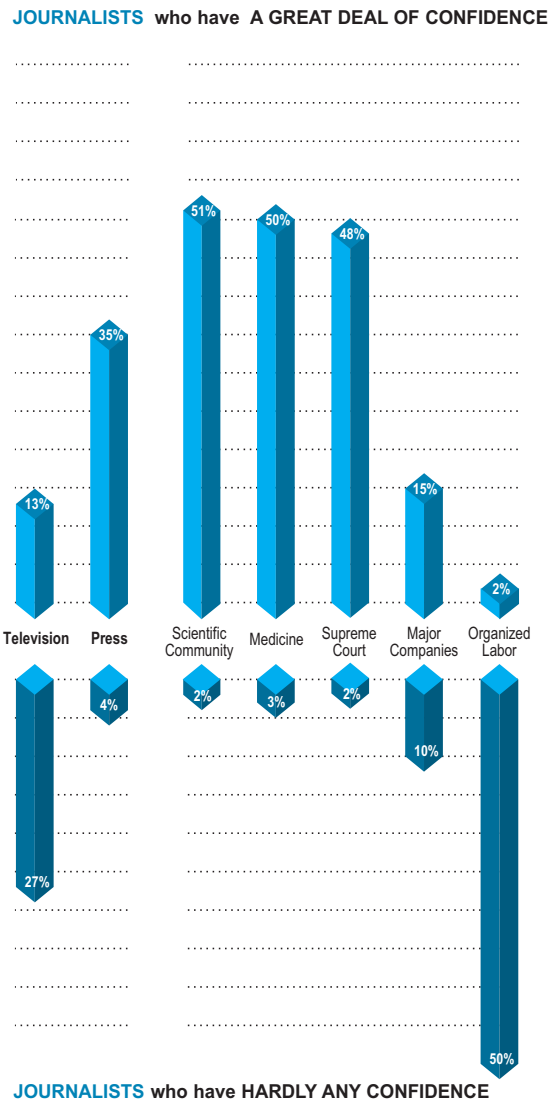
Journalists also frequently mentioned in their comments that science stories need to address the issue of relevance to the reader or viewer, often because the very nature of science research is "complex." (Scientists cited this as an unfair requirement that, in their view, doesn't apply to other subject areas—crime and celebrity, for instance—covered extensively by the media.)

According to Jim Keelor, president of Cosmos Broadcasting in Greenville, S.C.: "Most local news research says science is important to viewers only if you explain benefits/problems they can expect."

Journalist Al Volker of Birmingham, Ala., echoed the sentiment. "Generally, I find little interest in science and technology issues unless we can tell our audience how the story affects them," he wrote.

Journalists' confidence in various institutions

(Fig. 4)

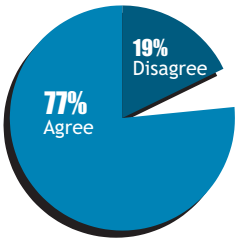


Journalists look at themselves

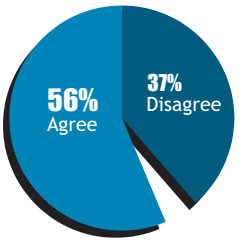
Asked to respond to the same negative statements concerning the news media's coverage of science that scientists had addressed, journalists expressed reservations about their own abilities and performance. Although their responses were not nearly so negative as those of the scientists and engineers, many members of

Journalists' agreement with various negative statements about the news media

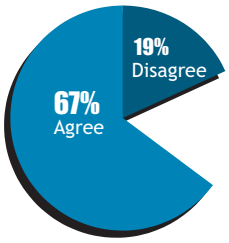
(Fig. 5)



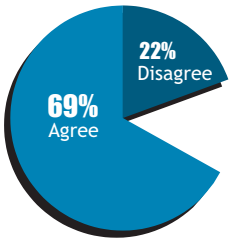
Lack Understanding
Few members of the news media understand the nature of science and technology, such as the tentativeness of most scientific discovery and the complexities of results.



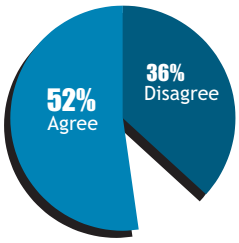
Are More Interested in Sales
The top managers of the news media are more interested in selling newspapers or increasing viewership than in telling the public what it needs to know.



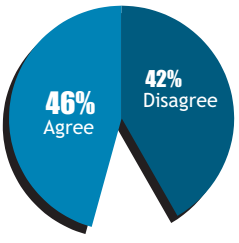
Focus on the Trendy
Members of the news media who cover science and technology concentrate far too much on trendy discoveries rather than on basic research and development.



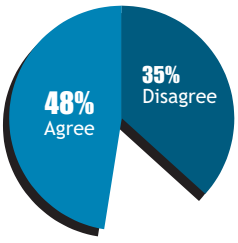
Seek the Sensational
Most members of the news media are more interested in sensationalism than in scientific truth.



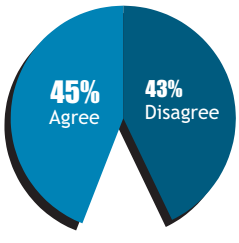
Want Instant Answers
The news media do not cover science better because they are interested in instant answers and short-term results



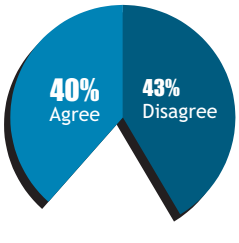
Are Ignorant of Process
Most members of the news media have no understanding of the process of scientific investigation.



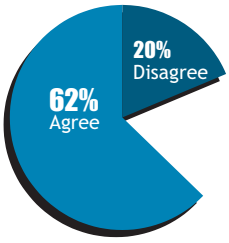
Can't Interpret Results
Most reporters have no idea how to interpret scientific results.



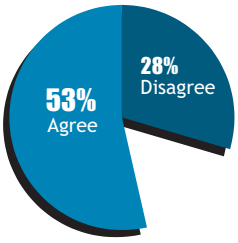
Overblow Risks
The news media have overblown the risks of consuming many substances or partaking in many activities, unduly alarming the public.



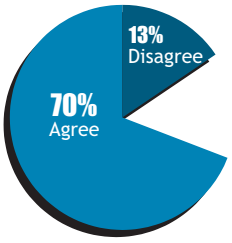
Lack Education
Most reporters who cover science are not well enough educated to cover news about scientific and technological affairs.



Rarely Get Details Right
Most members of the news media rarely get the technical details about science and technology correct.



Don't Grasp Funding Need
Most members of the news media have no appreciation of the need for funding for basic scientific research and development.



Focus on Personalities
Science reporting centers too much on personalities and not enough on actual findings.

the news media obviously recognized their shortcomings in dealing with scientific and technological issues.

On the other hand, a significant number of the survey respondents disagreed with statements concerning reporters' educational deficiencies (43 percent disagreed with the premise), the media's tendency to overblow risks (43 percent disagreed), sales as the primary media motivation (37 percent disagreed) and journalists' inability to interpret scientific results (35 percent disagreed).

Although half disagreed, at least 40 percent of the journalists surveyed did agree that the news media underestimate the public by assuming it prefers stories about scandals to stories about major challenges confronting science and technology. The biggest obstacle to good science reporting, wrote Mark Ward of the *Milwaukee Journal Sentinel,* is the "myopia of newspaper management who underestimate the public's interest in science news, and devote insufficient resources to cover this area."

When asked to focus on the quality of science reporting by various news media, journalists—not surprisingly—handed out higher ratings than the scientists did. The one notable exception was local radio, which scientists rated higher.

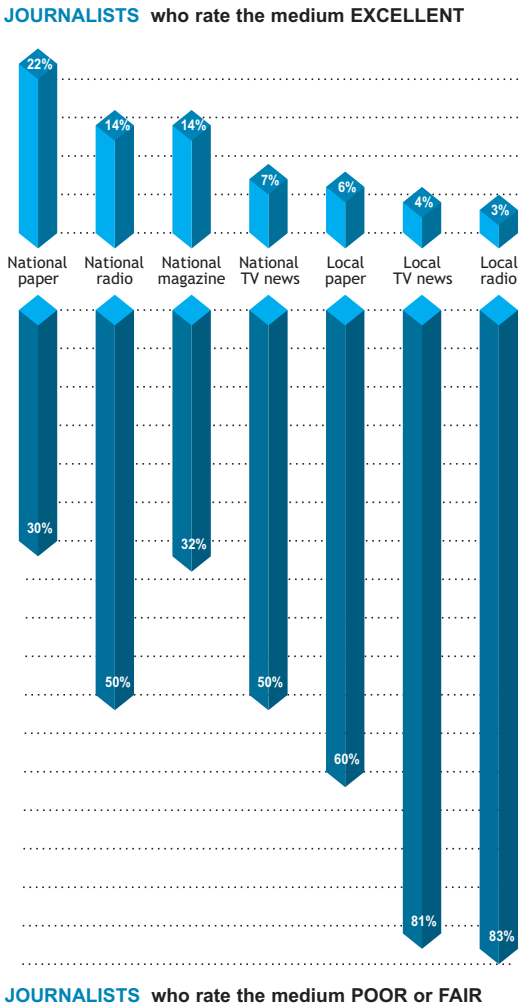
Asked if they agree that there is a "professional code among the news media that ensures high standards in journalism," 13 percent of the journalists agreed strongly, 41 percent agreed somewhat, 21 percent disagreed somewhat and 11 percent disagreed strongly.

Eighty-nine percent of journalists disputed the idea that science reporting is biased. A majority (62 percent) also disagreed with the statement that they rarely get the technical details of science stories correct. However, a substantial majority (62 percent) acknowledged that "the biggest problem with science reporting is that it only tells a small part of the whole story." Eighty-two percent said they rarely or never allow sources for science/technology stories to read them prior to publication.

Almost half the journalists (49 percent) said they understand the connection between scientific research and the economy. Some, like Ward of the *Milwaukee Journal Sentinel,* were disturbed that their media employers do not assign more importance to covering science and technology. (The average number of journalists assigned to science news—including health—within the news organizations represented by the survey respondents was 1.6.)

Journalists' ratings of *science & technology coverage* by various news media

(Fig. 6)



"It is mind-boggling to me," wrote Ward, "that at a time when science is exploding with new discoveries and the gap between the scientist and the public is growing, newspapers across the country are shrinking the resources devoted to science, even though revenues are up and public interest is growing."

When asked the sources they depend on for "scientific" information, more than two-thirds of the journalists (70 percent) said they "often" or "sometimes" look to the *New England Journal of Medicine* for stories. Just under two-thirds (62 percent) cited the *Journal of the American Medical Association*. Other journals used "often" or "sometimes" included: *National Geographic* (43 percent), *Discovery* (35 percent), *Nature* (32 percent), *Scientific American* (33 percent), *Lancet* (29 percent) and *Popular Science* (22 percent).

Obviously, health is the area of science on which most reporters focus, and it is interesting to note that they are going directly to the medical journals of record. Their use of journals in the other sciences—physics, chemistry, geophysics and space—is much less. Rarely do they look to the more scientific journals, such as *Physical Review Letters* or the *Journal of Geophysical Research*.

These latter might consider taking steps to make themselves more "journalist-friendly." This need is underscored by the fact that only 6 percent of the survey's media respondents hold a college degree in science, even though 50 percent of them have covered science.

Assessing the public

When confronted by the statement that "most members of the public do not really care about science and technology," scientists sharply disagreed —60 percent said it is not true, the public does care. Journalists were more emphatic—74 percent said the public cares.

Caring does not equal understanding, however. Scientists by a huge majority (80 percent) said they believe the public is "gullible about much science news, easily believing in miracle cures or solutions to difficult problems." Journalists (67 percent) agreed. Moreover, scientists (80 percent) and journalists (60 percent) indicated they feel the public doesn't understand the need for government funding of scientific research.

Are members of the public so ill-informed that their opinions about science and technology don't mean anything? Almost half the scientists agreed with a statement to that effect, but 34 percent disagreed. Journalists disagreed by a margin of 60 percent to 24 percent; the rest were unsure.

Over 78 percent of the scientists surveyed acknowledged that "research often produces contradictory findings, thus confusing the public." An identical number of journalists agreed.

Steve Snyder of Springfield, Mo., is one. He wrote that his "biggest problem is everyone jumps on some alleged 'major' scientific breakthrough or new health information—only to find out later than the information is inconclusive at best or completely wrong."

Another respondent, who requested anonymity, wrote, "Much of the problem, as I see it, in reporting on scientific discoveries is the discrepancies among researchers themselves. A substance which can kill you one day is good for you the next. Who is the public to believe?"

Scientists split on the question of whether the country is cynical about the benefits of science and technology. About 40 percent said it is, and 41 percent said it isn't. A majority of reporters said the country is not cynical.

Respondents were asked: "If America's leaders and people do not understand science, who is *most* to blame?" Many of the scientists (43 percent) blamed themselves. Journalists (39 percent) tended to agree that scientists are to blame. Only 18 percent of the scientists said it was the journalists' fault, and an even smaller number of journalists (16 percent) agreed. Nearly half the journalists (46 percent) said the public is at fault, and 39 percent of scientists agreed with that assessment.

Despite the numbers indicating the media largely reject responsibility for the public failing to understand science, journalists attached a number

of strong comments to their survey forms.

Carl Baker, Easton, Pa., lamented that "radio is nothing more than a money machine operating for the owners, thus very little news coverage. TV stations are only worried about ratings. … The TV networks have science correspondents but only scratch the surface."

David Scholes of Poughkeepsie, N.Y., wrote: "My biggest problem is with 'scientific' interest groups that play the media like a fiddle with scare stories about toxic apples and fatty popcorn. [The] media [are] fully to blame for using these stories to attract [an] audience.

"Deadline pressures make it difficult [for the] media to fully explore scientific topics," Scholes acknowledged. "But we must make the time to bring these stories to viewers. There is an interest in [the] subject, but we shortchange the viewers."

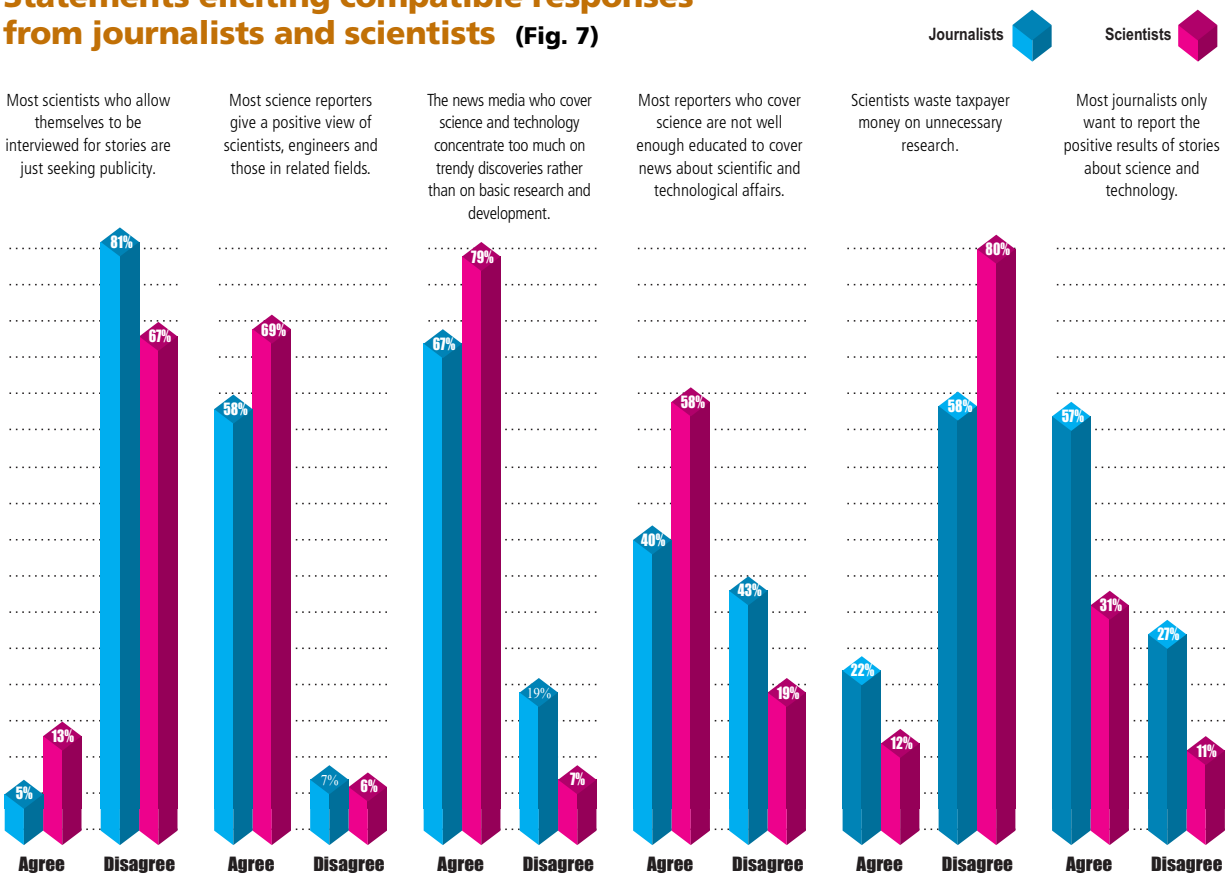
Common ground

Are the media capable of doing a good job of science reporting?

Yes, according to an overwhelming majority of scientists (72 percent), who said journalists do not "face a hopeless task in explaining the complexities of science." They strongly disagreed (64 percent) that the media are biased against science. In fact, most scientists (69 percent) said stories written by reporters who are regularly assigned to cover science are generally positive.

Both scientists and journalists were asked if 1) the news media should "usually attempt to independently verify" science stories "because the news media must make judgments about the truths of news," or 2) the media should

Statements eliciting compatible responses from journalists and scientists (Fig. 7)



"rarely attempt to independently verify" such stories because they "often lack knowledge and are likely to make mistakes." Both the media (81 percent) and scientists (80 percent) overwhelmingly opted for journalistic verification.

chapter endnotes

[1] For a full report on survey methodology and responses, see Appendix A.

CHAPTER **FIVE**

Scientists as Communicators

"We shall not cease from exploration/And the end of all our exploring/Will be to arrive where we started/And know the place for the first time."

—T.S. Eliot, 1888-1965

Here is how an American scientist of the '90s might try to explain to a journalist why his compatriots are not very good communicators:

"Scientists and engineers—those who are creating the new knowledge and the new technologies—are notably focused on their research, and their initial thought is that the maximum value that they give to society comes from their research itself. Their dedication to their research, however, tends to cause them not to assign a high enough priority to the issue of communicating what they have learned to the public."

That's true, of course. But it can be better expressed this way: "Scientists and engineers are notoriously focused on the project immediately before them. They think only of the outcome of their research and its value to society. This dedication blinds them to the need for telling the public what it all means."

The point of the example is that the initial link in the communications chain connecting new knowledge to the public must be forged by scientists and engineers themselves.

In their defense, it should be noted that scientists tend toward wordiness because they've been taught to write and speak in the calibrated manner befitting their profession. They bristle when a novelist such as Ken Follett says, "[S]cientists … should learn better English; most of them are lazy, slipshod writers."[1]

They are not lazy, slipshod writers. But neither are they novelists or newswriters (with the occasional rare exception). Their language is intended to convey a special meaning: the relationship between the problem expressed, and the results at hand, not a plot or storyline.

Journalists, above all others, should understand how most scientists view themselves, because most journalists have the same self-image: idealists in pursuit of the truth. But to describe scientists simply as Ivory Tower denizens is an insufficient depiction; they come in all sizes and shapes.

Some still have the enthusiasm that propelled them into the field in the first place. The young scientists and engineers who successfully landed the *Pathfinder* spacecraft on Mars in the summer of 1997 gave the nation a glimpse of this enthusiasm. Their delight was palpable and contagious.

Ernst

On the other hand, "those things that produce excellent scientists very often also produce very arrogant SOBs," candidly acknowledges David Ernst, chairman of the physics and astronomy department at Vanderbilt University.

Among some scientists there is, if not arrogance, barely concealed conceit.

As anthropologist Margaret Mead, one of the country's most beloved scientists, explained: "I was brought up to believe that the only thing worth doing was to add to the sum of accurate information in the world."

Isolated in the lab

Scientists readily admit that they are an insular lot. The heavy science hitters spend most of their time on narrowly defined research projects, and what little time is left is spent writing grant proposals.

"Face it," says Anneila I. Sargent, senior research associate in astronomy and executive director of the Owens Valley Radio Observatory in California, "scientists talk to people mostly in their own little, narrow area. And they can't even talk to one another."

It's gotten so bad, she says, that "Caltech is actually trying to make us speak to one another. We have seminar series to talk to people in other divisions. You don't realize how narrow the whole thing is. We need to learn to talk to other people."[2]

Sargent

In many of the roundtables convened for this project, in dozens of conversations with other scientists and in comments from the survey, there was near-universal agreement that the profession must consider ways in which it can bridge this gap—or chasm, as it might better be characterized. Many survey respondents (journalists) used the term "techno-jargon" when complaining about communication problems.

"There is a cross-cultural problem," admits Molly Miller, geology professor at Vanderbilt. "And we're a major part of the problem, in that we don't know how or what the needs of the media are or how to effectively convey what we know. I know that I have had a horrible time when suddenly asked by somebody in the media about, say, evolutionism versus creationism. It is very, very difficult to suddenly come up with a compelling discussion of that. We need some help in learning how to do that."

Boyce Rensberger, science writer for *The Washington Post*, contends that it's not just a matter of improving communications skills, that in our social system scientists have a responsibility to share their discoveries with people curious about the world around them, about their bodies, about what is out there in the sky.

"Scientists, as agents of the public's curiosity, have an obligation to report back their findings about these things," says Rensberger. "Our social system that results in scientists being allowed to spend years studying all of these things, depends on the largesse of the taxpayers.[3]

One of the chief dispensers of taxpayer dollars for scientific research agrees. Dr. Neal Lane, head of the National Science Foundation, says, "One of our responsibilities is to get out with the public every opportunity we can find.

"We don't have any trouble explaining to one another what it is we're doing, why we're excited about it, why it's important. And we certainly recognize that the reason the federal government supports a good bit of that is because we know, ultimately, science pays off for the American public," Lane says.

Why doesn't the public seem to know that?

It's simple, he says. "With the exception of a few people … we don't know how to communicate with the public. We don't understand our audience well enough—we have not taken the time to put ourselves in the shoes of a neighbor, the brother-in-law, the person who handles our investments—to understand why it's difficult for them to hear us speak. We don't know the language, and we haven't practiced it enough."

Ernst agrees, and adds, "[T]he scientific side has to realize that being an outstanding scientist is not equivalent to communicating."

Not smart enough?

NASA Administrator Dan Goldin is not nearly so charitable or patient. "How could someone who goes through undergraduate school, graduate school, earns a Ph.D., has to communicate with their professors, say 'I'm not smart

enough to communicate with the American public and journalists'?

"I don't want to sound like I'm coming on too hard, or harsh, but my God! If they can do the wonderful things they do in science, they can step back and take the time to speak plain English, to understand that the American public finances a major portion of this work, and [the American public is] the customer—not their scientific peers.

"Once that mindset [prevails], I think there will be significant change. So I say that we, the scientific community, have a lot of work to do to gain credibility with the American public."

Jon Franklin, Pulitzer Prize-winning author and former science reporter for *The Baltimore Sun*, sees the curtain coming down on an age of innocence and insulation within the American science community.

"Scientists thought of themselves as apolitical," Franklin says. "That they had that luxury was a measure of the privilege they enjoyed. In our political system, nothing is apolitical. As soon as science started being financed by public dollars, it was political. Science was the darling of both parties. Liberals had backed science from the very beginning of the Enlightenment, and conservatives had come aboard because of the Cold War. Scientists, innocents that they were, confused being in political favor with being apolitical."[4]

The science community is beginning to realize that it needs to get its house in order and learn how to influence the public and Congress for its own good. This will not be easy. Some critics argue that the media has judged the scientific establishment largely by its public pronouncements, "not looking too far behind the veil."[5] This should not be interpreted as promise of an impending assault on the integrity of science if it raises its profile. Rather, it means science will probably have to take a number, get in line and be prepared to talk fast when its turn comes—just like all the other interest groups.

In order to influence the public, scientists today recognize that they need to learn to communicate and, as noted in Chapter 4, a very high percentage (81%) have indicated that they are willing or very willing to make the effort. So there is promise of a newly forged link in the communication chain.

As NASA scientist Mark E. Williams succinctly puts it: "Unless we learn to get our point across in an effective manner, we will be doomed to ignorance on the part of the gen-

Scientists Needn't Take Themselves Seriously To Do Serious Science

Scientists might communicate better with the public at large if they could learn to lighten up.


Keel

As Albert Einstein observed in his memoirs, "We should take care not to make the intellect our god; it has, of course, powerful muscles, but no personality."[1]

One scientist who has taken that advice to heart is Dr. William Keel, an astronomer at the University of Alabama. He's always on the lookout for the combination of precision and peculiarity that sometimes slithers into scholarly writing, such as the following:

> No data were taken at station D during the period 0830 to 1630 due to the presence of a red racer snake (*Coluber constrictor*) draped across the high-tension wires (33,000 V) serving the station. However, even though this snake, or rather a three-foot section of its remains, was caught in the act of causing an arc between the transmission lines, we do not consider it responsible for the loss of data. Rather we blame the incompetence of a red-tailed hawk (*Buteo borealis*) who had apparently built a defective nest that fell off the top of the nearby transmission tower, casting her nestlings to the ground, along with their entire food reserve consisting of a pack rat, a kangaroo rat, and several snakes, with the exception of the above-mentioned snake who had a somewhat higher destiny. No comparable loss of data occurred at the other antenna site.[2]

Incidentally, Prof. Keel's sense of proportion is evident in the neighborly, good-natured and convivial web site he maintains. On it, he says of himself:

> Bill Keel makes a hobby of getting photons wherever he can, having made appearances at Kitt Peak, Cerro Tololo, La Palma, La Silla, the MMT, the 6-meter Bolshoi Teleskop Azimutal'nyi, and the VLA. He is slowly becoming multispectral, using data from IUE, IRAS, Einstein, ROSAT, and HST. These data support studies of the effects of interactions on galaxies, the history of galaxy merging, triggering of star formation and nuclear activity in galaxies, and too many other projects that have struck his fancy. In the more socially respectable part of his job, he teaches at the University of Alabama; mostly introductory astronomy courses with occasional forays into extragalactic astronomy and observational techniques at the graduate level.[3]

[1] Albert Einstein, *Out of My Later Years* (Westport, Conn.: Greenwood Press, 1950).
[2] N. Bartel et. al. 1987, ApJ 323. 507.
[3] Internet http://crux.astr.ua.edu/keel/billkeel.html

eral public and sensationalism or poor reporting on the part of the news media."

Robert Lee Hotz, science writer for the *Los Angeles Times*, says improvement is not going to be an easy process, but he says, for starters: "I think it would be helpful for all concerned … if someone stopped training [scientists] *not* to communicate."


Hotz

Hotz no doubt speaks for a number of journalists, as well as scientists, when he says, "I wade through an enormous stack of technical journals every week, and it's a common observation that in recent years it is increasingly difficult to understand what anyone is talking about, even if you are a specialist. The purpose, clearly, of scientific communication is not to communicate research results; it is to satisfy a kind of caste system of language and vocabulary."[6]

Concise writing

A significant part of the challenge will be translating complex science and technology issues into language that the average person can understand. Jared Diamond, a UCLA scientist who writes frequently for general-circulation publications, says communicating with one's fellow scientists and with the public are two completely different matters. For other scientists, the importance is in the details.

A lay reader with little time and, perhaps, a short attention span needs writing that is concise.

"When we write research articles for our colleagues," Diamond says, "we are trained to avoid simplification; to be precise, using technical terms, inserting all appropriate qualifiers ('if,' 'but,' 'maybe'), and supplying all relevant details; to avoid vivid, poetic language, which suggests that we seek to convince by slick words rather than by correct arguments; to write impersonally, replacing the first person ('I did the experiment') with the third person ('The author did the experiment') or the passive voice ('The experiment was done'), because science is supposed to be about the truth rather than about one's ego; and to give exhaustive credit to colleagues, lest we seem to be claiming undeserved credit."[7]

As Kathy Sawyer of *The Washington Post* puts it, "…We have to be able to communicate with scientists, partly by getting on their level, learning a bit of their language, but also they need to learn to speak to us common folk …."

David Hercules, chairman of the chemistry department at Vanderbilt University, adds a cautionary note regarding word choices.

"You have to address [the scientific subject] in the form which is relevant or understandable to the individual. I will give you a vignette from my own experience:


Hercules

"I had a very dear aunt who was actually the first person who bought me a chemistry set—over my parents' objections. And when I was a graduate student, I was working on optical spectroscopy, dealing with luminescence. One day, Aunt Elsie said to me, 'David, what is it that you do?' So I started explaining to her about singular and triplet states, and … that didn't get very far. [So I] started to explain about luminescence.

"And she said, 'Well, luminescence?' I said, 'That is fluorescence. Fluorescence.' I said, 'You know, like in the light bulb up there. That's a fluorescent light.' And she said, 'Oh, now I understand what you do. You make better light bulbs.'

"Well, the point is, that is where I learned that you really have to communicate in terms of the understanding of the audience to whom you are speaking, not the audience that you are coming from, because they are sometimes

vastly different.

"And, obviously, I blew that one completely—although she was always convinced that I was a great guy because I was making better light bulbs."

Communicating effectively with one's Aunt Elsie is one thing; slight misunderstandings, even large ones, matter little in such a context. On the other hand, when scientists venture into the public arena, the audience is different. It is far more critical. And the stakes are infinitely higher.

Talk to the customers

NASA Administrator Goldin is acutely aware of the special needs of multiple audiences. "The media [are] in business to sell TV time; the media [are] in business to sell newspapers," he says. "And while they're doing it, they must perform a service."

Goldin's point is that every complex enterprise operates on at least two levels—internal and external. The media, in Goldin's paradigm, are profit-making enterprises. They must make money to survive, and they have unique internal structures to do that. But also, "they have to talk to their customers."

Science, he says, should be no different. "It is the job, especially of those scientists that are on the government payroll, to speak in plain English and to devote their time to it," Goldin says. "This is not something that they ought to do in their spare time. This is a requirement. So I've been telling our scientists and engineers: You have an obligation to speak in plain English."

There is, however, a set of issues that scientists deal with in communicating to the public that makes them hesitate to deal with reporters. One of those could be called the "Carl Sagan effect." Sagan, an astronomer, was an immensely successful communicator of science, particularly space science. He had an ability to describe very complex processes that happen, say, in the birth of a star or in the evolution of a planetary system in ways that the public could grasp and respond to. His *Cosmos* series, for example, is the most successful portrayal of science ever produced for television.

When Sagan did this work, he was criticized by some of his peers in the science community, because they felt that he was spending too much time talking to the public and not enough time on his research.

Sagan

"A scientist who devotes his life to studying something arcane like the hyperfine structure of the molybdenum atom, and whose work is ignored by everyone except the world's three other experts on molybdenum, naturally is jealous and outraged to see reporters hanging on me for my latest pronouncement about the possibility of extraterrestrial life," Sagan said.[8]

But he seldom wavered in his determination to demystify science. Naturally, he was a favorite of reporters.

Among scientists, there is a certain element of competitiveness and self-esteem that motivates them to do their research but also causes them to be, in some instances, uncomfortable with public interest in their peers. In recent years, since the importance of communicating to the public has been clearly recognized by the science community, this tendency has somewhat diminished. However, it has not entirely disappeared.

Andrew Szegedy-Maszak says that, in some quarters, the business of engaging the public in scientific matters is called "resp pop" for "responsible popularization."

"I admit to having some qualms about resp pop," he reports. "They stem not from the idea itself … but rather from the resistance within the academic world to any kind of popularization, responsible or not. I worry about the disapproval of my academic colleagues. Some regard 'responsible popularization' as an oxymoron, like 'friendly fire.' They cling to the

belief that full access to what we know should be restricted to a select group of initiates. In its most extreme form, this means that if you aren't able to read Sophocles in Greek or Virgil in Latin, you don't deserve to read them at all. Such territorial protectiveness strikes me as self-defeating, precisely because it drives people away from the field. It may even be one of the reasons for the dwindling public interest in classical studies."[9]

An end to infighting

"I would suggest, as a matter of scientific culture, scientists learn not to punish those among them who do speak well to the public," says Lee Hotz of the *Los Angeles Times*. "And I cite the example of the late Carl Sagan, who, as we all know, was actually denied membership in the National Academy of Sciences, in part because many of the members there felt it was unseemly for him to be so popular, so well-spoken, to get so many lucrative book contracts.

"We have a more local example of Jared Diamond at UCLA, a gifted popularizer of science [who] is continually encountering bitter criticism from many of his scientific colleagues about his willingness and his ability to speak to the general public."[10]


Bredesen

Phil Bredesen, a physicist who is currently mayor of Nashville, Tenn., says the internal criticism has to stop. "I think there is a sense that, if you try to communicate in a popular way what you do, that somehow diminishes the science that you do. I genuinely think people have to get over that concept."

Mary Woolley, president of Research!America and a frequent writer on the subject, says today's scientists are seeking common ground, but at a higher level. "I think what they're looking for is a comfort zone," she says, "a way to tell their story so they will get the approval of fellow scientists but they'll also be listened to by journalists and by members of the public. I think it's about more than … just telling the science story; it's conveying an attitude of accountability, accessibility and pride in serving the public's interest."


Woolley

There is a second reason a scientist may hesitate to go public with research results: If his or her words are inaccurately reported, scientific colleagues will have no way of knowing whether the researcher or the reporter was the source of the error. Scientists who have been unjustly ridiculed by their colleagues in such circumstances are unlikely to welcome future interactions with the media.

This issue speaks directly to the mechanism for verifying the accuracy of science stories. There is no hesitation by most scientists to have their stories verified. In fact, there is a great deal of interest on the part of scientists in being able to see a story before it runs, so as to assure that the information in the story is correct. There is, on the other hand, a traditional hesitation by reporters to allow their stories to be reviewed before publication or airing, not because they do not care about accuracy, but because they think the source—the scientist, in this case—might try to adjust the spin, or bottom line, of the story.

In a discussion with the National Association of Science Writers in Washington, D.C., Boyce Rensberger commented on the issue of story verification. He said that he shows about half his stories to his sources and always passes his most complex stories by authorities in the field to ensure accuracy.

"I've been preaching for several years now a reinterpretation of this canon of journalistic ethics that you're not supposed to show your copy to your sources. Science [has] gotten a lot more complicated. To assume that we understand all this stuff well enough to explain it to the public … I think it is arrogant and ignorant.

"You're not telling the person you're having review your copy that they have the right to change anything. All you're doing is asking them to point out any mistakes. Wouldn't you rather not look stupid?"

The idea is not to give scientists the right to change any part of the story, but to give them an opportunity to assure that the story is correct. If verification of stories would become routine, the science community's fear and hesitancy about being quoted would begin to alleviate.

The incremental nature of science

Another impediment in science communication devolves from the nature of the scientific process itself. Science is constructed incrementally. Occasionally there are significant breakthroughs that happen suddenly, providing obvious opportunities for breaking-news stories. But far and away the most common process in science is for researchers to learn progressively, one small discovery at a time. Nobel Prizes, for instance, are typically given for work accomplished over many, many years—sometimes over the course of a scientist's entire career.

Reporters, who need an angle or hook for a news story, find the incremental nature of science a difficult challenge. Incremental development is incompatible with journalists' desire—and need—for a story to make as large a splash as possible. It is the case, however, that things learned incrementally may be presented in a way that will satisfy many journalistic needs.

For instance, a reporter can write about a set of small advancements in knowledge by using a profile approach to reveal the longtime devotion of a single scientist or a group of scientists who have spent long years working to achieve understanding. The duration of the period of discovery does not diminish the scientific achievement or make the scientist's accomplishment any less significant.

Such stories can engage the public's interest, even though the scientific results are more cumulative than dramatic.

chapter endnotes

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Scientific Publishing

Cut the Communications Fog, Say Physicists and Editors

By James Glanz

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It's an opening sentence that seems designed to put off even a physicist: "The need to obtain adequate ELMy H-mode energy confinement simultaneous with operation near the neoclassical tearing mode beta-limit and at/above the Greenwald density limit suggests that careful optimization of plasma performance will be required to obtain the desired fusion power performance, and that 'active means' to control or inhibit the onset of neoclassical tearing mode activity—a common precursor of plasma energy collapse or disruption in present experiments operating near the beta and/or density limits—will be required."

Take a breath, and don't worry if that quote from a recent physics journal seems as impenetrable to you as ancient Mayan script. In the past, physicists have fretted over their inability to communicate with the lay public. Now, the flood of unexplained acronyms, cryptic symbols, endless sentences, and nightmarish graphs has risen so high, say some leaders in the field, that physicists can no longer understand each other.

No one is claiming the problem is unique to physics. "My impression is that the state of communication is about the same in astronomy, chemistry, and biology," says Mitio Inokuti, a physicist at Argonne National Laboratory in Argonne, Illinois. But it has become especially painful in physics, in part because of the humbling example of the great writers and lecturers in physics of decades past, such as Enrico Fermi and Richard Feynman. And it's gotten so bad that a band of reform-minded physicists and journal editors has decided to take action. Their first step was a meeting here last April, organized by Inokuti and Ugo Fano of the University of Chicago, to discuss what they see as a fog of poor writing and ideas about how to dispel it. Since then, meeting participants have settled on what Fano hopes is "a gospel that can be accepted in the community"—a set of guidelines for clearing the fog.

The written guidelines will be presented in November to the publications board of the American Institute of Physics (AIP), which publishes many physics journals, in hopes that the AIP will consider officially adopting them. The guidelines suggest that journal editors make clarity of presentation "an [explicit] condition of acceptance of an article," that abstracts be made more generally intelligible and that the best-written articles receive special recognition by the journals. In short, says Steven Rothman, chief editor of the Journal of Applied Physics, he and others intend to tell authors: "I can't make you do anything, but I can sure make you wish you had."

Along with cajoling authors, the largest physics organizations are taking steps of their own to mend the communication lines in physics. Science has learned that AIP and the American Physical Society (APS) are quietly seeking an editor for a new electronic publication, tentatively called Highlights, which would aim to report on selected journal articles in a form comprehensible to physicists in any specialty. The publication, which has secured initial funding but has no firm publication date so far, would likely employ a staff of several science writers and be loosely patterned after the online Physics News Preview, now written by AIP's Phillip Schewe and Ben Stein. "The idea is to make a small dent in this loss of general understanding," says Martin Blume, editor-in-chief of the APS. "It is very much along the lines of the [Chicago] conference."

How effective any specific measure will be is a matter of open disagreement among editors, physicists, and science writers. Even the agreement on the "gospel" of good writing didn't come easily. But there's little dispute about the severity of the problem: The state of physics communication was

universally deplored at the April conference, held on the campus of the University of Chicago.

"We had a disastrous colloquium here yesterday," grumbled Fano, a quantum physicist who has worked with Werner Heisenberg and Fermi. "[The speaker] lost me after three or four minutes." The sin was compounded, said Fano, because unlike departmental seminars, such colloquia are supposed to be tailored for a general audience of physicists. Ben Bederson, the previous editor-in-chief of the APS, added that the colloquia in his own department at New York University are often so bad that he wonders whether it is counterproductive to encourage young students to attend. Instead of kindling their interest, said Bederson, the ordeal "sometimes turns them off from physics."

As the discussion turned to journal papers, the complaints multiplied quickly. "There are papers one-third of which are acronyms," said John Light of the University of Chicago and editor of the Journal of Chemical Physics. Obscurity begets more obscurity, said Anthony Starace of the University of Nebraska, Lincoln, and an editor at Reviews of Modern Physics, since poor communication between subfields often leads researchers to invent new jargon for slight variations on existing physics. The physics of many-body interactions is similar in chemical, atomic, nuclear, and condensed-matter physics, for example, but each field has its own terminology, said Starace. And since some of the most fertile areas of physics are interdisciplinary, those kinds of barriers may do disproportionate harm.

Starace and others observed that the weakening humanities background of many physicists may be contributing to the trend. Major universities in the United States, for example, have eliminated most literature and language requirements—even foreign languages—for the physics Ph.D. The preponderance of foreign authors—many of whom don't have a full command of English—in journal submissions may also be a factor. Sometimes, though, the reasons behind obscure, techie writing boil down to "basic psychology," said AIP's Schewe: "You lose all your readers, but at least you can't be accused of being an idiot. Instead, the readers are made to feel like they're the idiots."

No one at the meeting saw a quick way out of this communications miasma, but there was no shortage of ideas. Schewe suggested rethinking the role of journal abstracts. Instead of serving as a telegraphic summary that only specialists can follow, he said, an abstract could act as a prose "invitation," or short introduction, to the subject of the paper. Argonne's Inokuti put forth the notion of formally recognizing well-written papers—either by publishing them in a special section of a journal or by issuing periodic awards. "It becomes a line in your curriculum vitae," said Inokuti.

Others focused on catching physicists-to-be as undergraduates, before poor writing habits have become irreversible. Christopher Fasano of Francis Marion University, a liberal arts college in Florence, South Carolina, described a recently instituted requirement that all physics majors take a minimum number of "writing-intensive" courses there. That category includes certain offerings in the physics department itself, such as lab courses in which reports are stringently graded not just on content, but also on clarity, organization, and style. "Students get better [at writing]," said Fasano. "Practice helps dramatically." If such programs ever find acceptance at the large research institutions that produce most future physicists, Fasano thinks, the journals could see that same dramatic improvement.

What's needed most is "basic training," agreed Argonne's Nghi Q. Lam, editor of Applied Physics Letters. "We should have some kind of standardized textbook so that every [physics] student—not only in the United States, but also in other countries—receives the same fundamental training in this area." The text would cover everything from sentence structure and style to the proper organization of a good paper, said Lam.

The group has now distilled these discussions into a set of written suggestions for reform—watering down their recommendations in some areas of persistent disagreement, such as the proper role of journal abstracts. Although they expect a sympathetic hearing from AIP's publications board in November, any proposal that requires new resources could face an uphill battle. For writ-

ing awards, for example, "there's simply not enough staff, not enough people to be able to judge," says Peter D. Adams, editor of Physical Review and the board's chair. Meanwhile, Highlights won't be launched until the right editor turns up, says Blume. "The best we could do is get started by the beginning of next year," he says.

To skeptics who say that the reformers' goal of markedly simplifying communication in an increasingly complicated field is unrealistic, Fano responds: "People are very much looking for this kind of guidance." A word from physicists who have seen better days, he says, could make all the difference.

CHAPTER **SIX**

Science and the Fourth Estate

Of the Corporation of the Goosequill—of the Press … of the fourth estate. … There she is—the great engine—she never sleeps. She has her ambassadors in every quarter of the world … They are ubiquitous."

William Makepeace Thackeray, 1811-1863

Who are these people, the "fourth estate," anyway? Where'd the name come from? And what gives them the right to go everywhere?

The term "fourth estate" was first used as a backhanded acknowledgment of the growing power of the public press in 18th-century England —the other three estates being the clergy, the commons and the nobility—and it has stuck until today.

A much more common term, of course, is the "media," which, frankly, is about as useless in describing the vast number and variety of newsgathering organizations and individuals as is the "fourth estate." In practice, "media" can refer to anything from *The New York Times* to the *National Enquirer*, from *Time* to *Hustler*, from dial-o-porn to the Internet. The term encompasses television, motion pictures, videos and books—just about any point-source method of communication with a mass audience.

Those who comprise it range from desktop publishers of small-circulation newsletters to corporate giants that own networks and huge newspaper chains. What gives them the right to operate freely in this country is the First Amendment to the U.S. Constitution. It says they can go almost anywhere they like and write almost anything they please.

They might be a thorn in the side sometimes. They might get their stories wrong. They might unduly harass the objects of their attention. They might pursue the wrong leads. They might even defame the subjects of their stories, in which case to obtain redress it must be proved they acted with a reckless disregard for the truth. As some anonymous author has wryly noted: "Doctors bury their mistakes. Lawyers hang them. But journalists put theirs on the front page."

The press, journalism, the media—the terms are all squashed up these days—the people who report the news, as a group, come about as close to achieving total independence as is possible in modern society. And that's what the framers of the Constitution intended. The idea is to have as many independent voices as possible.

In fact, the founders were so adamant about the free flow of information, ideas and opinions, they went a step farther (probably recognizing that not everyone could afford a printing press), and said there could be no prohibition against any kind of peaceful gathering to talk about anything—including, specifically, complaints about the government. This all-encompassing, sweeping ideal protects

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everything from idle gossip, to the *Encyclopedia Britannica*, to inaccurate reporting.

There is nothing in the First Amendment about fairness or precision. There is nothing about exaggeration or sensation. The language is deliberately vague. It neither prescribes or proscribes. It is neutral.

Public disillusionment

In this climate, consequently, all manner of "journalism" has appeared—from the idealistic to the exploitative. None of it has been immune to the kinds of criticism traditionally attached to the journalistic enterprise.

There is, however, something new in recent years. Large numbers of people are no longer just complaining about their unhappiness with the mainstream media, they are tuning out. In fact, it might be said they are stomping out.

The trend probably began in the early '70s with Vice President Spiro Agnew's attacks on the press. Never mind that he resigned from office in disgrace, the seed was planted. And it grew, until today only 2 percent of Americans believe everything they read in the newspapers and 5 percent believe the network news, according to a recent Roper Poll.[1] Another national survey found only 11 percent had "a great deal of confidence" in the media. Less than half of Americans say they have read a newspaper or watched a newscast in the previous 24 hours.

Journalists have long said they are not in a popularity contest, that when they do their job properly, readers and viewers often will not like what they say. They refer to the kill-the-messenger syndrome. This doesn't particularly bother many journalists.

"I don't sit around sucking my thumb about why the public doesn't like us more," says Bob Rivard, managing editor of the *San Antonio Express-News*. "We're contrarians. That's why we got into this business."[2]

However, journalists do want at least grudging respect. The evidence is, they are not getting it. The trend in the polls is downward and long-term. And it seems to be fueled by more than a vague sense of disillusionment. A Times Mirror Roper poll in 1994 found respondents believed the media now actually "get in the way of society solving its problems."[3] What's wrong?

"In holding up a mirror to America, journalists too often have filtered out the good, embellished the bad and produced a distorted image," says Kenneth Walsh, senior White House correspondent for *U.S. News & World Report*. "Americans have come to associate the media with everything that has gone wrong. We have become chroniclers of the country's failures."

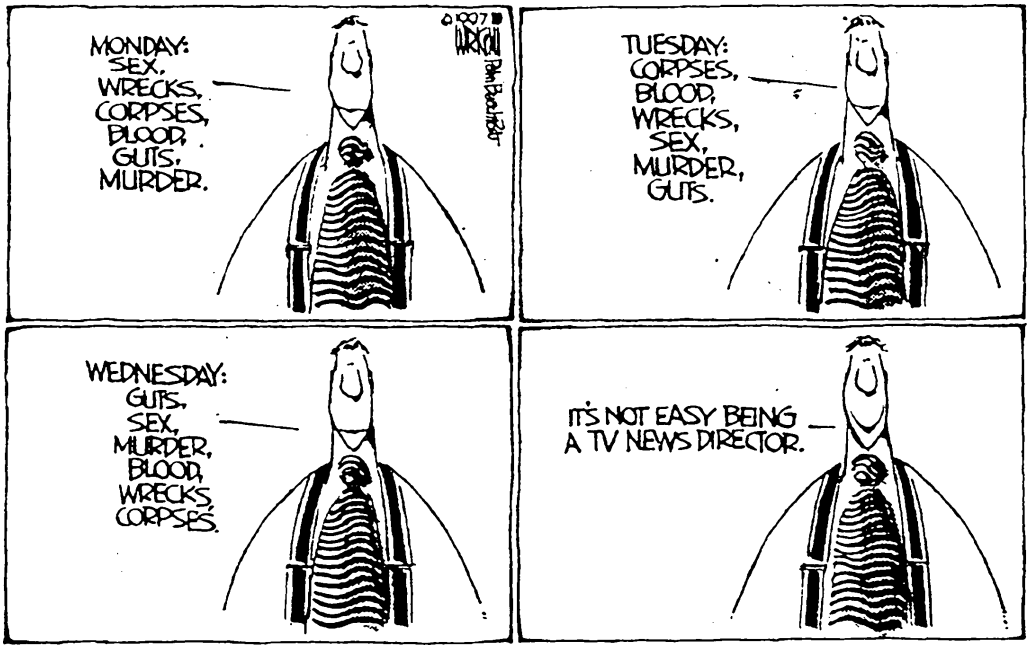
In his 1996 book *Feeding the Beast; The White House and the Press,* Walsh diagnosed the media's problem succinctly. "Four major trends," he wrote, "… are undermining the credibility of journalism: (1) We have too much attitude. (2) We too often rush to judgment about events, trends and people. (3) We are too negative. (4) We are losing contact with everyday America."[4]

Spreading tabloidization

This is happening not only to the Washington press corps but to local reporters as well. With a heavy diet of crime, disaster, fluff and celebrity, local television is presenting a picture that is not representative of American society.

Local station management sometimes tries to present a picture not even representative of its own news departments. Witness the departure of two highly respected anchor people from station WMAQ in Chicago when management hired Jerry Springer, a trash-talk-show host, to do commentaries. The audience went south, too, and Springer lasted two days.

Writing in 1995, former *Wall Street Journal* reporter Ellen Hume lamented that the mainstream media are looking more and more like supermarket tabloids. "Standards and definitions of news always have varied widely," she wrote, "depending on the era and the news organization. But now even in the most respected newsrooms the traditional standards



of verification, objectivity and relevance become more elusive by the day."[5]

"Many if not most reporters fail to read—to study background issues and facts," says Carol Pozefsky of Northeast Broadcasting. "They run for the flashy headline, the sound bite, the sexy angle."

As for science journalism, Charles Meyerson, news director at WNUA in Chicago, says there is a big difference between "full-time science journalists (for *Time, Newsweek*, the major dailies)—generally a talented and insightful bunch—and bubble-headed (generally local broadcast and wire) general-interest reporters stuck writing about science—people who don't know that 'a million' isn't a big number in space and couldn't tell a polymer from a polymath. Unfortunately," Meyerson concludes, "it's the latter who form much of the public's opinion."

By any measure, all this is an impending calamity for the news business. The reaction in many quarters has been "more grab-you-by-the-lapels, sensational coverage of crime and malfeasance, delivered with just a hint of cynicism," wrote Alexandra Marks in *The Christian Science Monitor*. The public's response, she concluded: "Newspaper circulation continues to decline or stay flat. Network news audiences are still plummeting."[6]

This does not mean, however, that talented men and women do not persevere and that quality publications and other outlets do not exist. It does mean that attracting media attention to serious science and technological issues is and will continue to be difficult.


Thompson

Some members of the science community have given up trying to win media attention for the latest discovery, opting instead for the longer-haul strategy of building a relationship with reporters who show an interest or inclination to dig deeper into scientific and technological issues. Travis Thompson, director of Vanderbilt University's John F. Kennedy Center for Research on Human Development, reports that the scientists

he works with are now "…a little reluctant to go with their latest findings to the news media, when that's not really an effective vehicle."

Thompson says a "much wiser" course is to try to educate a reporter "over four, five or 10 conversations" and strive for more "substantial" articles. He said, "We were very successful with this last year in getting, I think it was, four different pieces sequentially on a particular genetic syndrome. Incredible coverage in a local newspaper. I mean it was amazing. Very well done. But it took six months."

Unprepared but interested

It shouldn't come as a surprise to scientists (who by all accounts are fascinated by their own work) that reporters can be intrigued as well, if a means can be found to stir their interest. Doreen Hemlock, a writer for the *San Juan Star*, probably speaks for many of her contemporaries.

"I mostly write about business," she says, "but I just keep bumping into science everywhere I go, and I really do not know how to deal with it very well."

Hemlock and the *San Juan Star* were handed an entirely new beat to cover when, thanks to changes in the tax laws several years ago, drug companies shifted much of their manufacturing to the island.

"I write about the pharmaceutical industry, and I do not understand half of the products that I write about, what they do, or how to express it. Lately, I have started covering science and technology policy, R&D, and I do not really understand how it works," she says.

Hemlock is typical of many reporters and editors who have had high-tech industries descend on their towns and states.

"I never even took high school biology. We had no requirements for science at the university. I don't understand science, but I know that it is important."

Is she discouraged? Hardly.

"The more I learn about it, the more I find to like about it," she says."[7]

In 1987, general assignment reporters all over the nation got the chance to write about high-energy nuclear physics and, according to Dr. Leon Lederman, they did a pretty good job. It happened during the nationwide search for a site to build the huge superconducting supercollider. Lederman says the episode "illustrates the fact that … if you build it, they'll come. If you have the news, it'll be shown."

Lederman

Lederman said local newspapers all over the country wrote lengthy articles about the massive project, which promised an economic boom for the state chosen as its site. But the writers, he said, were also "constrained to explain what the scientists were going to do there. And they didn't get it right exactly, but it was not bad, it was pretty good. I was amazed at how good these articles were by, not science writers, but people who took a little time to … try to figure out what they want to do here with this superconducting supercollider. In addition to us all getting rich, why did we want it? And I was amazed at that."

The regional press

NASA Administrator Goldin professes faith in reporters outside the large cities as well. "I think it's important to have *The Washington Post* and *The New York Times* and major papers and CNN," he said at a roundtable held in conjunction with this study. But most Americans read regional newspapers, he took pains to point out.

"We have a tendency in the scientific community to ignore the regional papers," he said, "the ones that talked about the superconducting supercollider. I say: This is where the scientists have to reach out.

"I've been there, done that; it's like water on the parched desert. They may be writing the society column for a small town, but they believe in the future of this country as much as any one else does.…

"We also have got to talk to the regional newspapers, the local newspapers, the small cable TV stations that broadcast to people who don't have the benefit of going out Sunday morning and getting *The New York Times*. They read their local paper, and we have a tendency to forget about them.… We must communicate with all of America."

As it turned out, Texas was chosen as the site for the supercollider. The project was begun, then abruptly terminated by Congress, wasting several billion dollars. The lesson in this, if there is one, is that the reporting—and thus the support—for the supercollider tended to be parochial. As long as all 50 states were in the running for a massive infusion of federal dollars, there was widespread interest. However, as the list of states narrowed and Texas finally was chosen, the enthusiasm in the rest of the nation vanished. The job of "selling" the supercollider to the American people on its scientific merits alone was a failure. The supercollider saga epitomizes the science story that develops sufficient "critical mass" to morph into a political story.

This is just the kind of transformation that worries science writer Jon Franklin.

"Political coverage is much more in the journalistic tradition," he says. "Journalism grew up with democratic politics, has even been called the fourth estate of government. Many reporters have degrees in political science. So they do a better job of politics, or at least they used to. Today, with so much science tangled up in politics, I'm not sure that is true anymore."[8]

The good science reporter

What makes a good science reporter?

"Science journalism is no different than any other journalism," says Ira Flatow, host of NPR's *Science Friday*, "except it takes someone who really likes science and is willing to put in the hours and the time and have the talent to make what most people would think is a dry story into a story."

Flatow says he always approaches science news "as detective stories, because scientists are really detectives … working on a larger piece of the puzzle."

"I like to think that a smart journalist can cover science, just as he or she can cover politics, or any number of other fields, by asking smart questions and not being embarrassed to ask any stupid-sounding question," says Kathy Sawyer, science writer for the *Washington Post*. But, she adds, "…we need a lot of help from scientists in that effort."

Sawyer is typical of many science reporters. She has no formal training in science. In the 1980s, she was one of the *Post*'s top political reporters, long before her first "science" story—the chance assignment of covering Christa McAuliffe, the first teacher in space, who had the misfortune of being aboard the *Challenger* when it exploded. The *Post* kept Sawyer on the *Challenger* story as it developed throughout the investigation, and she has been on the science beat ever since.

John Noble Wilford of *The New York Times* says he also "learned science on the job."

The opposite tack—science majors trained later as journalists—works just as well. Sharon Begley, senior science writer for *Newsweek*, majored in science at Yale. She does not write off a single reader.

"I want everybody to read my stories," she says. "If they don't, I might as well not have shown up that week. And I am, maybe, too Pollyannish, but I am a firm believer that if you write it right, they will read it all the way through."

How does she define 'science'? "At *Newsweek*, science is basic research," Begley says.

What do you have to discover to get her attention?

"I cover everything from archaeology to genetics, neuroscience, physics. I do not do medicine, which is defined as anything having

to do with sick people. And I don't do technology. I'll do genetics. I'll do neuroscience. But once it gets into somebody sick, I give it to 'medicine.'"

Those who can walk both sides of the street—scientists trained as journalists or reporters steeped in science—who can tell science stories that fascinate readers, are "just very talented people," according to Gerald Wheeler, executive director of the National Science Teachers Association.

Hooked on science

Many of the most talented science writers say they entered the field and stay in it because of the undeniable thrill of discovery. "I'll tell you why I was a science writer," says Jon Franklin, "and there wasn't a drop of altruism in it. I like science. I like the game. I like the idea that knowledge is a frontier, that inquisitiveness is a force. I was enthralled by the revolution in neuroscience, and I followed it like some people follow baseball. I got to dabble in everything."

Franklin

Franklin says it was the variety of stories that hooked him. "I remember seeing my first autopsy, my first brain operation. And hey! Any of you guys ever seen a manned flight lift off, down at the Cape? The sound is what you remember. It doesn't come through the television speakers, it's too deep. You have to be there! It makes your bones vibrate for hours afterwards.

"Did you know, I had a shot at the short list to ride that thing! And I'll tell you something else: It was some of the best material a writer could possibly ask for. It was like covering a major war and the United Nations and the White House and a mass murder, all at once, and with almost no competition. So much for altruism. I didn't do it for science, and I didn't do it for mankind. I did it for me, and it was worth it."[9]

Franklin acknowledges that science writers in the past, and some still today, have gotten too close to their stories and their sources. The very enthusiasm that he describes has sometimes produced gee-whiz coverage. *Newsweek*'s Begley says that, in some cases, hard-news editors are leery "because the science journalists seem to have been co-opted by the people they are covering, which is not what a journalist is supposed to do."

Now professor of creative writing at the University of Oregon, Franklin says that 20 years ago, "science, whatever its complaints about journalism, almost always came out on the glorious end of the story. That's why it could stay above the fray.

"Our tendency, with certain exceptions, was to idolize science. The public bought this. Science was Teflon, science spoke for Truth.

"In my era, we didn't do investigative reporting on science, except maybe around the edges. Newsrooms are intensely political places, and muckraking is a weapon wielded by reporters against political hard targets. We never, ever, went after science. Science was sacrosanct."[10]

chapter endnotes

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Gauging the Importance of Science

One journalist's candid confession

By Dave Barry

Perhaps you wonder, how come we here in the news media always make such a big deal about the stock market. The answer is simple: We don't understand it. We have an old saying in journalism: "If you don't understand something, it must be important."

This is also why we media people get so excited about science. In our scientific educations, we got as far as the part in biology class where they gave us a razor and a dead frog, and told us to find the pancreas. Right then we started thinking two words, and those words were: "English major."

So we quit studying science, which is why we do not begin to understand—to pick one of many examples—how electricity works. We believe that electricity EXISTS, because the electric company keeps sending us bills for it, but we cannot figure out how it travels inside wires. We have looked long and hard at wires (some of us have tried blowing into them), and we cannot begin to figure out how the electrons, or amperes, or whatever, manage to squeeze through there into the TV set, nor how, once inside, they manage to form themselves into complex discernible images such as the Pillsbury Doughboy.

We in the media write our stories on computers, but since computers contain both electricity and "modems," we have no idea how they work. If you observe us professional journalists covering a news event, you'll see that we divide our time as follows:

- 1 percent: Getting information.
- 6 percent: Writing stories.
- 93 percent: Trying to get the computer to send the story back to the newspaper by pressing keys pretty much at random with growing panic until we have sent our stories to some destination—possibility the Kremlin; possibly the radio room of the Titanic—but not to our newspapers. Then we call our newspapers and beg for help from the Computer People, who are technically competent people, the kind of people who always found the frog pancreas.

They understand "modems," and whatever they tell us to do to our computers, including wave a Magic Bone over the keyboard, we do it.

We in the media are especially impressed with space. We cannot comprehend how anybody could get a rocket to land on another planet. Many of us cannot consistently parallel park. This is why we got so excited about the recent Pathfinder mission, which day after day resulted in excited front-page headlines like:

ROCK FOUND ON MARS!
And:
ANOTHER ROCK FOUND ON MARS!
And:
MARS APPARENTLY COVERED WITH ROCKS!

We in the media believe that the Mars rocks are important because scientists tell us so. We will cheerfully print, without question, pretty much anything that scientists tell us about space ("STANFORD—Scientists here announced today that, using a powerful new type of telescope that uses amperes connected to a 'modem,' they have located six previously unknown galaxies shaped like all the major characters on *Gilligan's Island* except Ginger").

My point is that this same principle applies to media coverage of the stock market. We in the media, as a rule, are not good with financial matters. Some veteran journalists have not yet turned in their expense accounts for the Civil War. So as a group, we don't really have a solid handle on (1) What the stock market is; (2) Why it goes up and down; (3) Which is good, "Bull" or "Bear"; (4) Whether "points" means the same thing as "dollars," and if so, why the hell don't they just call them "dollars"; (5) Who "Alan Greenspan" is; and (6) Whether he is the same as "Dow Jones."

Because we don't understand these things, we have naturally concluded that the stock market is extremely important, and whenever it does anything, we write front-page stories filled with quotes from financial experts. But I suspect that these experts sometimes like to yank the media's chain. Consider the following quotation, which actually appeared in a Washington Post story back in August explaining why the stock market went down:

"'For Coke, an icon of the market, to show feet of clay is upsetting,' said Barton Biggs, global equity strategist at Morgan Stanley, Dean Witter, Discover & Co."

I have read this sentence at least 35 times, and every time I have more questions, including:

- What kind of job is "global equity strategist"?
- What kind of name is "Barton Biggs"?
- Since when does Coke have feet?

These are just some of the issues that lead me to believe that if we were to call "Morgan Stanley, Dean Witter, Discover & Co.," we would find ourselves talking to the very same scientists who are always "discovering" new galaxies and showing us pictures of "Mars rocks."

That's right: I think that science AND the stock market could be part of some giant hoax, and I intend to transmit this information to the newspaper, just as soon as I can locate the Magic Bone.

Dave Barry is a syndicated humor columnist for *The Miami Herald*.

CHAPTER SEVEN

Media Gatekeepers

"Obviously, a man's judgment cannot be better than the information on which he has based it."

—Arthur Hays Sulzberger, 1891-1968

The reporters and field producers who fashion the raw material that is "news" take their direction from the editors, news directors, publishers and owners of the American media—the gatekeepers.

A curious dichotomy is at work in this group. They have enormous power, yet they often deny it. The prevailing spin is that they are only giving the public what it wants. Indeed, much of American journalism these days is governed by what polls and focus groups tell editors and owners the public wants. The gatekeepers often say they are not in the business of "education" or "uplift," that they are mere chroniclers of the days' events.

To some extent, this is true. An unending stream of events—mostly wrack and ruin, fires, floods, disasters and the like—spills from the TV screens and the pages of the papers each day. These are part of the pageant of life, the unfolding cares and human concerns of a community or nation.

In this respect, newscasts and newspapers function much like the letters we wrote to one another a century ago, providing detailed descriptions of life's dimensions. Even today, most local newspapers carry many items that once were of interest only to individual families: who was born, who died, who married, who divorced, how much the neighbors paid for their house, which black sheep is in trouble with the law. Invariably, the offbeat and unusual show up in the news, just as they appeared in letters of old. No one is interested in a letter that says, "Everything's okay, Sincerely yours." We all know that hardly anything is ever okay, and it's a mark of our society that we seem to want to fix things that are not.

Alexis de Tocqueville wrote about this peculiarly American characteristic as early as 1835: "They have all a lively faith in the perfectibility of man, they judge that the diffusion of knowledge must necessarily be advantageous and the consequences of ignorance fatal," he wrote. "[T]hey all consider society as a body in a state of improvement, humanity as a changing scene, in which nothing is, or ought to be, permanent; and they admit that what appears to them today to be good, may be superseded by something better tomorrow."

Thus, if "bad news"—crime, floods, political corruption—can be translated into social improvement—better policing, a new dam (or maybe fewer dams, according to some studies), cleaner elections—there is really nothing wrong with bad news. It is, in effect, "good news." It's only when such matters become the predominant news diet, without explanation, clarification or possible solution, that the media do a disservice.

A good example is the never-ending prominence of crime news on local television—"if it bleeds, it leads,"—in the face of overwhelming evidence that crime is decreasing. This picture is not only incomplete, it is distorted. And it's self-reinforcing. William Raspberry of *The Washington Post* writes that: "[Readers] phone us with tips on accidents and hostage-takings and kids having sex in schoolrooms because they know, by reading us, that we like stories of disasters."[1]

The current agenda

Their ability to set the agenda—and in so doing to draw at least an outline of contemporary

culture—is the most important franchise media gatekeepers have. Thus the question: What kind of culture is evolving from the daily agenda many gatekeepers are now setting out for their readers and viewers? Is our table talk to be of fear, helplessness and scandal, born of senseless crime sensations and disasters mixed with the sordid and banal private lives of celebrities?

"The media no longer ask those who know something … to share that knowledge with the public. Instead, they ask those who know nothing to represent the ignorance of the public and, in so doing, to legitimate it,"[2] observed French film critic Serge Daney in1992.

Or as American journalist Carl Bernstein laments: "The lowest form of popular culture—lack of information, misinformation, disinformation, and a contempt for the truth or the reality of most people's lives—has overrun real journalism. Today, ordinary Americans are being stuffed with garbage."[3]

This is the mix into which stories about science discoveries are thrown. Whether or not they surface, according to Ira Flatow, often depends on the writing ability and zeal of reporters who are able to grab the attention of the gatekeeper.

"I think to most TV producers—and I'll speak about news producers—science is medicine," says Flatow. "They know science is medicine. It's the disease of the week, it's what's happening in AIDS or cancer, and as soon as they see that tag there, they don't have to be told anything more, they'll go with the story.

"On the other hand, if you talk about other aspects of science—physics, chemistry, even environmental stories—they have to be educated about why that is important. And usually the education occurs, in a large organization, [when] a science reporter [pitches] a story."

Of course, reporters from every beat—crime, courts, government, schools—are competing for a piece of the daily "news hole." (The news hole is the amount of space in a newspaper that is left for news stories after the space for advertising and other "must" items is subtracted. Except on very rare occasions, the number of newspaper pages is dictated not by the amount of news, but by the amount of advertising. The same formula is true of television.)

"Today's news is created, packaged, and delivered by a priesthood of journalists," says Ellen Hume, "trained by editors who hired them because they had the right 'instincts'—that is, they had the same set of cultural expectations and values as the editors themselves. The news is delivered, take it or leave it, to a passive audience."

In Hume's thesis, readers and viewers have no choice—either accept "news" as it's defined by the media, or cancel the subscription and flip off the switch.


Hume

"The public has little ability to add anything to the news agenda or to correct errors of interpretation or omission," Hume says. "Theoretically, both the news production process and the product are protected from outside influence in order to preserve journalists' ability to tell the truth, without fear or favor."[4]

Journalists responding to the survey connected with this study contradicted this view somewhat, suggesting several other reasons for the dearth of quality science-and-technology reporting in U.S. newspapers and television newscasts. Here are the reasons most often cited.

First of all, newspaper editors and publishers say it is difficult to find advertisers for a science section, especially in small- to mid-sized markets. This failure to lure advertisers is puzzling, especially in the face of evidence that science is very successful in other venues.

Newsweek's Begley says, "Our science covers are among the best-selling we ever produced. My mail outpaces that of any other section."

Without advertising, however, it is hard to justify the additional expense a science section

would impose. According to Frank Sutherland, vice president/news and editor of *The Tennessean*, the cost of printing only one extra page in the Sunday edition for one year is $130,000. "That's just for newsprint," he says, "before I starting hiring anyone to write."

On the other hand, *The Tennessean* prints a daily, multi-page business section, complete with stock tables, that carries little or no advertising except the classifieds, which could be printed in any section.


Wilford

Many papers have tried putting out regular science sections and failed—meaning the venture was not financially successful, i.e., advertisers were not attracted in sufficient numbers to justify the expense. In the near future, it is probably not realistic to hope that any but the largest newspapers will commit to regular, ongoing coverage.

"I don't expect all papers to cover the science the way *The New York Times* does," says John Noble Wilford. "We have 15 people who put out a weekly section."

Perhaps the solution to advertiser indifference is a semantic one. Just don't use the word "science."

"Maybe when you use the word 'science,' people think, 'Oh, Christ, I flunked physics,'" says Michael Gartner. "Maybe you just have a problem with words. And maybe there is a whole line of journalism going on that covers the environment, that covers medicine, that covers all these developments, whether it is space or anything."

Gartner makes an interesting point. Many routine news stories contain elements of science; the subject pervades our lives.

"A few days ago I read through my local paper as a reality check, and it was full of science news," says Jon Franklin. "Social science, space science, a story on salmon ecology, another on medicine. Science is pervasive in our civic life … in our lives, generally. But a smaller and smaller percentage of this science journalism is being written by science writers, or even by science reporters. Much of it, as a result, is grossly inaccurate, if not in fact, then in tone, play and context."[5]

Franklin is the author of four books and the winner of two Pulitzer Prizes for journalism. These days he is ambivalent about what science reporting is and what to call it. "In the late 1970s I was forced to rethink my journalistic strategy," he says. "I had been reporting and explaining discoveries, but my stories were not being widely read. I generally used the word 'science' early in the story, thinking it would attract readers. The word generally ended up in the headline.

"But I now realize that the effect was to tell general readers what to avoid. They might trust science in theory, but in practice it had bad personal associations. It confused them, made them feel negative about themselves. Science pages ghettoized science news, gave people a whole section they could throw away unread."[6]

Not enough interest

Second, editors often contend that there is not enough reader or viewer interest in science matters to justify additional coverage.

"There's an interesting paradox," says NPR's Flatow. "Every study has shown that people who watch television want to see science on the evening news. They rate it very highly when they are asked: 'What kinds of stories do you want to see on your six-o'clock newscast?'

"But you cannot get the gatekeepers—the producers, the news directors—to put it on. They abhor it. They think no one wants it, because they [themselves] had a bad experience with it, perhaps in high school. They don't think anyone else can stomach it."[7]

The New York Times' Wilford agrees. "I think, to a large degree, editors underestimate the public's interest in science and underestimate

[readers'] ability to understand science when it's well written."

Wilford's opinion is corroborated on the airwaves by ratings for the Discovery Channel, which consistently draws a larger audience than CNN. And recent surveys do show a sizable, if not monumental, desire by newspaper readers for increased science coverage. [8]


Greenberg

"By numerous accounts, the American public is enamored of science and scientists," says Daniel Greenberg, editor and publisher of *Science & Government Report*, a Washington newsletter. The public, he says, "follows their work with respect and interest and thinks the government should spend more on many fields of research. These affectionate attitudes are registered in 25 years of public opinion surveys commissioned by a bedrock of scientific respectability, the National Science Foundation, which bankrolls basic research in universities."[9]

Third, some editors are convinced that not only do their readers not care much about science, but they won't understand it either. In some cases, this may be true. However, complexity is no excuse for a failure to report. Many local zoning questions are complex, the rules of baseball are tortuous, criminal law is enigmatic, but newspapers generally take the time and use the space necessary for public understanding of such matters.

A careful writer and a discerning editor can make science intriguing, understandable and absorbing. Moreover, very complex matters, often involving health and medicine, are elbowing their way to center stage. The controversies over mammograms and possible genetic links to breast cancer, for instance, involve issues of life and death. Common sense would lead one to suspect that most women would be more than interested.

"I learned never to underestimate readers," says Gene Roberts, former managing editor of *The New York Times*, "… they expect depth when stories arise that are important to them."[10]

Unfortunately, depth was what the public rarely got in coverage of the mammogram controversy. That story was largely garbled in the media.

Gatekeepers as obstacles

Finally, perhaps the greatest impediment to increased science reporting in the nation's news media might be editors' own discomfort with the subject. Of the hundreds of news managers around the nation who returned survey responses for this project, only 6 percent had science degrees. Given that statistic, it's not surprising that many editors are irresolute when it comes to making decisions about science stories. The same person who can make flawless snap judgments about political stories may well founder in the ocean of science and technology.

One survey respondent, who requested anonymity, wrote: "Editors are the biggest obstacles to science coverage. They are not interested and/or are confused by science, from the basics to advanced theories. Consequently, they allow little time for reporting and writing on science matters. That leads to quick interviews with scientists, little reporter control over content and mistrust all around."

If editors struggle with content, they also have problems with form. Consider Ira Flatow's experience at CBS.

"I was a science reporter on CBS for *CBS This Morning* for about a year. And they were very eager to do science stories, and they gave me just about [everything] on science stories that I could come up with. I was unique, in that I liked science. I was able to pitch it, and I had a producer who liked to put on science.

"On the other hand, he had his own constraints. At one point, he called me into the office after working for three months, and he

looked at me and he said, 'I don't know how to tell you this.' And he hemmed and hawed.

"And I said, 'Let me tell you what you want to say.'

"He said, 'What?'

"I said, 'I'm the science reporter, so you want me to wear a lab coat, don't you? Because that's what the public thinks science reporters do, right?'

"He said, 'How did you know that?'

I said, 'I've been in this business a little while, I know a little about commercial television.' I said, 'I'll make you a deal. If your business reporter wears a green eye-shade, I'll wear a lab coat.'

"And he looks at me and says, 'You know, what you have on now is just perfect.'"

Flatow

Flatow says in his years at CBS, and now at National Public Radio, the key to getting science stories on the air is finding "the gatekeeper—meaning a producer or an editor—who is sympathetic, who actually liked science as a child or enjoyed studying science." Short of that, he says, "pitch it as a human-interest story … everything on television has to be seen as a human-interest story and have a human-interest slant."

If all this makes the gatekeepers seem detached, or even capricious, and hard to reach with science news, blame it partly on the current newsroom climate of uncertainty and unease about the future. But that said, there are inexplicable lapses in judgment, even in the largest and most secure news organizations.

"When *The New York Times* quotes the tabloid *National Enquirer* as the basis for a news story," says Ellen Hume, "when former *60 Minutes* veteran Diane Sawyer asks Donald Trump's mistress, 'Was it the best sex you ever had?,' when *Dateline NBC* stages an explosion to 'prove' that a certain truck is unsafe, and when, as *CBS Evening News* anchor, Connie Chung goads the relatives of public officials into name-calling—separating news from entertainment and propaganda is next to impossible."[11]

Is the trend toward the sensational and away from the substantive just a temporary aberration? Or are we at the beginning of a long-term lowering of traditional journalistic standards? One way to measure that is to look at the next crop of reporters and editors.

According to Jon Franklin, a "most frightening poll was taken at the Columbia graduate school of journalism, one of my profession's most elite institutions. Fifty-seven percent of the student journalists believed in ESP, 57 percent believed in dousing, 47 percent in aura reading, and 25 percent in the lost continent of Atlantis."[12]

chapter endnotes

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Nothing Succeeds Like Substance

By Eugene L. Roberts, Jr.

The following is excerpted from a speech given by Eugene Roberts, former managing editor of The New York Times*, after he received the National Press Club's Fourth Estate Award. It subsequently appeared in the December 1993 issue of* American Journalism Review*. It is reprinted here by permission of* American Journalism Review *and NewsLink Associates.*

Today, as competition diminishes and disappears, many newspapers seem to be in a race to see which can be the most shortsighted and superficial. We are relying too much—far too much—on weather maps, charts, graphs, briefs and color.

If we had looked upon these devices as nothing more, or less, than desirable improvements, then our papers would have been all the richer for the additions. But in far too many newspapers, we introduced these devices while slashing newsroom budgets and newsholes. The result, all too often, has been that instead of becoming additions to news coverage, the devices have become substitutes for news coverage. And this, in a word, is folly.

We, of course, introduced many of the devices in order to reach out to marginal readers and non-readers. This was good. But when we started cutting back on substance, we put serious, devoted readers at risk by becoming less essential to them. And this was, and is, a very bad tradeoff. I think, quite simply, that we are imperiling newspapers in the name of saving them.

Not only is this trend weakening our hold on the most loyal readers, it is causing long-term confusion and instability on our staffs, which further threaten our readership. Evidence of this abounds.

Recently, I talked to a newspaper consultant who estimated that he had given advice to more than 100 newsrooms in the past two years. The consultant found a common problem at almost every paper. The mid-level tier of editors seemed traumatized.

The problem? Lack of resources. The mid-level editors didn't think it was possible to perform at an acceptable standard given the resources at their disposal.

You could go to any editors' meeting in the past three or four years and encounter widespread angst. And not meetings of mid-level editors. Top editors.

… Much of the newsroom cutting was done in the name of recession-related downsizing, although some companies say that the downsizing is permanent. But the recession is only part of the problem. The real problem is that we're further along in concentration of newspaper ownership and corporatization.

We're now in the second and third generation of professional corporate managers who are judged and compensated on the profits they generate during their tenure, not on what they do to guarantee the survival of newspapers. It should be noted that even in the worst of the recession, average operating profits, as a percentage of revenue, were in the 14 percent to 15 percent range for publicly held newspapers. Many basic American industries never reach that level of profit even in the best of times. And some newspaper companies reached those levels in recessionary times by mortgaging the future, by stripping away the glue that binds our most loyal readers to our papers.

Just how bleak is the situation? Scary to be sure, but not hopeless if corporations become aware that there is no security in superficiality and fadism. Here and there, thankfully, are newspapers—a distinct minority—that understand this and are riding out the recession without shortchanging their readers. And there are executives on still other newspapers who are beginning to worry about what they are doing to the future of their papers by focusing on short-term, rather than long-term, profit goals.

It will be interesting and telling to see, as the economy improves, how much newshole and staff will be restored, and whether management has learned that newspapers are not accordions, that their content cannot be pushed up and down at will without long-term damage.

Let us hope that there is enough understanding to produce a strong counter movement for substance and continuity. Let us hope that more executives learn what some of us were taught in the streets and fields where the readers are—that you might get a large audience by being a quick, superficial read, but not an intense, dedicated audience.

And journalistic history is, of course, littered with the corpses of large-circulation newspapers that failed to make long-term and lasting reader relationships and, thus, were viewed as dispensable by their readers and, consequently, by their advertisers.

CHAPTER **EIGHT**

Running Scared

Human history becomes more and more a race between education and catastrophe.

—H.G. Wells, 1866-1946

H.G. Wells made the above observation about the nature of human history shortly after the close of World War I, and for the next 70 years, the race he had identified was a near thing, with World War II immediately followed by the Cold War and nuclear brinkmanship.

But education finally pulled ahead. The Soviet Union's launch of Sputnik in 1957 led to a crash program to improve U.S. education, especially in science and technology. The enduring phrase from the era was "missile gap." For while *Sputnik* was launched as part of the International Geophysical Year—an international science program—the military implications of orbiting even peaceful payloads were clear. And that scared America to death.

Real or not, there was a perceived science gap as well as a missile gap. The Soviets, with their success in space, rode to orbit as the masters of what seemed like an explosion of technological breakthroughs. The threat seemed clear. The United States was no longer a half a world away from its enemy; potential devastation was measured in minutes.

As columnist Walter Shapiro explains: "Amid the hysteria of the Cold War, *Sputnik* was portrayed in chilling death-rays-from-outer-space terms. … Our technological supremacy has its roots in the panicked post-Sputnik emphasis on teaching math and science."[1]

It's interesting to speculate whether the United States would have embarked on its high-tech crusade if we had reached outer space first, a feat that was well within our capabilities. By the time the USSR had placed Sputnik in orbit, Wernher von Braun and his team of German scientists, who surrendered to the U.S. at the end of World War II rather than be captured by the Soviets, had already built the rocket that was eventually to launch the first American satellite. For political reasons not readily understood today, it lay unused in a hangar at the Redstone Arsenal in Huntsville, Ala. Only after the U.S. Navy had endured a spectacular series of launch failures with its Vanguard rocket in the wake of Sputnik was von Braun given the opportunity to launch his creation, the Redstone rocket, which orbited the first Explorer satellite on its initial attempt, Jan. 31, 1958.

Sputnik

In typical American fashion, the nation at this time embarked not only on the huge rocket-building program, but also began a vast science-education campaign that would produce many of today's scientists and engineers, who in their time not only would accomplish great feats in space flight but

Shapiro

Meanwhile, Back in Astronomy 101 …

Non-science majors in college are seldom taxed beyond learning a few generalities, and often graduate with little more than one or two, sometimes no, elective introductory science courses.

The following examples of student comprehension come from an introductory astronomy course taught by Prof. William Keel at the University of Alabama. These are "genuine, unexpurgated snippets," says Dr. Keel.

- "Mesopotamia was an area in the valley of Euphrates and Tigris river, now the region of Iraq. Much of the celestial bodies and their ways came from the people of this area. The summarians, a pre-semantic population, occupied this ancient area of land."
- "Most impacts on the Earth's surface are impact craters."
- "During the winter months, the Earth is higher away from the Sun so we have longer days."
- "The gravity of the earth while rotating receives a bulge on the sides due to the speed of the earth and in what relation the moon is to the earth. When the ocean waters become full to capacity it overflows upon the beaches. After the earth rotates the oceans can hold that water again and the beaches become dry. The two bulges are directly opposite each other on the earth due to the relation of gravity and mass of the two direct points."
- "Since the distance from the center of the earth to its outer edge is 4000 times farther than from the earth to the moon, the gravitational pull from the moon pulls the liquid part of our earth to a slight point."
- "During a solar eclipse the sun tends to stay out longer and is much more damaging—it takes longer for the earth to rotate. The lunar eclipse means less sunlight and the earth rotates faster."
- "During lunar eclipses, the moon travels around the sun preventing light to the earth. During solar eclipses, the earth travels around the moon."
- "The star starts out by being formed by gravity pushing being pushed back."
- "A main sequence star transforms into a Red Giant—the Red Giant is very hot. The Red Giant goes to the envelope magnitide and after gradual cooling, the end process is a white dwarf. A white dwarf generates no energy inside its core. This whole process can take months and sometimes years."
- "This era has experienced a new aspect of science termed Radio Astronomy, a vile new science which stemmed from radio engineering but finally became established as a powerful complementary ally to the most ancient of the sciences."
- "A radio telescope often sends messages to the astronomer by the use of frequencies."
- "It is believed that neutron stars produce pulses of radio emission due to the stars absorption ability of rays in which produce this type of radio emission pulses."
- "The Sun is one of the clearest stars to be seen on earth because it has the largest animosity."
- "As all the stars in the universe the Sun might have resulted from the huge cloud theory. But whatever the reason was, the Sun have been founded for at least 4.5 million years."
- "Most of this reasoning lies in the fact that the Milky Way is not alone. It is part of the magnificent Milky Way Galaxy which is still being studied today."
- "There is a bright side to being the first and only intelligent beings in our galaxy—we will have the chance to found the Galactic Empire!"

Professor Keel says such college writing "certainly abolishes my illusions of teaching effectiveness." It is also a devastating comment on critical thinking and English language standards.

would usher in much of today's post-industrial world as well. Even the environmental movement was "sparked in part by the first unforgettable photographs of a green-and-blue Earth as seen from space," writes Shapiro.

Scientific devolution

Unfortunately, the heady scientific and technological triumphs of the past four decades have not been enough to support a universal and sustained push. It's impossible to know exactly when, but slowly the momentum subsided. A particularly virulent strain of anti-intellectualism arose in America. By the early '80s, Fran Lebowitz would be counseling teens to: "Stand firm in your refusal to remain conscious during algebra. In real life, I assure you, there is no such thing as algebra."[2] The computer engineers who forever altered the way the world makes and manages just about everything became "nerds." By the mid-'90s, eighth-graders in the United States had sunk below their peers in the Czech Republic, Hungary, Slovenia and Bulgaria in math scores. Altogether, students in 20 other nations could outfigure American middle-schoolers on math tests given as part of the Third International Math and Science Study.[3]

These results contrast starkly with the much higher scores U.S. fourth-graders achieved in the same study. The younger Americans rate near the top of the worldwide heap. Something profoundly debilitating is happening in four short years.

"My experience," said Carl Sagan, "is that young children are natural-born scientists, asking very deep questions. By high school, they've become leaden and incurious. Something terrible has happened between first and twelfth grade—and it's not just puberty. I think teachers and parents discourage young children from asking deep questions. The most important thing we can do is encourage their curiosity and sense of wonder while we develop their critical sensibilities."[4]

Nobel Prize-winning physicist Leon Lederman blames it on teachers. "We don't teach our children science," he said. "We teach it very badly, if at all. And what happens all too often is, the teacher communicates his or her own fear and uncertainty about science to the child."

Boyce Rensberger, science writer for *The Washington Post*, is even more blunt. "There are two reasons why people do not continue to be scientists. Parents and teachers."[5]

Though it is not the proximal cause of the gap between scientists and journalists, the depressed state of science education—and, therefore, of general comprehension—in the United States is a contributing factor, if only a psychological one. Only one in 10 Americans thinks he or she is very well informed about scientific matters. With such low scientific self-esteem, the average person is not going to understand routine scientific matters without a great deal of help.

The scientists responding to the survey done in conjunction with this study mentioned the subject of science education more often than any other single topic in their comments.

"The media can pass off poor reporting of science because of the abysmal failure of most of the American populace to understand even the rudiments of the scientific method," wrote Dr. Greg Wright of Chicago.

A doctoral candidate at Georgia State University, Rusty Harvin, who is chronologically closer to recent educational trends, noted that: "The schools have done an incredibly poor job of science education. In part this is because of a shortage of good science teachers. Most of them can make more money elsewhere."

Dr. Joanna Muench of Falmouth, Mass., wrote: "Unfortunately, the dismantling of our public education system has rendered the teaching of science to nothing, so the journalists mostly know nothing of the subject and therefore cannot communicate with an equally ignorant public."

Lamented Dr. John Dockery of Reston, Va.: "It is chic to be ignorant of science."

Rampant illiteracy

In 1996, the National Science Foundation commissioned a survey to determine how many Americans knew the answers to 10 simple science questions.[6] Only 22 percent of the 2,006 adults who participated in the survey could correctly answer seven or more of them. Astonishingly, less than half knew that the earth's orbit around the sun takes 12 months—one year.

As late as February 1997, the U.S. Education Department reported that nearly 40 percent of eighth-graders still lack even basic number skills.

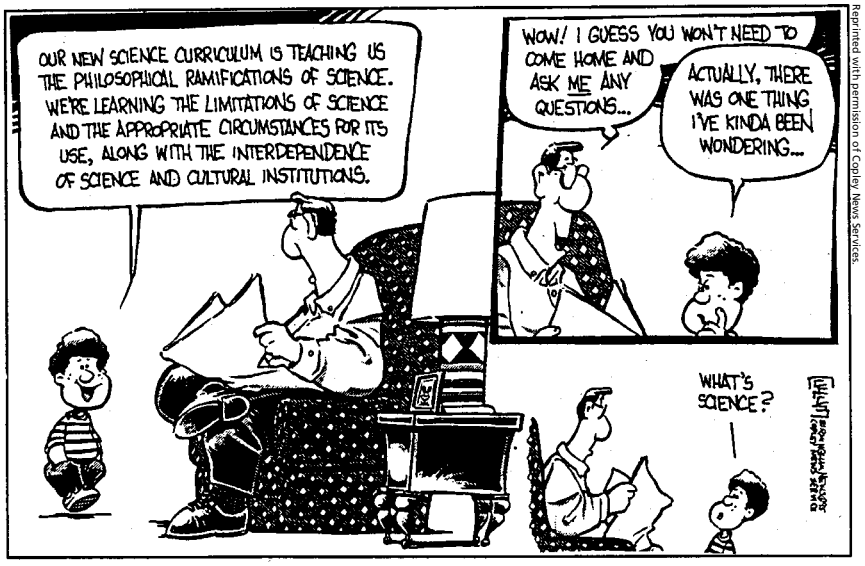
According to NASA Administrator Dan Goldin, understanding science and math is now crucial to survival in our world. "If you are sick," says Goldin, "the doctors don't do all the work on you. You have to understand fundamentals, the science of medicine, to help diagnose yourself. It's a personal responsibility; you cannot leave it to the physician. When you go to the polls to vote, and you have to understand environmental policy, it is irresponsible not to understand it. But people can't be held responsible if they don't have the basic training."

Why do Americans have such a dismal understanding—even a fear—of science?

There's little question the problem starts in school. At a time when youngsters are wide-eyed and enthusiastic, hungry for new knowledge, they are often taught by people who are barely qualified. According to the National Science Foundation, "Many mathematics and science teachers have very little training in mathematics and science, particularly among elementary and middle-grade teachers. As recently as 1993, less than 4 percent of elementary mathematics and science teachers had majored in mathematics or mathematics education, or science or science education. Only 11 percent of middle school mathematics teachers and 21 percent of science teachers majored in their fields of teaching specialization."[7]

The NSF findings were confirmed in a Rockefeller Foundation/Carnegie Corporation study in the same period that was summarized in *The Washington Post* on Sept. 13, 1996: "Commission members said that during two years of research they found that about one fourth of high school teachers lack college training in their primary classroom subject; that nearly 40 percent of math teachers are not fully qualified for their assignment; that 500 of the nation's 1,200 education schools lack accreditation; and that three of every 10 teachers quit the job within five years.[8]

The article by *Post* education writer Rene Sanchez went on to quote one of the study's most devastating observations: "Although no state will permit a person to write wills, practice medicine, fix plumbing, or style hair without completing training and passing an examination, more than 40 states allow districts to



hire teachers who have not met these basic requirements."

And finally, "Most states pay more attention to the qualifications of veterinarians treating America's cats and dogs than those of the people educating the nation's children and youth."[9]

How much useful information are Americans getting from the media about the science and math turmoil in the U.S. educational system?

While national polls indicate that education is very near the top of American concerns, few newspapers and almost no local television stations devote extensive time and space to it. Two independent analyses made in 1997 of local television newscasts showed that educational issues made up 1.7 percent and 2.0 percent respectively of the content.[10]

Better than Lithuania

It's ironic that, just when Americans were increasingly searching for answers as to why their children were falling behind in educational skills (and the media were reporting less) the first detailed and meaningful answers were emerging from a massive, carefully constructed survey of teaching methods worldwide. Parents and teachers were afforded the chance to see what works and what doesn't, especially in comparisons between U.S. schools and schools in several Asian nations, particularly, Japan, that prepare their students far better in math and science.

In 1995, 4,000 seventh-grade and 7,000 eighth-grade American students from more than 185 randomly selected public and private schools took part in a worldwide examination of their mathematical and scientific knowledge. In all, 500,000 students from 45 nations took part. The tests were designed to eliminate the effects of cultural differences, concentrating instead on basic understanding of the subject and the effectiveness of teaching methods. Known as TIMSS (The Third International Mathematics and Science Study), it was the largest and most comprehensive international comparison of education ever undertaken.

The United States ranked 28th out of 41 countries in eighth-graders' math performance and 17th in eighth-graders' science achievement. Singapore claimed the top spot in science and math at both the seventh- and eighth-grade levels. It was followed by South Korea, Japan and Hong Kong in math. U.S. students also were outperformed by youngsters from the Czech Republic, Hungary, The Netherlands, Austria, Slovenia and Bulgaria.

The U.S. beat only four countries in both mathematics and science: Lithuania, Cyprus, Portugal and Iran.

Another way to compare U.S. students with the high-scoring Singaporeans is through percentiles. How did our best math and science students do against their best? The American eighth-graders in the 95th percentile—the top five percent—were equal to those in the 50th percentile—the average students—in Singapore. In Japan, our top students would be at the 75th percentile.

If a world-wide talent search were conducted for the top 10 percent of all students who participated in the TIMSS study, 5 percent of Americans would make the cut in math and 13 percent in science. By comparison, Singapore would place 45 percent of all its students in the math sweepstakes and 31 percent in science. Among the top 10 percent worldwide, 32 percent of all Japanese students would make it in math and 18 percent in science.

Student achievement is a complex matter, but it's largely dependent on three key factors: curriculum, teaching skills and student receptivity.

In the United States, we typically try to address the quality problem with quantity. American schools attempt to teach far more math topics per semester than schools in other parts of the world. Thus American students get a smattering of many subjects but little depth in any. Because subjects are not well-learned the first time around, they are often taught over and over, so that by the time students reach the eighth grade, they are generally still

taking subjects taught on average in the seventh grade in the better-performing countries.

Another big difference: U.S. teachers typically teach far more classroom periods than, say, their Japanese counterparts. Also, the U.S. school year is shorter—typically 180 days versus 220 in Japan.

It's common for Americans to believe that homework improves learning, to feel that if American kids just had more homework piled on, they would achieve more. It is frequently assumed that teachers in high-achieving countries assign more homework than U.S. teachers do. However, Japanese teachers actually assign less.

The TIMSS results disappointed the U.S. educational establishment, whose goal—set during the Bush administration—of making American school children No. 1 in math and science by the year 2000 was largely dashed.

'Mile wide, inch deep'

More ominous was the verdict of American industry. Norman Augustine, head of Martin Marietta and chairman of the Business Roundtable, said, "Neither result is good enough to compete in today's high-performance, technology-driven workplace."

But the national coordinator for the U.S. component of the TIMSS project, Michigan State Professor William H. Schmidt, says the country should forget about the rankings and concentrate instead on the deeper meaning of the data.

"U.S. performance was disappointing in an international context," he says. "As a nation, we have a splintered vision of what mathematics and science education should be for our children. In fact, our nation is atypical among countries surveyed in its lack of a nationally or regionally defined curriculum."

Such a national curriculum has been resisted in many localities by parents and school boards who distrust the federal government, and jealously protect their own turf. Another problem, Schmidt says, is this country's scattershot approach.

"Our unfocused curricula and textbooks fail to define clearly what is intended to be taught. They influence teachers to implement fragmented learning goals in their classrooms. They emphasize familiarity with many topics rather than concentrated attention to a few. Our curricula, textbooks and teaching are all a 'mile wide and an inch deep.'"

It's not how much we teach, rather it's the "quality of instruction," he says.

The TIMSS study should be a wake-up call to America, Schmidt declares. "Our children, and our nation's future, are in the balance."[11]

Mondale

Walter Mondale, former vice president and former U.S. ambassador to Japan, has had a chance to observe the educational differences first hand. He noted in an article written for *Science* magazine that "science in America today faces decreased federal support, the declining quality of our K-12 educational system, the inability of our budget process to deal with long-range international research projects, and declining interest on the part of our brightest young people in pursuing scientific careers."[12]

Lane

While the science community worries about the decline in U.S. recruits, the general level of science education is just as troublesome. If the overall quality continues to decline, the United States "won't have this position of leadership in the 21st century because we won't have the work force—not just in science and engineering, but anyplace in a society, in a workplace, that's in-

creasingly technologically based," says Neal Lane of the National Science Foundation.

Thirst for scientific knowledge

Such a state of affairs would seem to make communication between scientists and the public next to impossible. However, Americans say they want to know more about the world of science; despite their own deficiencies of understanding, down deep there is a remarkable yearning for science information. Nearly 60 percent of Americans say they are very attentive or interested in science developments. Yet, less than 10 percent consider themselves very well informed, and another 15 percent say they are only moderately well informed. Interestingly, this dichotomy is a phenomenon now noted in all developed countries.

Is there other evidence of widespread interest in matters scientific? Certainly. Two pioneers who brought science to the masses, both of whom died during the period of this study, captured the world's attention and focused it on complex issues. Jacques Cousteau took us to the bottom of the oceans; Carl Sagan took us to the farthest reaches of the universe. Cousteau's first book, *The Silent World*, written in 1953, sold more than five million copies and was translated into 22 languages.[13] The success of Sagan's first venture into television staggered him. "I was completely unprepared for the success of *Cosmos*, now seen by 500 million people in over 60 countries. I think it clearly indicates an enormous, unfulfilled hunger for accessible and inspiring science in the general public," Sagan said.[14]

Sagan and many others have pounded home the notion that we have to improve our standards for science education, that the subject can no longer be viewed as a "specialty," that it's not just a part of life, but life itself. A failure to understand science leaves the individual vulnerable.

"There are just too many cases where the science teacher merely hands down, as if from Mount Sinai, the findings of science without giving any idea of the method by which that information was acquired," Sagan said in an interview with *U.S. News & World Report*. "So when someone else comes along and hands down, as if from Mount Sinai, a result from pseudo-science, it sounds just the same.

"Wouldn't it be great if science textbooks spent some time on erroneous past understanding that everybody believed, that the church and the state and the scientists and the philosophers and the schools all taught, and that turned out to be completely wrong? Isn't that a very useful lesson to teach our children?"[15]

Theodore Schick Jr., professor of philosophy at Muhlenberg College in Allentown, Pa., agrees in part but sees more urgency in the problem. He says "… unless our educational system focuses more on teaching students how to think than on what to think, our populace will become increasingly credulous. Scientists and educators alike need to realize that the educated person is not the person who can answer the questions, but the person who can question the answers. In our age of rapidly changing information, knowing how to distinguish truth from falsity is more important than knowing what was once considered true and false. Only a person who knows the difference between a justified and an unjustified belief can truly appreciate the value of scientific inquiry."[16]

Ira Flatow echoes Walter Lippmann, quoted earlier in this study, saying: "Until we make science as much a topic of conversation around the dinner table as we do business and health, and other things that people talk about all the time, we're not going to really create … the generation of kids who are interested in learning about science."

"I think part of that problem is broader than just science," says NASA Administrator Daniel Goldin. "Young children are not reading. They're watching lots of TV, and they're playing video games. I probably go to 40, 50 schools a year, and I ask the children this question: 'How many of you read a book a week or a book a month?' Very few children raise their hands.

"I sometimes do it with adults. Very few adults raise their hands Now, when you read a book, it's a long time investment, and our culture is going to shorter and shorter pieces of information. … So, I say, it's more than the issue between the media and the scientists, it is our general population. If we want our population to be educated, we've got to start training our children that they can't watch three to five hours a day of video and still be able to dream and visualize things in their heads—and read more than press bites."

Goldin visualizes his NASA scientists as leaders in the race between education and catastrophe.

"I say an hour a week, out of a 50-hour schedule, for a scientist to stand in front of an eighth-grade class and learn how to communicate with America is a necessity. It's an obligation. It is the future of our country.

"I think this is the key issue: We must help the American public understand. Our young people, in another generation, are going to fall out of the labor force. We'll have two categories—those that understand science and technology and are part of the economy, and those that don't and aren't. It's a race."

More than that: It's a race the news media are largely missing.

More bad news

In June 1997, the Rand Corporation issued an appalling warning that America's colleges and universities are facing a severe budget crunch, that if present trends continue, the university system will come up $38 billion short in the year 2015. To make up for the shortfall, tuition will have to double, pricing half the country's potential students out of the market. Tuition has already doubled in the past 20 years, largely because public and private funding has not kept pace with university costs or student enrollment.

Where has the money gone? At the state level, at least, it's going into construction of prisons rather than universities. According to the Justice Policy Institute in Washington, state governments increased their spending on prisons 30 percent between 1987 and 1995, while spending on higher education declined 18 percent. In 1995 alone, prison construction budgets increased by $926 million, while university building went down by almost the same amount.

Two states, Florida and California, now spend more on corrections than on higher education. Since 1984, California has built 21 new prisons and only one university.

It's beyond the scope of this report, but the budget numbers for prison construction raise an interesting corollary question: Has the decade-long diet of crime reporting the nation has been fed by its news media led to an irrational impulse to lock up wrong-doers of all stripes—even when dozens of scientific studies show this is not always the best, or the most cost-effective, means of curbing destructive behavior?

As one English educator has noted: "Education costs money, but then so does ignorance."[17]

chapter endnotes

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A Conversation with Bill Nye, the Science Guy

The following excerpts are from a segment of the radio interview program *Fresh Air*, broadcast on Dec. 4, 1997, over National Public Radio member stations.

BARBARA BOGAEV, HOST: This is Fresh Air. I'm Barbara Bogaev in for Terry Gross.

Ever since the pocket protector was invented and probably long before then, people interested in science have been considered nerds, dweebs, outcasts, geeks, losers. Now, it's one man's quest to change all that.

Bill Nye is the creator, host and head writer of the TV show Bill Nye the Science Guy, *which airs weekdays on public television and weekends on commercial stations around the country.*

Through a frenetic mix of video clips, scientific explanations, song and movie parodies, cheap sound effects, bad puns, and do-it-yourself experiments, Bill Nye the Science Guy proves beyond a doubt that science is cool.

With lab coat and bow-tie intact, he jumps out of airplanes to demonstrate gravity, or scuba dives to get a first-hand look at undersea invertebrates. Although the show is aimed at 9- to 11-year-olds, over half its viewers now in its fifth year in syndication are adults—people like me and possibly you who have only the shakiest grounding in basic science. …

BOGAEV: It seems as if there was a kind of science black-out for years on children's television. I'm thinking, when I grew up, there wasn't all that much to watch. But now, there are lots of TV programs about science—there's the Magic School Bus*; there's* Newton's Apple*;* Beakman's World*; of course,* Bill Nye the Science Guy.

Is this just a television fad: Or do you understand it as science's time has come? It's now a hot commodity in popular culture.

NYE: Well, both. By that I mean, its—its cycle has come around again and it is a hot topic right now. And the guy that I had when I was very young, and I was so young that I didn't get most of it, was *Mr. Wizard*—Don Herbert—who's still around and he comes to science-teacher conventions to reassure you out there. He's 80. He's kind of hard of hearing, but he's a genius. You know, I mean, he probably—or as I say, he sent this country to the moon.

But after he retired, there was a void, and I don't know why that is exactly. And a big problem that's very well-documented in studies done in the education community is that people who were raised in this void that you're talking about—in this era, say, from the mid-'60s right after the success of the Apollo missions, to the early 1990s—you know, a period of almost 20 years.

People who were raised in that time and became teachers do not have this firm science background that we would like them to have. And I say "we"—people in society would like them to have; you as a parent would like them to have. And so we're—there's a lot of evidence to suggest that over half of what you learn about science—what you learn about anything—comes from sources outside of school; what's called—technically called "informal" education.

So on my show, we're doing our best to enhance informal education and bring it up to as high a level as we can. …

BOGAEV: There's a famous documentary that I'm pretty sure you might have seen. It's a series of interviews with Harvard graduates ...

NYE: Oh, yeah.

BOGAEV: ... right on—on graduation day, right there. They've got their [mortar]-boards on ...

NYE: ... with their (unintelligible)

BOGAEV: ... right—they have their diplomas in hand, and they're asked to explain why it's warmer in the summer.

NYE: That's right. Yeah.

BOGAEV: And virtually none of them can do it. It's just amazing. And they come up with the most hilariously scientifically illiterate answers.

NYE: Now, before we go too far, Barbara ...

BOGAEV: Yeah.

NYE: ... can I ask you?

BOGAEV: Oh, please.

NYE: Why do we—why is it warmer in the summer?

BOGAEV: Now, I know it's about the axis, and the Earth is tilted and ...

NYE: That's it. That's the key word.

BOGAEV: ... it spins—yes, right.

NYE: The Earth is tilted.

BOGAEV: Why is it that people can leave Harvard not having reached basic competency in science?

NYE: I'm not an expert on that, but I—I'm—I'll tell you right now I think it's really bad. And here's why I think it's bad: We have gotten to this point in the world, in human history or in history on the earth, where everybody buys a calendar; everybody wears a wrist watch; everybody has a computer that has a clock in it.

And the computer runs, by the way, with a clock in its central processing unit—that's what "CPU" means for those of you who didn't know—and it uses the clock to access data and to have these so-called "interrupt driven" programs and so on.

And it's human's understanding of the passage of time that has allowed us to have a society. It's a way—understanding clocks is a way more significant thing than understanding the wheel. There was a time, an era, when people would actually lose count of the number of days of the year—when the Nile was going to flood—and they would not have crops. They would, like, starve. They would, like, mess up their agriculture, because they didn't have this understanding that we take so for granted.

And then to have people graduating from our universities without this fundamental understanding of what makes the earth's seasons is crushing.

BOGAEV: So how—so how do you define scientific literacy? What should we all have a handle on to get along in life?

NYE: I think everybody has to have a fundamental understanding of the seasons. Everybody has to have a fundamental understanding of where the earth is in the solar system. For example, do you know what keeps the air on the earth's surface? It's a really interesting question. It's gravity.

BOGAEV: Gravity.

NYE: Yeah. It's the same thing that makes the Earth round. The Earth is rounder than the shiniest ball-bearing or BB you've ever seen. And that's because of gravity. And yet, interestingly enough, Barbara, no one really knows exactly, exactly what causes gravity. I mean, we're very close to understanding, but we don't really actually know.

Anyway, so that would be very important, I think, to know what holds the air and ocean on the Earth. There're a lot of things, Barbara, I'm sorry—there're a lot of things everybody should know about science and I'm sure there are many things that I should know that I don't know. But that's the charm of science, is that it's a process. You always learn—constantly picking up new stuff.

BOGAEV: Before you were the science guy, were you the science nerd?

NYE: Yes, I was the science nerd. I was in high school as a member—a proud member—of the Mad Scientists Club. There were four of five of us, depending on kind of—we actually ...

[LAUGHTER]

... we wore ties to school, we were such—we were so backward. We actually wore ties to school as sort of a—you know, to show respect for our teachers. That was how nutty it was.

BOGAEV: Do you remember the first time you were in a school science class and you thought: "Wow, this is really cool. That is what I want to do with my life."

NYE: Yeah, I think so. Well, I remember a couple of times, but I was in second grade and we had made barometers out of bottles with eyedroppers in them, 'cause the eyedropper provides a tube from a liquid up to the—up above the surface of the bottle. You know what I mean?

Anyway, and they overflowed when a thunderstorm came. The atmospheric pressure got so low that the barometers were in a sense exploding all over the classroom—food coloring running all over the floor ...

BOGAEV: Now, that was cool.

NYE: ... Yeah, it was cool.

[LAUGHTER]

And then just a few moments later, it's this astonishing downpour with lightning and thunder and all that fabulous staff. And I mean, you never forget that. That was spectacular. …

BOGEAV: Now, you've applied to be an astronaut. Are you in the running? What are your chances?

NYE: Well, January of '98; January '98's my next rejection postcard.

BOGAEV: How often have you been rejected?

NYE: Three times. I've applied three times. Actually, no. I've been rejected twice. Excuse me. I've gotten three postcards acknowledging my—receipt of my application. I think I'd be—I mean, first of all, first of all athletically, I could do it, and I still have better than 20/20 eyesight. I mean, I feel good about that.

And I have a pretty good understanding of aeronautics, astronautics, vacuums, and I've been around very complicated machines like jet aircraft and diving equipment and stuff—I'm very comfortable in those environments—submarines.

And I could—I could pull it off. And I think I'd—I think I could do a better job for NASA. I would make people embrace the space program in a way they don't right now.

BOGAEV: What do you say to those people who say: "Look, the space program is too expensive; it's not a priority." What's your rationale for them?

NYE: Well, turn on the news every night, and I'm not talking about the space program, but everybody watches the satellite picture—the Doppler radar of the weather. Everyone accepts now that there's a hole in the ozone. Everyone knows what satellite television is. Everyone knows—everyone wants his or her phone call or radio broadcast to come to him or her via satellite. That's all the space program.

Let alone the astonishing things we've discovered about the ocean and El Niño, and these things about ancient civilizations, when the radar was—when there was radar from space. It's just amazing. I'm not talking about Velcro and all that other stuff that was brought up 20 years ago. Those are cool things—the spin-offs, so-called.

But just the fundamental knowledge and expectation you have everyday about your environment—we learn so much of those—so many of those data from space exploration. And every radio/television broadcast relies on satellites, for crying out loud. Communication is the key to democracy, so you have to have a space program nowadays to have democracy.

BOGAEV: Bill Nye is host and head writer of Bill Nye the Science Guy, *seen weekdays on PBS and weekends on commercial stations.*

(BEGIN AUDIO CLIP, CHILDREN DISCUSSING CAREER PLANS)

CHILD: "A movie star."

CHILD: "A pro quarterback."

CHILD: "I want to be a computational fluid dynamics engineer."

CHAPTER NINE

A Case-by-Case Analysis

Newspapers always excite curiosity. No one ever lays one down without a feeling of disappointment.

—Charles Lamb, 1775-1834

We are living in the golden age of astronomy, and how frustrating it is," lamented syndicated columnist Charles Krauthammer in the summer of 1997.

"We see pretty Pathfinder pictures of Mars, and even more glorious Hubble pictures of distant galaxies. We know that scientists are acquiring extraordinary new knowledge of the universe—leaps into the cosmos more profound than any since the invention of the telescope itself—and yet the layman has no real idea what is going on.

"There is the occasional breathless story in the newspapers reporting, say, that the universe is 5 billion years younger than previously thought, and we are supposed to make sense of this. But, in fact, those outside the scientific priesthood have as little real understanding of the new discoveries about the state of the universe as the average Florentine had about Galileo's discoveries about the laws of motion." [1]

Whether the 17th-century Florentines were worse off for this lack of knowledge, we'll never know. More to the point: Should the citizens of our own time be privy to the revolutionary discoveries of the late 20th century? Or should enlightenment be left to some future generation?

Editors and producers say they are not in the education business. Nothing could be further from the truth. True, theirs is not the formal sort of education characterized by compulsory attendance, grades, etc. But what is news *except* education? And because so much of what is discovered in the world transpires after most people leave school, someone has to continually fill the gaps—not only in science but in a hundred other areas as well. If not the media, then who?

The anguish Krauthammer expresses over the fact that so much is known and so little is mastered is central to the thesis of this report as well. Knowledge is piling up at an awesome rate. In most cases, the progression is not arithmetical but geometric, the upward curve sometimes so steep that it tempts us to give up without even trying. The range of discovery is so vast, it sometimes seems beyond comprehension.

But retreat is not the answer. One has only to consider, for instance, that in the current debate over the U.S. educational system, no one is proposing that we teach our children less. Why, then, should the U.S. news media not also tackle the challenge?

According to Krauthammer, the greater mystery is why our vision is so narrow, why there is even a question of limits. A new age is upon us, he says, "the cosmos—all those pulsing, chattering quasars and pulsars and neutron stars—is speaking to us. And because we are living in a wondrous age in which we are finally beginning to understand the words, how can one live in this age and not be curious?" [2]

The aim of *Worlds Apart* is to urge journalists to focus their curiosity on science and technology in much the same way they would on the more familiar topics of politics, economics, crime and sports—by searching out what's novel, compelling, relevant.

Editors should be especially alert to trends, to the accumulation of detail and nuance. This dictum applies equally to stories that chronicle profound discovery and to those that center on warning and risk.

Scientists, too, should pay attention to these same elements by learning what makes news

and how to present the details of their discoveries with clarity and contextual perspective.

In an effort to present specific examples of well-done science reporting (and, for the sake of comparison, some not so well done) this chapter includes material gleaned from newspaper and magazine stories published during the period of research leading to publication of this report.

Colliding stars

In the spring of 1997, utilizing new instruments and techniques, astronomers documented what is probably the biggest recorded event in history. Typical of many science stories, it began as—and still is—a mystery. Reuters and several newspapers recognized its magnitude immediately upon publication of a scientific paper in *Nature* on April 16-17.

According to Reuters, "Astronomers said Wednesday they may have solved a mystery that has baffled them for more than 20 years—Where do bursts of gamma rays come from?

"Reporting in the science journal *Nature*, they said they had actually seen, for the first time, a flash of light to match the invisible gamma radiation—which should help them nail down just where the intriguing outbursts of shortwave radiation are coming from.

"Jan van Paradijs of the University of Amsterdam and a team of international colleagues said it could have come from an explosive collision between two neutron stars at the far end of the universe. If this is so, the explosion would be the brightest in the universe."[3]

The Boston Globe reported that "Joshua Bloom, of the Institute of Astronomy in Cambridge, England, and a member of the team that made the observations, said that if the bursts do come from galaxies at the edges of the universe, 'they are the most energetic phenomena known to humanity, releasing as much energy in a few seconds as the sun does in 10 billion years.'"

The Washington Post said it was possibly the "most energetic phenomena ever witnessed—possibly the titanic collisions of collapsed stars inside remote primeval galaxies." *Post* science writer Kathy Sawyer gave her readers a tantalizing hint at how long astronomers had been trying to decipher the mystery and how they had stumbled onto it.

"A quarter century ago," she wrote, "Cold War spy satellites searching for nuclear bomb detonations first detected monstrous explosions of energy known as gamma-ray bursts far out in space. They have inspired hundreds of theories, but they remain among the most baffling events in the cosmos."[4]

The *Globe*'s David L. Chandler wrote, "Because the bursts are so short-lived and unpredictable, and because instruments used to detect gamma rays are imprecise in locating their source in the sky, astronomers have never before managed to take a picture that showed the source of the radiation. But thanks to a new Italian-Dutch satellite called *BeppoSAX*, launched last year, they can get information about a burst much more quickly and accurately, then train some of the world's most powerful telescopes on the same spot.

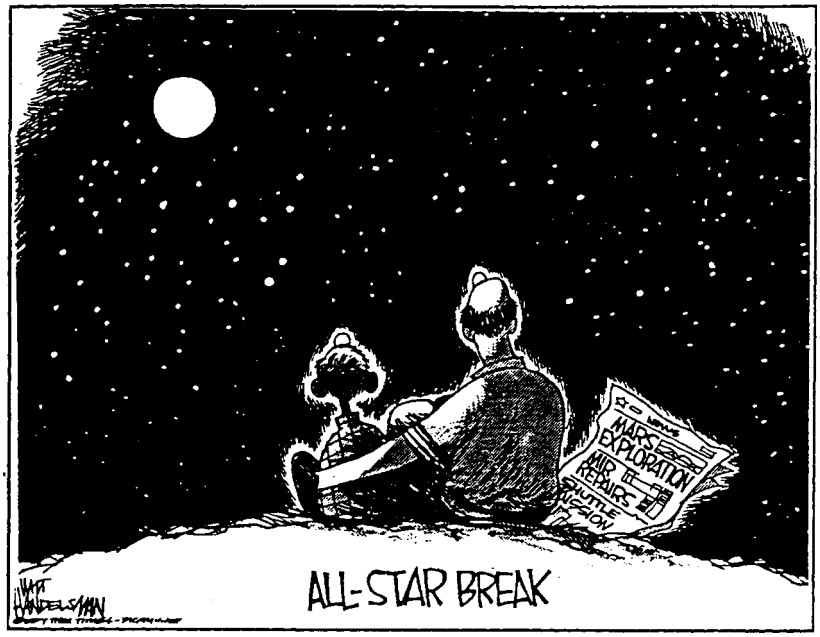
"That's what happened when a bright gamma-ray burst was detected Feb. 28, according to the group headed by Jan van Paradijs of the University of Amsterdam. They used telescopes in the Isaac Newton Group on the island of La Palma, in the Canary Islands, to find a faint galaxy at the exact spot where the burst had occurred. Follow-up observations were made with other telescopes, including the Hubble Space Telescope."[5]

Within days of the first published reports of the titanic detonation, another colossal gamma-ray burst was recorded. Astronomers around the world were poised at their telescopes. What followed was historic.

The *Los Angeles Times* reported: "California Institute of Technology scientists have captured images of the most powerful bursts of energy in the universe, solving perhaps the biggest mystery in modern astronomy."[6]

The new blast had occurred on May 8th. Two days later "the Caltech team had focused the Keck Telescope in Mauna Kea, Hawaii, on the rapidly fading object. Only the Keck—the largest telescope in the world—can spread out

the light from such a faint object and analyze its spectrum. Telltale dark lines in the spectrum of the light revealed the clear fingerprints of a large intergalactic cloud sitting in the line of sight between the energy source and Earth."[7]



The New York Times explained the meaning of that bit of information: "Further analysis of the spectrum revealed that the cloud must be about seven billion light-years away. The source of the gamma-ray burst must therefore be at least that far away, and the light it emitted traveled for roughly half the time the universe has existed before reaching Earth." The *Times* concluded that the new observations "appeared to be confirming evidence that the bursts are caused by tremendous detonations billions and billions of times brighter than the Sun."[8]

(The twin Keck telescopes, by the way, are only two of the new instruments scientists are now using. They have four times the light-gathering power of the famed Mt. Palomar telescope, and 17 times that of the Hubble Space Telescope. The 10-meter main mirrors are the most precise optical instruments ever made. Final polishing removed glass one molecule at a time.)

Exploding star

The gamma ray bursts came hard on the heels of the 10th anniversary of what had previously been the biggest bang in modern astronomy—a supernova known as SN1987A.

"On Feb. 23, 1987, astronomers in the Southern Hemisphere noticed a bright new light in the sky. It was the funeral pyre of a star—a star that had just blown itself up," wrote Keay Davidson, in the *San Francisco Examiner* on February 21, 1997.

"Around the world, astronomers were ecstatic. No one had seen such a bright exploding star since the early 17th century, when the Catholic Church prosecuted Galileo Galilei for teaching that Earth orbited the sun.

"This weekend, astronomers from around the globe have gathered in Chile to commemorate the anniversary of the latest celestial blast, which occurred 10 years ago this Sunday."[9]

Davidson and a few other reporters that week took the opportunity to write updates on what had been learned in the decade that followed the first event of its kind in nearly 400 years.

Alexandra Witze of *The Dallas Morning News* was enterprising enough to contact a local astronomer, J. Craig Wheeler, at the University of Texas in Austin, who said, "There just has not been another thing like it in modern astronomy."

Witze expertly explained to her readers how this particular supernova—a star with 20 times the mass of our sun—astoundingly collapsed in

"less than a second." In that massive burst, the star gave off more exotic particles known as neutrinos than our sun will emit in its lifetime.

Even though the explosion happened 166,000 years ago (that's how long it took the light and neutrinos to reach earth from the nearby Large Magellanic Cloud, a companion galaxy to the Milky Way), Witze noted that 20 of the neutrinos were captured on Earth, "12 in the newly completed Kamioka detector in Japan, and eight in an American facility near Lake Erie."[10]

In the meantime, *Examiner* science writer Davidson noted something more prosaic—and more relevant to the average reader—about supernovae: they produce all of the heavier elements of which all things, including ourselves, are made. "Those elements are spewed into the galaxy; in time, some condense into new planetary systems," he noted, and "Some of those elements are essential building blocks of humans. For example, the oxygen and iron that course through your bloodstream were born in an exploding star."[11]

Europa's ocean

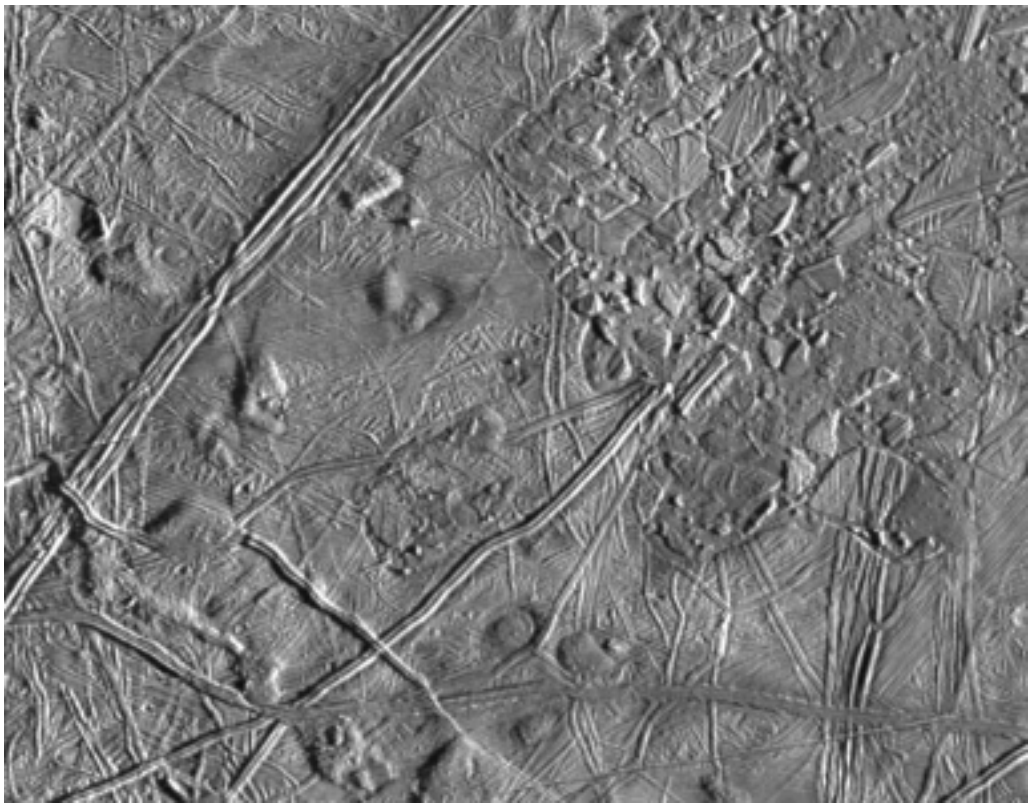
If exploding and colliding stars weren't enough, scientists in the same spring of 1997 evidently found a new ocean and, by implication, possibly a new nest for life.

"A vast ocean once flowed beneath the icy surface of Jupiter's moon Europa and might still be flowing today as an incubator of extraterrestrial life, scientists reported yesterday," wrote Kathy Sawyer in *The Washington Post*.

"New images from NASA's spacecraft Galileo—the most detailed ever taken of Europa—reveal 300-foot-high icebergs that have apparently drifted and turned in unseen currents, providing what ecstatic scientists called nearly conclusive evidence of a hidden sea.

" 'It's looking as though we've found the smoking gun, and it's pointing right at this ocean,' Michael Carr of the U.S. Geological

The icy surface of Europa



Survey said at a briefing yesterday at NASA's Jet Propulsion Laboratory in Pasadena, Calif., where the images were released.

"Not since Balboa discovered the Pacific in 1513 has anyone claimed to have found an entire new ocean."[12]

Robert Cooke of *Newsday*, added details: "Oceanographer John Delaney, from the University of Washington in Seattle, confessed enthusiastically that he is convinced life exists on Europa. His studies of subsea life on Earth show that creatures can thrive even in the dark if there is warmth and water. And it has been suggested that life on Earth might even have originated at sea-floor vent sites, where hot water rich in chemicals spews out of the ground.

"Throughout Europa's 4.5-billion year history, Delaney said, 'it is highly likely there was circulation of water through the rocky interior, driven by thermal processes. So the extraction of chemicals [from the rocks] would have been more than adequate to support the kind of life we see on the Earth's sea-floor.'"[13]

Faye Flam of *The Philadelphia Inquirer* explained, "Even a frigid body of water covered in a mile of ice might be a friendly enough environment. In Antarctica, perennially frozen lakes are slimy with living things, and ecosystems flourish in the coldest, blackest parts of the oceans."[14]

David Chandler of *The Boston Globe* noted that the new pictures showed a big "X" to mark the spot where NASA scientists were looking. "The X is the intersection of two huge cracks, each hundreds of miles long, through the layer of ice that floats on top of Europa's ocean. In the area between two of those cracks, the new close-up pictures clearly show huge iceberg-like chunks that have drifted apart and rotated in different directions—movements almost impossible to explain, [scientists] said, unless the ice is floating on a liquid layer."[15]

Recently, such a formation was found on earth. David Perlman, *San Francisco Chronicle* science editor, reported that scientists are designing "a mission that would look for primitive life in the depths of a vast lake of relatively warm water that Russian scientists have found beneath their Vostok base in Antarctica.

"Led by planetary scientist Joan Horvath, the group foresees an ice-penetrating robotic probe less than 5 feet long and 6 inches wide that would send a tiny craft called a "hydrobot" to sense the lake's water temperature and seek signs of living organisms."[16]

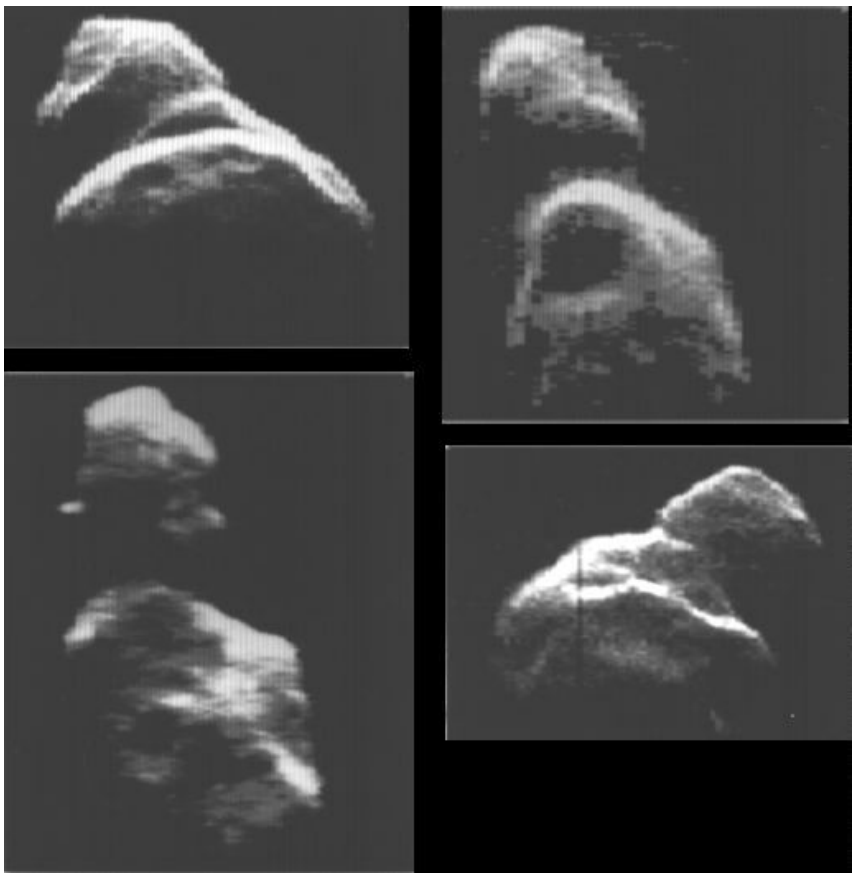
Asteroids

In late November 1996, an odd-shaped object, known as the Toutatis Asteroid, came whizzing by the Earth at a distance of only 3.3 million miles, a near miss in astronomical terms.

Toutatis is about 3 miles long and 1.5 miles wide. Its orbit brings it near the earth every four years. (The four pictures are radar images made by NASA when it passed within 2 million miles of the Earth in 1992.)

Curt Suplee, writing about Toutatis in *The Washington Post*, noted that 391 such objects

Asteroid Toutatis



have now been spotted nearby, of which 205 cross Earth's orbit.

"In 1993," he wrote, "a specially commissioned NASA panel estimated that there is approximately a 1-in-10,000 chance that the Earth will be whacked by something one-third of a mile in diameter or greater within 100 years. Other experts put the probability closer to 1 in 1,000.

"The issue is more than academic. Many scientists now believe that the extinction of the dinosaurs and numerous other species some 65 million years ago was caused by catastrophic climate change resulting from the impact of an object at least 6 miles in diameter that struck what is now the Yucatan peninsula in Mexico. By most projections, the splat released energy equivalent to several times the world's collective nuclear arsenal.

"Experts say it would take a ferocious impact by a massive object at least 1 or 2 miles in diameter to prompt planet-wide climate changes and crop failures through a combination of dust spewed into the atmosphere and smoke from extensive fires. But smaller projectiles could be locally lethal: In 1908, a comet-like fragment exploded in the sky over the Tunguska River valley in Siberia. Although the object was only 300 feet across, the blast flattened more than 100 square miles of forest."[17]

Asteroid Mathilde

In 1999, NASA will get its first close-up pictures of an asteroid. The Near Earth Asteroid Rendezvous (NEAR) spacecraft will go into orbit around Eros, then land on it. Paul Hoversten, writing for Gannett News Service, noted that "Eros, which measures nine miles across and 25 miles long, was selected because its orbit around the sun takes it near that of Earth's path, making it a 'near-Earth asteroid.'

"Eros and other asteroids like it someday could collide with Earth.

"At least 20,000 asteroids are known to exist in the asteroid belt between Mars and Jupiter. But only two have been photographed in any detail."[18]

In June 1997, NASA got a bonus from the NEAR spacecraft. By making a slight alteration in its trajectory, the agency was able to get dramatic photographs of another asteroid, Mathilde, "a very puzzling relic of the solar system's birth," according to David L. Chandler of *The Boston Globe*.

"The pictures show that the 37-mile-wide rock appears to have been almost unchanged in the 4.6 billion years since the sun and planets were formed, and thus could provide a valuable window into the earliest history of our neighborhood in space," he wrote. "On all the planets, that ancient record has been altered by billions of years of geological upheaval."[19]

The Associated Press noted that "Asteroid Mathilde is so battered by collisions with other space rocks that it is almost 'all crater,' with one pit big enough to swallow the District of Columbia and some of its suburbs."

Hale-Bopp Comet

When an event attracts as much national media attention as Hale-Bopp, the sterling work of smaller news organizations is frequently overlooked. One such case involves coverage of the comet in the under-100,000 circulation *Fayetteville*, N.C., *Observer-Times*.

The newspaper's chief photographer is Johnny Horne, 43. He's been filling the paper with pictures since he was hired in 1973 at age 18. Today, he is in charge of seven full-time and two part-time photographers. He is also the author of a monthly column, "Backyard Universe," which in 1997 put the *Fayetteville Observer-Times* on the map.

Photo by Johnny Horne

Comet Hale-Bopp

Horne's superb images of the Hale-Bopp comet were picked up by the Associated Press and transmitted worldwide, and the prestigious magazine of astronomy, *Sky and Telescope*, featured his work extensively in its pages and on its web site.

"I've been an amateur astronomer since age 10," Horne says, and "have been shooting pictures of the night sky since age 14 …." He's also "accumulated a collection of equipment to allow me to do those types of photos rather reliably."

Using everything from a standard 35-mm camera to an 8-inch Celestron Schmidt telescope, Horne produced magnificent photos of the comet as it soared across the heavens in the spring of 1997. Besides the AP and *Sky and Telescope*, the chief showplace for his work was the *Observer-Times*' web site, Fayetteville-Online.

During a single week in March, the web site recorded approximately 200,000 hits, as Internet-users looked for Horne's pictures of Hale-Bopp. "Folks can't get enough of Hale-Bopp," Horne says. "Events like that really get them going."

Horne has enjoyed the confidence of the newspaper's owner and management from the very beginning of his efforts. His monthly "Backyard Universe" column, which runs with color photos on the front page of the features section, began in January 1989. "The column almost always covers objects and events that can be easily seen and appreciated by the average person," Horne said. "No discussion of black holes, crop circles, UFOs or Big Bang here."

It was a "labor of love for the first four years," Horne said, then he started getting paid for it.

His early work, however, was not without its compensations—both to Horne and the paper. Even before the column began, the paper recognized his unique abilities and contributions. The *Observer-Times* "completely funded a trip for me to Australia in 1986 to photograph Halley's comet from the Outback. That was back before online images, but we ran a Sunday feature front about the trip and the comet. I also gave talks to local civic groups so the effort resulted in lots of good community feedback."

Horne says "anytime there is a big astronomical event, the phone in photo rings all day long."

Thyroid cancer

The New York Times is for the most part an exemplar of science reporting. However, the *Times* is not above lapses.

In the summer of 1997, under the dramatic headline "U.S. Atomic Tests in '50s Exposed Millions to Risk, Study Says," the *Times* reported that: "Atmospheric nuclear bomb tests in Nevada from 1951 to 1962 exposed millions of American children to large amounts of radioactive iodine …" a potential cause of thyroid cancer.

Moreover, according to the *Times*, the exposures were "… at least 10 times larger than those caused by the 1986 explosion at the Chernobyl nuclear plant in Ukraine."[20]

Citing a summary of a draft report by the National Cancer Institute, the *Times* said the "average dose to the approximately 160 million people living in the country in that period was 2 rads," but that people living in western states near the tests "… received doses averaging 5 to 16 rads. Children aged 3 months to 5 years had doses 10 times higher …."

Such exposures "… were large enough to produce 25,000 to 50,000 cases of thyroid cancer around the country, of which 2,500 would be expected to be fatal."

And the exposure wasn't confined just to areas near the tests. Over 130 "hot spots" were found in "large areas of New Mexico, Oklahoma, Iowa, Wisconsin, New York and Massachusetts …."

This startling information came from an NCS study that was breathtaking in magnitude.

Authorized by Congress in 1983, the draft report of the study was completed 11 years later in 1994. According to the *Times,* "It has been undergoing revisions and rewriting since then." The draft report was 100,000 pages long.

What, one might ask, did such a gargantuan report mean to Americans in 1997? Has there been an epidemic of thyroid cancer?

Well, yes and no. It is an extremely rare form of cancer. In 1947, the rate was 2.4 cases per 100,000 population. In 1970, the rate was 3.9 cases per 100,000. Could that increase be blamed on the nuclear tests?

"The leader of the cancer institute study, Dr. Bruce Wachholz, said it was not clear that the exposures were high enough to increase the cancer risk. Studies of people in Utah immediately downwind from the test site did not find a clear association with thyroid cancer, Wachholz said."

The *Times* quoted Dr. Wachholz as saying "we really don't understand the dose-effect relationship" for radioactive iodine. And the paper noted that "… doctors had been using radiation to treat everything from acne to deafness from the 1920s on."

Not only were there doubts about the levels of radiation that cause thyroid cancer, the NCI also said "that its dose estimates were subject to 'a large degree of uncertainty' because they were based on a small number of radiation measurements made at the time." And those measurements (in 1959) showed exposures "more than 100 times smaller than the average now cited for Western states." The *Times* didn't offer any explanation of how the exposures increased 100 times in 40 years.

Nor did the *Times* raise any questions about why it had taken 14 years and 100,000 pages, plus three years of rewrite, to reach a conclusion that was "not clear." It did, however, find comments from E. Cooper Brown, chairman of the National Committee for Radiation Victims, who said, "I think it raises some serious questions," and Arjun Makhijani, the president of the Institute for Energy and Environmental Research, who said, "This is especially tragic, because it could have been avoided."

Did the cancer institute have anything to show for its 14-year effort? According to the *Times*, "The institute said it had accomplished two of the goals that Congress set for it in 1982: developing a way to estimate the dose, and making the estimate. The third, assessing the risk of cancer from the exposures, is still to be finished …, which it plans to complete by October."

In the end, the 25,000 to 50,000 cases of thyroid cancer cited earlier in the article evaporated, and the bottom line was, "The

cancer institute could not say whether any cases of thyroid cancer were caused by the fallout."[21]

The *Times* article raises two interesting questions: one about the media, the other about scientists. First, why did a responsible newspaper print the totally unsubstantiated claim that 25,000 to 50,000 cancers might have been caused by fallout from a half-century before? Second, why didn't some scientist dedicated to the truth blow the whistle on the study, say somewhere around seven years and 50,000 pages into it?

Estrogen therapy

Here's the kind of science coverage that must drive women crazy. Based on some shaky data published in *The New England Journal of Medicine*, these are examples of trying to read too much into epidemiological studies.

On Thursday evening, June 18, 1997, the Associated Press, under the headline: "Study Links Estrogen and Breast Cancer," sent out on its wires the following lead:

"BOSTON (AP)—For older women, the difficult question of whether to take estrogen for the rest of their lives has grown even more complicated."

A careful observer would note that the lead paragraph did not mention cancer, although subsequent paragraphs did, and of course that was the peg for the story. Any story about cancer makes news.

However, the three major U.S. papers that generally provide the best science coverage went their separate ways.

On the morning of June 19, *The New York Times*' front-page headline was: "Hormone Therapy Found to Cut Women's Death Risk." The first paragraph read: "Hormone replacement after menopause can significantly reduce a woman's risk of death as long as she continues it, a large study has found."[22]

The *Washington Post*'s front-page headline was: "Women's Use of Hormones Has Benefits, Risks." The lead paragraph read: "Taking hormone supplements after menopause reduces a woman's risk of death for about 10 years, at which point its benefit is narrowed signifi-

cantly because of the rising risk of breast cancer from the therapy, according to a new study."[23]

The *Los Angeles Times* buried the story in its "Science in Brief" section under the headline: "Estrogen Therapy Found to Cut Post-Menopausal Risk of Death." The first of two paragraphs read:

"Estrogen replacement therapy can reduce the risk of death in post-menopausal women as much as 37 percent, especially among those with high risk factors for heart disease, but the benefits decline for some women with prolonged use, according to a report in the June 19 *New England Journal of Medicine*. The results were obtained from the Nurses' Health Study, begun in 1976, of more than 121,000 women."[24]

The New York Times' story, incidentally, reported there were 121,700 women in the study, of whom 60,000 were post-menopausal. The *Post* said the study was based on 122,000 women. The AP put the number at 121,700. Neither the AP nor the *Washington Post* mentioned post-menopausal women, even though they were the object of the study.

The real confusion, however, lay in the interpretation of the data, the selective quotes used and the lack of raw data in any of the stories.

The *Times*, for example, did not report the total number of deaths in the study. The *Post* did—3,637—but it was unclear whether these were among the 121,000, 121,700, or 122,000 in the total study, or only among the 60,000 post-menopausal women, so it was impossible to figure out the actual death rate.

Boiled down, the crux of all the stories was that post-menopausal women who are on hormone replacement therapy (HRT) seemed to be dying of all causes at a lower rate (37 percent) than the women who were not taking the hormones—at least for the first few years. Most of the initial difference was in the rate of heart disease. After a few years, however, the difference narrowed, mostly because breast cancer was then on the rise. In other words, the women who lived longer because they were not getting heart disease were succumbing to breast cancer. Indeed, as the *Post* noted, "… after 10 years of hormone use, a woman's risk of dying of breast cancer was 43 percent higher than that of a non-user." That made it sound like women were starting to drop like flies from breast cancer.

The real percentages were something else, however, as the *Post* reported in the very next paragraph: "For example, a 60-year-old woman not on HRT has a 1.8 percent chance of being diagnosed with breast cancer in the next five years. A 60-year-old woman on HRT has a 3 percent risk of developing breast cancer in that period." Indeed, that is approximately a 43 percent rise in the rate, but the real increase was only from 1.8 percent to 3 percent—an actual elevation of only 1.2% in the number of breast cancer diagnoses. Note too, these are diagnoses, not deaths. How diagnoses got mixed up with death rates in the *Post* story is anybody's guess.

The *Times* gave no such figures, so women in New York and other cities where the *Times* was distributed were left with the idea that the death rate from breast cancer among those who had been on HRT for a number of years was a horrendous 43 percent higher. However, the *Times*' story took an unexpected turn in the 13th paragraph:

"In the first 10 years of hormone use, the women who developed breast cancer had lower death rates from their disease than did women who never took hormones."

Whoa! Hormones protect you at first, then suddenly make you vulnerable?

A look at *The New England Journal of Medicine,* where the original research was published, suggested the source of confusion. In an editorial, the journal indicated that the part of the study about the effects of HRT on breast cancer might be suspect, because "… the proportion of deaths due to breast cancer was higher in the study cohort than in the general population, possibly limiting the generalizability [sic] of the results." The bottom line, according to the editorial, was: "It is possible that the inconsistency in the results for short- and long-term users reflects the small number of deaths in each category."[25]

With that caveat, it's understandable why the *Los Angeles Times* buried the story. It's also understandable why *The New York Times* quoted another researcher in the field of hormone therapy as saying it would be "incorrect to interpret the new findings as saying all women should be on therapy," adding, "but it would be equally incorrect to interpret the study as saying that all women should stop taking hormones after 10 years."

What's not understandable is how this story got on the front page of any newspaper. The confusion created by these stories clearly indicates the need for reporters to stay up to date on current research. And to be aware of what various kinds of studies can actually show. And the proper questions to ask about "scientific" studies. Medical writer Dr. Susan Love had explained it clearly to readers of the *Chicago Tribune* several months earlier:

"Hormone replacement therapy (HRT) in post-menopausal women for prevention of heart disease is the latest of the 'wishful thinking' based therapies. We have not as yet proven that HRT will prevent heart disease. The studies we have are observational. This means that they take women who are already on hormones for whatever reason and compare them to women who are not on them.

"The women who are on hormones have fewer deaths from heart disease. But they are of a higher socioeconomic level, more likely to go to the doctor (that's how they got on them in the first place), more likely to exercise, eat a good diet and treat their high blood pressure and high cholesterol than women who are not on hormones. It is quite possible that it is not that hormones make women healthy, but rather that healthy women take hormones.

"Until we have a study with the same number of couch potatoes in each group, we won't know. That study has been started and will not be available until the year 2008. Is it possible that over the next 11 years we will put millions of women on HRT to prevent heart disease and then the Women's Health Initiative will show that it doesn't work or, even worse, that the resulting increase in breast cancer is higher than we thought? It certainly is possible, and some such as myself think it is even likely. But we won't know until we actually have some hard scientific data.

"Women are perfectly capable of making decisions based on inadequate information. We do it all day every day. But we need to know that that is what we are doing. Let's stop pretending we have definitive answers when we don't. Let's tell women when our advice is based only on preliminary data so that when the studies come out they won't feel betrayed and confused. Let's strive for honestly presenting what we know and don't know. Enough wishful thinking. What we need is the truth."[26]

Breast cancer

Women have had a hard time getting the truth about one of the most contentious and frightening issues facing them: at what age and how often they should get mammograms. They have been badly served by the science community, and it has taken some time for the media to sort the question out.

Daniel S. Greenberg, writing in *The Washington Post* was outraged:

"A committee of distinguished specialists, summoned to a study a few months ago by the federal government, reported that the best available evidence does not support the claim that mammography for women 40-49 years of age saves lives. Advocates of mammography, including the affluent providers of X-ray services, erupted with angry reaction. The U.S. Senate went on record as opposed to the negative report on mammography.

"The National Institutes of Health, which sponsored the initial study, quickly convened another committee. It examined the same evidence and meekly concluded that mammography for ages 40-49 does indeed save lives.

"In response to this political mugging, what did we hear from the institutions that stand guard over scientific and intellectual integrity, from the statesmen of science who, at the drop of an honorary degree, extol scientific independence? Nothing."[27]

continued on page 84

New View Sees Breast Cancer as 3 Diseases

By Gina Kolata

The New York Times (April 1, 1997)

For years, cancer specialists repeated their hypothesis as if it were a mantra: virtually all breast cancer has spread by the time it is detected. But now, seemingly overnight, that prevailing view of breast cancer has changed.

At a recent meeting at the National Institutes of Health, speaker after speaker said, as though it was indisputable, that breast cancer was really three separate diseases whose boundaries were indistinct.

The changed view of breast cancer has profound implications, not only for women with the disease but also for women worried about developing the disorder. It helps explain a puzzling fact about mammograms for women in their 40s: although X-ray screening tests can find cancers in these women's breasts, regular mammograms have little or no effect in decreasing their death rate from breast cancer.

The effect, if any, is so hard to determine that an advisory group to the National Cancer Institute, recommending last week that women in their 40s have regular mammograms, had to look at combined data from seven different studies to see even a minimal benefit from mammograms for younger women.

The analysis of these studies showed a 17 percent reduction in the death rate, and the group cautioned that "to many, but not all experts, this is statistically significant," and added that "this level of mortality reduction appears impressive but is difficult to detect with a high level of certainty." The changed view also helps explain why the benefits of mammograms for women 50 and older, while greater than those for younger women, are still not overwhelming. And it helps explain why, decades after mammograms were introduced, the mammography debate continues.

Dr. John Wasson of Dartmouth College, a member of the panel of experts at the recent meeting that was held at the health institutes to assess mammography, explained the cancer types this way: "There is the mean type that spreads so quickly that current technology can't detect it or treat it. Something is wrong at the cellular level and the cells spread rapidly throughout the body. The second type is one that is growing at a rate where it will cause trouble and begin to spread within a relatively short period of time: we're talking 5 to 10 years. Then there is a third type that may take even longer to spread, if it spreads at all."

Even mammography does not offer much hope for women with the fast-growing cancers, he said. And many of the slow-growing ones are so languid that it may not matter if they are found now with mammograms or later, when they become palpable lumps. In either case, they are easily treated.

When breast cancer is viewed in this light, adherents of the new view say, the disappointing results of mammography make sense. It fails to markedly prolong the lives of women in their 40s and offers only limited benefit to older women because the medical prognosis for most cancers that it finds is not altered by early detection.

Dr. Samuel Hellman, a radiologist at the University of Chicago, is a principal promoter of the new hypothesis. At age 62, he says, he has seen breast cancer theories rise and fall. This one, he says, illustrates how and why notions of disease gain adherents and how treatment strategies can be driven by ideologies.

The first doctrine originated in 1895 when Dr. William S. Halstead, a surgeon at Johns Hopkins University in Baltimore, argued that all breast cancer began as a small tumor in the breast and then spread to the lymphatic system and from there to

the rest of the body. That indicated to Halstead that the way to treat breast cancer was to remove the breast, the surrounding tissue and the lymph nodes nearby. Thousands of women underwent the mutilating surgery that bears his name, the Halstead radical mastectomy.

"His approach was scorched earth," said Dr. David Plotkin, a breast cancer specialist who directs the Memorial Cancer Research Foundation in Los Angeles. But many women who had the surgery survived and those who did not survive died of distant metastases—remnants of their breast cancer that had spread to other organs, like their bones or lungs or liver. According to the Halstead hypothesis, they had seen the surgeon too late.

"This hypothesis became fixed in medicine," Hellman wrote in the journal *Cancer* in 1993. "Its acceptance was similar to that of the acceptance of religious dogma."

Around 1980, the hypothesis gave way to one propounded by Dr. Bernard Fisher, a surgeon at the University of Pittsburgh, and a handful of others. They theorized that breast cancer had already spread by the time it was discovered, with errant cells swarming through the bloodstream and taking root throughout the body. At the same time, researchers had developed chemotherapy and hormonal treatments that could attack these metastatic cells, making the new hypothesis appealing.

As Hellman put it in his 1993 paper, "The medical oncologist now supplants the surgeon as the central figure in cancer management."

As evidence for the dogmatic nature of the new hypothesis, Hellman cited an incident in 1993 when the National Cancer Institute issued a clinical alert to the nation's doctors, a notice it deemed too important to wait for publication in a medical journal. The institute said that all breast cancer should be treated with systemic therapies, like chemotherapy or hormonal therapy, no matter how small the cancer was and no matter whether it had spread to the lymph nodes.

"This truly is dogma, rather than hypothesis generation and testing," Hellman wrote in his 1993 paper. "Current practices seem more consistent with religious excesses than with the conditional nature of scientific hypotheses and learning."

Fisher, however, replied that if his hypothesis became dogma, it was because it had been overinterpreted and oversimplified by the cancer establishment. While agreeing that he had said that every cancer was systemic from the time of diagnosis, he asserted, "That does not mean that every patient is going to get a metastasis and die." Instead, he said, "It means that the potential is there." If conditions are right, if certain hormones and growth-stimulating chemicals—many of which are as yet unidentified—are present, every tumor can become deadly, Fisher said.

In fact, Fisher said, it is true that some tumors are metastatic from the time they are discovered, even though they are discovered when they are extraordinarily small and barely recognizable as tumors. "That occurs infrequently, but it can occur," Fisher said. "It shows there is a potential for spread."

But now it is Hellman's hypothesis that is ascendant, promoted by radiologists like himself who ask how mammography results can be reconciled with the notion that all cancer is metastatic from the time it is discovered.

If cancer spreads systematically in a predictable way, as Halstead proposed, mammography could make a major difference. It could find tumors that had not spread and allow surgeons to cut them out before it was too late. And the better mammography got, the better it would be in prolonging lives.

But, in fact, mammography has not slashed breast cancer death rates. For women in their 40s, there is a tiny benefit, if any. For women over 50, only a small proportion of those who have regular mammograms live longer as a result. Dr. Russell Harris, a co-director of the program on health promotion and disease prevention at the University of North Carolina in Chapel Hill, estimates that if 1,000 women from 50 to 75 had mammograms, breast cancer would be found in 21 to 34 of them, but only 2 to 6 of them would live longer because their cancers were found with this X-ray of the breast. The numbers have not changed much since the first studies of mammography were conducted in the 1960s.

The mammography data also do not support the hypothesis that virtually all breast cancer is a systemic disease from the time it is discovered. If that were true, virtually all tumors found years before the stage at which they become palpable lumps in the breast would have already spread. Early diagnosis would have no effect on mortality, said Dr. Jay Harris, a radiologist at Harvard Medical School. But it does.

Dr. John A. Spratt, a surgeon at the University of Louisville, found another discordant feature of breast cancer. The cancers grow at widely varying rates and only a minority of them seem to be the type that mammograms are looking for. The average time it took a tumor to double in size was 260 days, but the doubling times for tumors ranged from 10 days to 7,051 days.

At one extreme are cancers that grow so quickly that they can spring up and become lethal in the time between a woman's annual mammograms. Anywhere from 13 percent to 17 percent are of this type, Spratt has found.

At the other extreme are perhaps 10 percent to 15 percent of cancers that grow so slowly that any treatment beyond simply removing the tumor may be superfluous. For example, a 55-year-old woman with a half-inch wide tumor growing at the slowest rate would be 70 before her tumor was an inch in diameter.

One implication of the new view of cancer, Dr. Jay Harris said, is that better and better mammograms cannot magically turn the breast cancer statistics around. Since the challenge now seems to be to discriminate between the different types of breast cancer, Harris said, "I'm not sure that mammography is going to be the tool to take us to the next stage" in the breast cancer battle.

Many, including Hellman, are now studying molecular markers, like aberrant cancer genes, that might indicate a tumor's potential to be lethal. So far, however, no one has found a test that is accurate enough for widespread use.

The hope, Hellman said, is to be able to discover which women need systemic therapy and to be able to spare the vast majority of women, who do not need this therapy, from having to endure it.

"Giving all those women adjuvant chemotherapy when the majority don't need it puts us in an awkward circumstance," Hellman said. Because doctors do not want to harm the many women who do not need the treatment, they tend to "water it down," he said. Yet that means that those who do need it may not be getting enough.

"We end up with a poor mix in the middle," Hellman said.

The *Post*, to its credit, covered the controversy closely. It also provided a forum for two scientists who did get into the fray. Dr. Steven Woolf, a professor of family practice at the Medical College of Virginia, and Robert Lawrence, a professor of health policy at the Johns Hopkins School of Hygiene and Public Health, weighed in on the front page of the Sunday Outlook section.

"The recent controversy over breast cancer screening," they wrote, "highlights a disturbing trend: Medical policy is increasingly being shaped by political pressure and special-interest groups, rather than by objective scientific inquiry. … Politicians are now pressuring scientists to alter their advice to doctors and patients."

After recounting the acrimonious debate, they asked, "Why is there any uncertainty about the benefits of mammography?," then went on to give a lucid, non-jargon-filled explanation.

"The test can save lives, reducing breast cancer death rates by 17 percent for women in their 40s and by over 30 percent for women older than 50. But because the incidence of breast cancer is low for women in their 40s, the actual benefit is very small, so small that ex-

perts debate whether the observed difference is real or due to chance: A 40-year-old woman who undergoes annual screening for 10 years has one chance in 1,500 to 2,500 of preventing death from breast cancer. And although modern mammography is safe, the medical workup triggered by a positive test result brings its own risks. In 10 years of screening, an estimated 30 percent of screened women will require repeat testing, and 8 percent will go on to have a biopsy or surgery, often for lesions that prove not to be cancerous. For the estimated three cases of cancer detected by screening 1,000 women, 997 women undergo screening for what turns out to be little or no gain. If all 40- to 49-year-old women in the United States were screened, roughly 200,000 would need follow-up breast biopsies to distinguish true positives from the much larger number of false positives.

"The decision to screen all women in this age group is therefore far from straightforward. Whether a one in 1,500 to 2,500 chance of benefit is worth the 8 percent risk of breast biopsy is a subjective judgment, a matter of personal priorities and not hard science. Women reach different conclusions about such trade-offs. And judgments of this sort are not always best made by the government, but by individual women in consultation with their families and doctors, as was originally recommended by the NIH panel."[28]

Thousands of words had been written about the breast cancer enigma by the time Gina Kolata of *The New York Times* set it down in plain, understandable English on April 1, 1997. Any editor who had access to this article from The New York Times News Service and didn't print it may want to ask him/herself if it would be profitable to spend a little more time carefully reading the items that come in labeled "science." Kolata's article cleared the air of a lot of jargon and was of enormous value to every woman in America.

Mass media

If there's one thing that gets scientists fired up, it is the mass media. Most see the tabloids, movies and especially network television as leading the anti-intellectual movement in America. Scientists are most distressed by what they view as the uncritical manner in which pseudoscience is now presented on television. "One of the things we have these days, that's viewed with growing alarm," says Dr. Leon Lederman, "is this anti-science—all kinds of weird things that are going on. Psychics, and UFO witnesses who've been molested. American citizens! By aliens!"

Lederman is part of a group of distinguished scientists known as the Committee for the Scientific Investigation of Claims of the Paranormal (CSICOP). Other organizing members include: Stephen Jay Gould and Gerald Holton of Harvard University; Sir John Maddox, editor emeritus, *Nature* magazine; Eugenie Scott from Berkeley; Gerard Piel, former president, American Association for the Advancement of Science and former publisher of *Scientific American*; and John Rennie, editor-in-chief, *Scientific American*, among others.

Alien abduction

CSICOP members, many of them at least, are almost messianic in their drive to bring some scientific common sense to television.

Paul Kurtz, chairman of CSICOP, says, "The media have now virtually replaced the schools, colleges and universities as the main source of information for the general public.… The irresponsibility of the media in the area of science and the paranormal is a worldwide problem. But it especially applies to the United States, where the media have been distorting science, and in particular presenting pseudoscience as genuine science. Indeed, we are appalled by the number of 'documentaries,' which are really entertainment programs, presenting fringe science as real science."

The criticism is valid. Network documentary standards have all but disappeared in recent years. Once, documentaries were the sole province of the network news departments. Today, that is no longer true. The new genre, labeled "infotainment" or "docudrama," is most often produced by independent companies based in Hollywood. Needless the say, their values are not in concert with the network news departments. In fact, the news departments disavow these programs, which are ostensibly entertainment, except they have a "news" veneer.

"The major networks have been running two or three such specials almost every month," says Kurtz. "Recently there have been programs on prophecies, astrology, psychic powers, creationism, Noah's Ark, angels, alien abductions, etc. This is in addition to the popular *Unsolved Mysteries*, *X-Files* and *Sightings*, as well as new programs such as *Paranormal Borderlands*, *Poltergeist* and *Outer Limits*."

The committee took special issue with an NBC infotainment special, *The Mysterious Origins of Man*, narrated by Charlton Heston. The scientists complained that "[t]he program promoted pseudoscience and suggested that evolution is questionable, that human civilization originated 100 million years ago, and that humans coexisted with dinosaurs." CSICOP complained that television talk shows give inordinate time to "the paranormal … but skeptical dissent is rarely heard."

Kurtz says he realizes the networks have to make a profit and that he is not in the business of censoring TV. "We only ask that they provide some balance and provide some appreciation of the scientific approach. If the United States is to continue to provide leadership and compete in the global economy, then we need to raise the level of scientific literacy and understanding of the general public."

Ironically, not all of the programs mentioned are always slanted toward pseudoscience or the sensational. Ira Flatow recalls, "I was watching a wonderful piece on the Martian rock that landed in Antarctica. [I]t was a terrific piece and it was done in the best style of journalism; all the right NASA scientists were interviewed. It was fantastic. They got all the facts in there.

"They took 15 minutes to do this, but it was on *Unsolved Mysteries*. That's where the piece showed up. It was an excellent piece of journalism, … the kind of stuff you used to see on the best newscasts where they would take 10 or 15 minutes to do a really in-depth piece. And it shows up on *Unsolved Mysteries*."

According to Vanderbilt University physicist Taylor Wang, "Actually, somebody made a study [that showed] that scientists on television series [belong to] the most deadly profession. Almost every scientist on the television either is a nerd or is a mad scientist who wants to conquer the world. So they usually get killed at the end of the series."

Jon Franklin says it's no different in the movies. "Look, for instance, at *ET*. What did the scientists want to do to this friendly little feller from another world? Why ... they wanted to cut him up, of course! Vivisection, that was what was on their minds. They were little better than butchers.

"The evil father in *Star Wars*—what had happened to him? He had been touched by science. Or take *Jurassic Park*: who was the villain there? These are all remakes of the Frankenstein theme, and they play well in Peoria."[29]

Frankenstein, sensationalism, gee whiz—these are themes that often run through science stories, fiction and nonfiction. Unfortunately, such exaggeration is rarely necessary; indeed, it usually clouds the genuine excitement and import inherent in much of science. As in any complexity, richness and subtlety are found in the substance of the thing, not in the adjectives summoned from an overwrought imagination.

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CHAPTER TEN

Recommendations for Scientists

All of the great leaders have had one characteristic in common; it was the willingness to confront unequivocally the major anxiety of their people in their time. This, and not much else, is the essence of leadership.

—John Kenneth Galbraith, 1908-

Carl Sagan's final work before his death, *The Demon-Haunted World*, was an eloquent condemnation of the pseudo-scientific nonsense that's swept the nation in recent years. He said scientists themselves must enter the fray, to defend both their institutions and themselves.

"The unprecedented powers that science now makes available," he wrote, "must be accompanied by unprecedented levels of ethical focus and concern by the scientific community—as well as the most broadly based public education into the importance of science and democracy."[1]

That echoed a theme sounded over 40 years ago by J. Robert Oppenheimer, who felt the great saga of science achievement in the nation was no different from the war stories of heroic soldiers or the great tales of exploration. All of these, he said, are "the threads which bind us in community and make us more than separate men."

Wang

Dr. Taylor Wang, 57, is a thoughtful scientist, serious about his life's work—physics. Born in Shanghai in the midst of World War II, he came to America via Taiwan and earned his Ph.D. from UCLA in 1971. He immediately went to work at the Jet Propulsion Laboratory in Pasadena, Calif., as a 32-year-old physicist. Three years later, at 35, he became a citizen of the United States. In 1985, Wang flew aboard the Challenger as one of seven crew members (April 29 - May 5). Now an engineering professor at Vanderbilt University, he holds over 20 U.S. patents and is the author of approximately 180 papers.

"If we are going to be portrayed as other than just mad scientists on television," Dr. Wang warns, "we have got to show that what we do has some relevance to the people walking the street.

Wang was one of nearly three dozen scientists who gathered at a First Amendment Center roundtable at Vanderbilt University in what turned out to be a very frank discussion of the anxieties and unease that have descended on their world. The central question: Is the United States about to surrender its long-held position as the world leader in cutting-edge research? Is the country going to turn away from its great institutions of higher learning, its world-renowned laboratories and its elite cadre of researchers—the very elements that brought Wang and thousands like him from Asia, Europe and every other part of the planet to America?

The consensus around the table, borne out in the survey conducted for this study, was that the nation is in danger of losing it all, in part because the American taxpayers really don't understand what their investment in research and development is buying. And one of the primary reasons for this is that scientists themselves aren't explaining it.

The mayor of Nashville, Philip Bredesen—himself a Harvard-trained physicist who left the world of science for business and politics—told the assembled scientists: "… There

are a lot of people around this table who are supported by … two cents a week out of the bricklayer's check, and three cents a week out of the stockbroker's check."

It's essential, he said, to explain to those people "not about triplet states, but about why what it is we are doing at this university and other places is meaningful to society as a whole."

Bredesen made clear that he is not just another budget-slasher. High-level research "is a very appropriate process for the public sector," he said, and federal funding must be preserved because "the notion that the private sector is somehow going to be the primary funder of anything like the research that has gone on in our country … is just clearly wrong. That's just not going to happen."

The importance of world-class science, Bredesen said, "is not being communicated. This is a fundamental problem."

The critical question is: How does the average scientist make himself or herself understood and appreciated? How can the scientist's work be made relevant to the average citizen?

Apply the scientific method

Perhaps scientists should apply their own scientific method to this problem.

Jacobson

"As scientists, you like to look at data, interpret data," Dr. Harry Jacobson, Vanderbilt vice chancellor for health affairs, told the roundtable participants. "And I wonder if, in looking at this issue, we[might] go to the people who are supposed to be communicating to the politicians—the lay public—and actually find out what message they are getting now …, what they feel is missing, or how they interpret what they are hearing. [I wonder] if that might guide us a little bit more into formulating what we need to do."

The roundtables, the survey and the one-on-one interviews with scientists and journalists conducted for this study have established a beginning for that process. Now scientists must take the initiative to open a direct dialogue with reporters and editors in their own communities, trying to discover on a case-by-case basis why their story is not getting through.

Journalists who responded to the survey have suggested some of the possible reasons:

"Scientists are sometimes bad judges of their best stories," said Paul Conti of station WNYT-TV in Albany, N.Y.

"Scientists should be aggressive not only in their research but in publicizing their work," said Susan Raff of Middletown, Conn. "Scientists in all communities should have a pro-active relationship with the media."

Tom McNamee of the *Chicago Sun-Times* noted that: "Good scientists are remarkably competent in explaining technical matters in terms intelligent lay people can understand. Reporters are less ignorant than they are rushed."

Scientists are used to criticism, obviously, and welcome it when it's warranted and balanced. Nils Bruzelius of *The Boston Globe* offered comments on the shortcomings of science as well as of his own profession.

"Although our own paper is one of the exceptions," he wrote, "most media organizations devote too few resources to covering science, medicine and the environment, and to developing experienced and talented reporters committed to those beats."

But scientists are at fault, too, he said, "because of their acquiescence in a style of scientific communication that is unintelligible to most peers in other disciplines, let alone the public. That is not necessary," Bruzelius concluded, "and needs to change."

Media training

If the scientists and engineers are ready to address this issue, one fairly simple approach would be to tap the skills of media training experts. Widely available, such professionals are now commonly employed by businessmen, lawyers, the military, athletes, even astronauts. Media training that addresses the special needs of scientists can be quite valuable.

The good ones will tell the client up front that effective communications skills are not inborn but acquired. The best communicators—Broadway and motion-picture actors and actresses—spend years learning their trade. This is not to recommend acting either as a substitute for or even as a method of communicating science, only to note that "professional communicators" spend many hours in preparation before they ever appear before an audience. U.S. presidents, for instance, routinely rehearse their answers before every news conference, calling for tough practice questions from their staffs.

Prior to any appearance before the media or any interview with a print reporter, scientists should carefully prepare their remarks, preferably in the presence of non-scientists—perhaps someone from the public-relations department of the university or research facility.

"When I go to give talks about the civic scientist, I get some skepticism," Neal Lane says. "I get people [scientists] who stand up and say, 'I don't know how to do this; how do I do this?' And I say, 'You know, on your campus, you have public information officers. You have people who understand how to communicate with the public and who know the media. They can be helpful to you, and I bet they don't get all that many telephone calls from faculty members who want to do a better job communicating with the public.'"

Michael Deaver, the man who was as responsible as anyone else for crafting former President Ronald Reagan's public image, says, "Here's what I'd give as the most basic communications advice. One of the things that most people don't do when they get into this is to sit down and develop a strategy. They should set it all down: Where do you want to be, what is an endgame for you—and then figure out all the ways you can get there. Another key is to make priorities with the amount of time you've got. Keep your message as simple as possible and stick to your strategy. That works whether you're the president of the United States or whether you're somebody who's out there worrying about alcohol-syndrome problems for babies."[2]

As well as determining their own aims, scientists need to think carefully about the needs of the journalist. What does he/she want? Two things that are vital and that are found in nearly all good stories about science: relevance and context.

Since so much of science is incremental, the reporter and the public need special help in placing research in the context of the big picture. It's worth the time to give reporters comprehensive background on why the research was carried out, where it fits in the bigger puzzle. If the puzzle isn't solved yet, a reporter might want to present the story as an unsolved mystery.

If the research is the final piece of a puzzle, the work's relevance is usually much clearer and easier to explain. The story is no longer a mystery; the reporter will probably want to look to the future. In either case, the significance of the work is more and more the key to public understanding and support.

"Scientists need to realize that they are, in fact, very good explainers and help journalists go about the process of explaining science to news audiences," says Katherine Rowan of the Department of Communications at Purdue University.[3]

Journalism education for scientists

Noting the many calls for journalists to be better educated in science, Bredesen says that maybe a course in journalism and communication for scientists might be more productive than a course in

science for journalists. He told the Nashville roundtable that it is not really "reasonable to expect that *The Tennesseean* is going to hire someone who is going to understand, in any reasonable way, what the substantial fraction around this table … are doing. I think it falls on the people around this table to explain ...."

In fact, it is a recommendation of this report that all future scientists be required to take undergraduate courses in communications.

A communications education program for scientists known as the Media Fellowship Scheme has been underway in Great Britain since 1987. It was set up by COPUS—the Committee on the Public Understanding of Science—sponsored by the Royal Society, the British Association for the Advancement of Science and the Royal Institution. The fellowships provide firsthand opportunities for scientists to experience how the media work. Scientists spend four to eight weeks working with a newspaper or magazine, or in radio or television, observing and taking part in the news-gathering process and learning how and why stories make news.

Some program participants have gone on to make journalism a career, or avocation.

"I have discovered that I enjoy journalism and write a regular column in the weekend *Financial Times*," says professor of psychology Andrew Derrington, "This will, of course, promote science in a small way, but I think that the most important thing is to make scientists more aware of the fact that the science journalist is their ally, and of how they can help."

Dr. James Shippen, a mechanical engineer and media fellow with BBC Radio, observes that: "At university, time scales are longer and more flexible. At the BBC, work is highly volatile. The deadlines are absolute. The program will be broadcast at a particular time. Excuses do not enter into the equation; there are none. This has the effect of focusing the mind wonderfully."

For those who haven't the time or inclination for a retrofit but who would still like to interact with the media, it's useful to engage the journalist who is conducting an interview in dialogue. Avoid if possible the "ping-pong" interview — question/answer, question/answer, question/answer.

A more rewarding method is to draw the reporter into a genuine conversation, much as one might a colleague. Find out how much background he/she has in your area, how much of the literature, if any, has been digested, who else the reporter has spoken to, opinions he or she might hold. Try to get as much information feedback as possible. It's better to correct a mistake in the office or lab than in the next edition.

Be clear about the tentative nature of the findings (if they are tentative). Do not engage in hype. Don't exaggerate. Provide whatever documents and background seem necessary. Through the use of analogies and metaphors, place the work in its proper context. ("Analogies prove nothing," Freud said, "but they can make one feel more at home."[4])


Mitchell

"This is a vitally important topic," says Dr. Clifford S. Mitchell of the Johns Hopkins School of Public Health. "Although both funding priorities and total dollars invested in research are directly related to public perception and attitudes, those priorities can be and are shaped by the news media's coverage of science and scientists."

Boyce Rensberger of *The Washington Post* says simply, "If the scientist is not willing to take the time to work with the journalist, then that scientist has no right to complain later about the content."[5]

Long-term relationships

Not everyone, of course, is involved in newsmaking research. This problem was described by Dr. Travis Thompson, director of the Nashville's Kennedy Center for Research on

Human Development.

"In the meantime," he said, "we are going down the tubes. And it seems like a lot of us around this table, and my friends out there in the science business, are not very good communicators, and they are not going to be very good communicators.

"We are not good at writing bumper stickers," Thompson said in frustration. "We are trained all our lives to not write bumper stickers. And to all of a sudden tell us, 'Now you should stop what you're doing and write bumper stickers' isn't going to work."

Thompson contends there is only a small percentage of scientists "who can do that with a little more—I wouldn't say grace—but at least they can do it. It seems like developing longer-term relationships with people in the media is a wiser strategy."

Indeed, it is a recommendation of this report that scientists develop long-term, informal relationships with reporters to help the media understand big-picture issues and to keep them abreast of current developments.

One avenue along this line is being explored by an increasing number of scientists, noted Dr. Douglas W. Johnson of Stow, Mass. "One role I have found useful is as a 'background' source in which the reporter comes to you not for attribution, but rather for context and explanation," he wrote. "I think if more reporters had this sort of non-judging source of information the overall quality of the stories would rise."


Brown

Science has tried for centuries to reduce all things to mathematical equations. The thrust now is to make a graphic of it. The mind grasps nothing quicker than a clear picture.

"Graphics are crucial to clear presentation of scientific ideas," says Dr. Jay Brown of the University of Virginia. "Sketches of the experimental design or how a study was performed enhance clarity much more than in other types of news. People need to be able to imagine themselves doing the scientific study or at least have a valid mental image of some else doing it. They cannot get this from text alone. TV does better than the print media in its presentation of graphics, but TV news stories about science are far too short."

High-profile web sites

Graphics work exceedingly well on the Internet, which leads to another point: this study recommends that the science community expand its Internet resources significantly. While most of the major professional societies already maintain web sites, for the most part these are designed for internal use rather than as aids to public or journalistic understanding.


Gray

These sites should be remodeled as easy-to-access sources of new scientific findings. Papers should be available online on their publication date—or better yet, beforehand, with suitable understandings about embargoes. Journalists function far better with advance information, especially when they are covering major developments.

One of the leaders in the effort to get useable science information on the Internet is Dr. Harry Gray, director of the Beckman Institute at Caltech. During a 1997 symposium on science and the media he said, "What I really have in mind is, if we have these stories on the web, and we have them flagged in a certain way—like 'We think this story would be of really great interest to the public'—and [reporters] can use a proper search engine to get away from all the other hits, to get to the hits that say 'the laboratories at Caltech' … that [would

make] the contact. Then they [could] communicate electronically to work on the story."[6]

Scientific and technological web sites should provide plain-English summaries and translations. This, in fact, is being tried at some institutions, notably at Fermilab.

The web sites also should provide the names, e-mail addresses and phone numbers of scientists who are available for interviews.

The various scientific disciplines should develop and train scientists who can speak fluently not only about their own research but about the field in general. Dr. Jonathan Richardson of Somerville, Mass., says "it is up to present-day scientists to pool their resources and choose leaders who can present a broad view of their field to the public. Such people have existed in the past (such as Bromley, Sagan, Happer, C. Everett Coop) and must be sought out in the future," he says. "There are plenty of good scientists with good communications skills who are willing to speak out if given the chance. This is not the time to give up, but the time to try hard, reach out and succeed."

Flagging the findings

In conjunction with making new scientific information more user-friendly, the publishing process itself should be overhauled. The journalist's job would be far easier if science journal editors would require researchers to submit a plain-English summary of their findings, as well as an abstract. The summary would place the research in context and provide some statement of its value or priority to its particuar scientific discipline. The summary and priority would be peer-reviewed along with the paper and prominently published.

As with web sites, journals should also develop a way to flag the most important findings, calling reporters' attention to especially significant news. *Science* magazine is good model for this, as it continues to publish excellent summaries of the most important papers presented each week. Its general coverage of science-related news has expanded and improved.

While "going public" is still controversial in some scientific circles, it also seems clear that Mary Woolley, the president of Research!America, is correct in her observation that many scientists are not at all comfortable with the current state of affairs.

"Instead of looking to the future, they are forced to look over their shoulders to see if they will survive the next round of funding decisions," she observes.

In late February 1997, Woolley wrote the lead editorial in *Science* magazine, noting that: "Members of the science community have come to realize that the continuation of even a modest level of comfort in science is by no means guaranteed, and many scientists (if somewhat begrudgingly) now understand that public advocacy is the route that must be taken to ensure the continued conduct of world-class U.S. science. Recent guest editorials and letters to the editor in *Science* have revealed different approaches to advocacy, reflecting some ambivalence on this topic among the concerned members of the science community. Such discussion and debate are timely, because collectively we're all seeking a comfort zone for advocacy."[7]

The late Carl Sagan noted that large, sustained government support of basic research is "fairly new, dating back only to World War II." He felt it was absolutely essential that scientists make the case for continued generous funding, now that the Cold War is over.

"[I]t would be an odd flirtation with suicide for scientists to oppose competent popularization," he said. "What the public understands and appreciates, it is more likely to support."

Sagan said this will not be achieved if scientists confine their efforts to writing for prestigious magazines.

"I'm talking about efforts to communicate the substance and approach to science in newspapers, magazines, on radio and television, in lectures for the general public, and in elementary, middle, and high school textbooks," he wrote.[8]

Dr. Ross S. Basch of New York University Medical Center agrees. "If scientists want public understanding they are going to 'tell' what they do, how they do it and why they do it, and then 'sell' why the public should pay for it," he says.

Goldin's Rule

One of the strongest proponents of the aggressive dissemination of science information is NASA's Daniel Goldin. What is Goldin's technique?

"When I first started working at NASA, I never did public speaking. And I thank God that I had a mentor, who every day made me speak to the public. Fifteen, 20 minutes a day, school children would come through—this was in the startup of the Apollo program—and I was terrified standing, talking to school children.

"But [my mentor] said, 'Dan, every day you get up, and you talk.' And within a half-year to a year, I learned how to talk to people—but I learned how to talk to young people that had a sixth- to seventh-grade education. And every time I talk to the public, I always talk at that level, because the average American has a seventh- to eighth-grade technical education."

"When I became administrator," recalls Goldin, "I held town hall meetings. I picked places where NASA is not, because I didn't want to get the people who were on the NASA payroll coming. And since that time, in the last five years, I've gone to the high-plains states, I've gone to rural districts, I've gone to inner-city areas.

"Each time, I go with a core group of people, and we take time to go talk to the newspapers and the TV stations. All of us have spent time very carefully talking to each other, trying to speak in plain English, eighth-grade technical background. I'm not saying that to be demeaning, but that's the average education technologically for Americans.

"Invariably, we walk into newspapers and they say, 'You're the first one from NASA ever to come to visit us.' We sit down with them, we talk to them about what we're doing, and we see a whole series of articles appear.

"So when I talk about [the fact that] it's necessary for scientists and engineers to reach out to Americans who are their customers, I really do mean it. I think it's a fundamental responsibility that we have to the future of this country."

Carl Sagan's formula was similar to Goldin's. "Above all, remember how it was before you yourself grasped whatever it is you're explaining. Remember the misunderstandings that you almost fell into, and note them explicitly. Keep firmly in mind that there was a time when you didn't understand any of this either. Recapitulate the first steps that led you from ignorance to knowledge. Never forget that native intelligence is widely distributed in our species. Indeed, it is the secret of our success."[9]

Should scientists be required, as part of the grant process, to communicate their work to the public that provides much of their funding? Neal Lane is cautious about adding new requirements.

"What really has made this country a leader in science and technology in the world has been freedom—not restriction, not deeper boxes, not narrower walls, not tighter constraints—but freedom to explore, to share information, to travel, to express and hold whatever ideas are consistent with the ethic and the rigor of science," he says. "So you want to be very careful when you start changing that system in a way that is more confining."

Notes Leon Lederman: "[A]s a feeder at [Lane's National Science Foundation] trough, I can tell you that his program offices, in fact, gently encourage you do that. … I think it's a plus. When you write your grant proposal, there's a place … to say what you've done in the way of communicating."

Lane draws a distinction: "That we do, and increasingly we're going to ask all of our scientists … to let us know what societal value they see ... for their work and how they communicate that. That's different from making it a requirement."

Warning

Writing in *Science* magazine in early 1997, Penn State Professor Rustum Roy issued a tough warning to his colleagues—a good news/bad news missive. The good news, he said, is that the American people strongly support basic scientific research—more so than the citizens of any other western nation. In his view, the nation is not "in the grip of an antiscience wave."

The bad news, he said, is two-fold: Whatever scientists do in the way of communication with the public will take years to show a benefit, and there is no guarantee that educating the public will have any effect on funding.

Roy

"Before scientists go before the public to persuade them to continue the lavish funding we have enjoyed for nearly five decades," he wrote, "they should prepare themselves for questions such as the following, which they will have to answer sooner or later.

"(i) The corporate world (not just U.S. companies) has decided that it gets little return from basic research that is unrelated to products and has cut it back drastically. Has academia faced up to a similar rebalancing?

"(ii) There is widespread agreement that the entire academic culture has emphasized research at the expense of teaching, but what attempts have been made to rectify this?

"(iii) How many of the research universities' instrumental "Taj Mahals" would stand up to the scrutiny of the U.S. General Accounting Office in terms of cost-effectiveness or hours per week of use? The track record of the "sealing-wax-and-string" approach in really significant research being so good, can scientists not design systems that share capital equipment and use communications technologies—and thinking—more intensively?

"(iv) A great deal of the creative energy of faculty, young and old, is consumed by proposal management in the world's most inefficient system for funding of research. Why not try modest experiments or radically redesign the system?

"(v) We can argue a plausible case before the public for mission-oriented science for defense, the environment, better transportation, more and cheaper energy, and so on. But what honest case can we make for funding totally undirected research at a level of several billion dollars per year? Why not privatize most support for research that is unconnected to useful products, through area-specific appeals such as the March of Dimes; or a check-off on an income tax form; or philanthropy from, for instance, the 100 or so billionaires who made their money from technology. I am certain that, freed from peer-group bureaucracy, such science would be much more creative.

"When activist scientists have done their homework on questions such as these, they will be ready to enter the fray of public debate. I hope many will be moved by conviction and high moral purpose, not just by the desire for more research money, because the slings and arrows of peer jealousy and honest disagreement will not be long in coming."[10]

Finally, Pulitzer Prize-winning author Jon Franklin believes no matter what avenue scientists choose, change is at hand.

"I speak to you now not as a science writer but as a writer. It is my artistic observation that my civilization is on the brink of a great decision about itself, and that it is high time to dispense with translators. It is time for scientists to come to terms with the fact that they're eating at the political trough and that they'd damned well better make their political case, and make it in a way that real people can understand it. It is also time for people to come to terms with the fact that the world as we know it, as a haven for couch potatoes and New Agers and critical humanists, exists only because of science and technology, and was cre-

ated at great cost not only in money but in individual effort, labor and, yes, faith."[11]

Rustum Roy's and Jon Franklin's views should serve as warning signs to both scientists and journalists, a reminder of the rough spots in the road ahead.

Public indifference and, in some extreme cases, hostility to science and its merits can only be countered with an honest, energetic and continuing stream of information from the scientific community that stresses not only the benefits of science but underscores the dangers of abandoning the path of discovery that has been spiraling upward for the past 50 years.

The ideas put forth here are by no means the only methods by which scientists can reach the public through the media. Nor should communications efforts be couched primarily in defensive terms. Science has a great deal to tell the world that is not commercial or utilitarian, but that simply satisfies a deeply rooted and delightful desire to "know"—to know where we came from, how we became what we are, what kinds of monsters once roamed the earth, indeed, where the earth itself is hurtling: those things beyond our meager vision.

And finally, because so much of science has "happened" in the years since most of us were in school, the media must reappraise to what extent it is an educational arm of society.

chapter endnotes

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3 Katherine Rowan, "Enhancing the Dialogue," symposium, San Juan, P.R., March 12-13, 1993.
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5 Boyce Rensberger, "Enhancing the Dialogue," symposium, San Juan, P.R., March 12-13.
6 Harry Gray, "The 21st Century: 4th Annual Cal-Tech Symposium, May 1, 1997.
7 Mary Woolley, *Science*, February 28, 1997.
8 Carl Sagan, *The Demon-Haunted World*, (New York: Random House, 1995).
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11 Jon Franklin, Hill Lecture, University of Tennessee, March 17, 1997.

CHAPTER ELEVEN

Recommendations for Journalists

The American public knows us. If we have lost some of their trust (and we have), it's not because we have become too serious but because, at times, we've become too frivolous.

—Ted Koppel, 1940-

One of the saddest findings of this yearlong look at the way the media covers science and technology is that a good portion of the public is having trouble swallowing not science but the media. A Roper poll taken in 1996 showed that 80 percent of the American people believed a free press is essential to the functioning of our society, but a majority of the respondents said the press today is too sensational, manipulated by special interests and biased.[1]

In the same year, a poll taken by the Pew Research Center for the People and the Press showed that Americans were continuing to turn away from the news media. Viewership for the network nightly newscasts was down to 42 percent, from 48 percent in 1995 and 60 percent in 1993. For television news overall, local and network, 59 percent said they had watched a newscast the previous day, down from 74 percent in 1994.

About 50 percent of those polled said they had read a newspaper on the previous day.

When the people who said they were watching less TV news were asked why, nearly half said they didn't have the time anymore. But 26 percent said they were critical of the coverage or had no interest in it.

When asked whether they could believe "all or most" of what appeared in their local newspapers, only 24 percent said they could.[2]

A similar Pew survey in 1997 asked respondents if they "enjoyed watching TV news a great deal," and only 26 percent replied yes, down from 42 percent in 1985. The same numbers applied to people who "look forward to reading the paper very much"—27 percent in 1997, 42 percent in 1985.[3]

Looking at these numbers, one of the questions the news media might ask itself is: Are we covering matters readers, viewers and listeners care about?

As noted earlier in this report, the local media tend to place heavy emphasis on crime and sensation. Yet only 41 percent of the respondents in the '96 Pew survey said they were interested in such stories.

However, 20 percent of the Pew respondents said they enjoyed watching and reading stories about science and technology, a category which beat out religion, political news, international affairs, entertainment, consumer news, business and finance, famous people and culture and the arts.

At about the same time, the Gannett newspaper chain surveyed reader interest, using slightly different category classifications. Things people most wanted to read about were "the good things happening in your area," "news from your own town or city" and "world and national news." When asked if they were "very interested" in science and technology" news, 29 percent said yes. When that number was combined with those who said they were "somewhat interested" in science and technology, the number jumped to 75 percent. That beat out other categories such as personal finance, outdoor recreation, pro and college sports and listings of stocks, bonds and mutual funds. Eighty-six percent of the survey respondents said they wanted news about the environment.[4]

Numbers like these indicate that editors and producers are underestimating the public's de-

sire for more news about science and technology and may be losing audience by spending so much time on frivolous matters.

Stupid questions

By failing to assign a high priority to science, gatekeepers also may unwittingly be contributing to the overall communications problem between scientists and journalists. Several journalist respondents to the survey wrote variations on the following: "Unsophisticated publications assign unqualified reporters to cover science and technology stories. They ask stupid questions, and write superficial stories. The scientists involved conclude all reporters are idiots."

Conrad

Former astronaut Charles Conrad Jr., told fellow roundtable participants that it drives him crazy "… to have a reporter ask me a question when he obviously hasn't done any homework at all. Someone says, 'Go out and talk to Conrad about when he went to the moon.' And the guy will sort of show up and he'll say, 'Well, how did you get there?' (laughter) Seriously."

Situations such as this may have inspired one Florida journalist to comment on his survey form that "most daily newspaper and broadcast reports on science and technology are laughable at best."

Are science stories harder to report? Unquestionably. It does take work on both sides—journalists and scientists—to "package these stories," says Kathy Sawyer of the *Post*, but "there's a lot of interesting stuff." Instead of digging into it, says Sawyer, journalists often are "just intimidated and think it has nothing to do with their lives."

One place to start might be with Einstein, who 60 years ago said, "The whole of science is nothing more than a refinement of everyday thinking."

What a concept! Except it's the reporter's job to stand that idea on its head. It's the reporter who is often called on to deconstruct the scientist's refinement—sometimes the work of an entire career—and express it in everyday thoughts and words. Some reporters surveyed for this study feel the lack of a scientific background may be an asset in this endeavor.

"Do not assume a reporter must be highly schooled in science and technology in order to cover the subject effectively," wrote Scott Mason of WCVE-TV in Richmond, Va. "A reporter with almost no scientific background can, in fact, cover the subject sometimes *more* effectively. After all, it's the reporter's job to 'step outside' the subject to explain complicated technical jargon in laymen's terms. Good reporters filter out the complexities while leaving the key 'ingredients' intact. This 'filtering' effect is sometimes necessary with a subject like science and technology; otherwise, the general public may find it too much to swallow."

While most science journalism traces incremental stories, once in awhile a surprise comes along, catching everyone off guard. The cloning of Dolly and the discovery of possible fossil life in the Mars rock are two recent examples. In such cases, journalists find themselves frantically searching for sources and background. One question that should always be asked at the very beginning of any science story—especially one about a remarkable breakthrough—is whether the material has been peer-reviewed.

Peer Review

Although it's no guarantee of total accuracy, proper peer review produces the best current thinking of the science community on a given body of research data. Absent peer review, scientists can be just as fallible as anyone else. As one journalist noted on the survey form: "With

Journalists' Guide to Gauging Reliability of Scientific Data

Stage of scientific process	Peer review status	Second source required?
Work in progress; journalist visits lab for tour and interview concerning research underway.	Not peer reviewed.	Yes.
Paper presented at a science conference.	Not formally peer reviewed; the presentation is actually the first stage of the peer-review process.	Yes; would help to set context and gauge reaction of the science community to the research data.
Paper published in a peer-reviewed scientific journal that is recognized as credible by the discipline.	Peer review complete.	No; but a second source might be helpful to establish context and relative importance of new data.

enough money, *any* group or organization can find a scientist/expert to verify and back its findings/beliefs."

"Yes, scientists might be motivated by ego or greed or the unwillingness to surrender their favorite ideas," admitted Carl Sagan. "But there are other scientists, maybe even similarly motivated, who have a reason to try to disprove the first guy's ideas. If you look at the collective enterprise of science, you see that it has elegant, self-correcting machinery built into it in a fundamental way, which makes it different from everything else. And it works," he said."[5]

But it's interesting how reporters can sometimes bollix up peer review.

The scientific method directs that a scientist be as certain as possible about research findings—even though, in the real world, the cutting edge of science sometimes is speculative. Research results are then written up and may initially be passed around to colleagues, if there is time. They may also be orally presented at one or more of the hundreds of science conferences held every year. But once submitted for publication in respectable journals—typically after months or years of research—a rather remarkable thing happens.

Long before publication, the proposed article is sent to other scientists who are experts in the same field of research. They may be friends of the author, but just as likely they will be the writing scientist's bitterest critics or intense rivals. The article is judged on several points. Is the discovery really new? Is it significant? Was proper care taken to ensure the integrity of the experiment and analysis of the data? If the reviews that come back are positive, the article generally proceeds to publication. If the reviews are negative, the article is returned for further work. If the reviews are mixed, a third referee is brought in. Finally, if the editors decide to call it a draw, the article may be printed with the objections of the reviewers included as letters.

And the letters can be scalding. The whole point of the exercise is accuracy. As Rousseau said, near the beginning of the modern scientific revolution: "Nature never deceives us; it is always we who deceive ourselves."

"The process of science may sound messy and disorderly. In a way, it is," says Sagan. "If you examine science in its everyday aspect, of course, you find that scientists run the gamut

of human emotion, personality, and character. But there's one facet that is really striking to the outsider, and that is the gauntlet of criticism considered acceptable or even desirable."[6]

Almost every scientific discipline has a publication for its research papers. None of them has a circulation base much larger than the number of members belonging to their society—a few hundred to several thousand. The subscription price for many of these journals is several hundred dollars per year. Depending on the publication, the articles range from mundane to revolutionary. The challenge for reporters is to ferret out the interesting research that can produce good stories. As Gerald Wheeler of the National Science Teachers Association observes: "It works extremely well within the institute of science. It just doesn't work [well for] communicating with the general public."

Peer review and formal publication do, however, give journalists a comfort zone by guaranteeing that the work presented is accurate to the best of the experts' knowledge. Of course, some reporters will want a second source. But often there is no second source at the cutting edge of science; the new findings are unique. In this case, other researchers familiar with the new findings can provide useful background and perspective. Most science reporters maintain up-to-date contact lists within the many disciplines for just this purpose.

Sigma Xi, the Scientific Research Society, also sponsors a service called The Media Resource Center. It has an 800 number for journalists seeking comment or background.[7] More than 30,000 scientists who are willing to provide information to print and broadcast journalists on short notice are in its database.

Science as detective story

Many good science reporters say they approach their subjects as they would a mystery story. The science process is incremental. Most new knowledge—especially in major fields such as AIDS or cancer research—comes in dribs and drabs, and usually not from just one laboratory. The big picture has to be pieced together.

"Scientists routinely publish preliminary evidence, not waiting until they have absolute proof," says Rensberger of *The Washington Post*. "It's their way of sharing findings and inviting criticism from colleagues. But it also gives the rest of us, like readers of a detective mystery, a chance to tag along with the investigators as they seek to unravel clues."[8]


Begley

While good science reporting might read like a mystery, "… science journalism has to adhere to the same criteria as other stories," says *Newsweek*'s Sharon Begley. "Conflict is good, having two sides is good. It's got to be new; it's got to be interesting. It is not public service."

Jon Franklin says the trick for him was to stop calling it "science journalism."

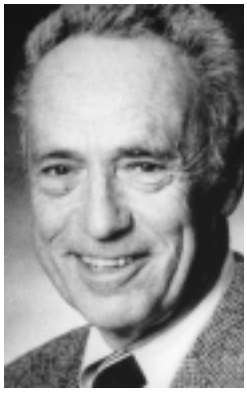
"Once I started down the road of leaving the word 'science' out of my stories, I wrote about science as though it were a normal human activity," he says. "That sold surprisingly well. Pretty soon I was concentrating on essays and narrated stories and getting a nice slice of readership. I won some prizes, which makes newsroom life easier, and I started thinking about books."

David Perlman, science editor of the *San Francisco Chronicle* says there is "excitement, elegance, intrigue" in science, "and a way of looking at the world in terms far more filled with wonder than the verbiage expended during the jousting of politicians." Perlman was a political reporter before taking up science journalism 30 years ago.

He wrote the introduction to an excellent new book, *A Field Guide for Science Writers*, published by the National Association of Science Writers. It lays out in 287 pages the "tech-

niques of the trade." A comparable effort is beyond the scope of this work, but here are a few suggestions.

A good metaphor for almost any science story is exploration and discovery. There are almost always elements of surprise and uncertainty, setbacks as well as successes. Science always learns something from every experiment, even those that are total failures. AIDS research is a good example.



Perlman

No one has yet found a cure for AIDS, but the many failed experiments have vastly improved scientists' understanding of how the virus lives, how the body responds to it and, of course, a whole range of things that don't work to control it. At each step, the information base is expanded. New insights on how other viruses behave promise a better understanding of less threatening, but more widespread diseases, such as flu and the common cold. The lack of success in any one experiment does not argue for an end to research. In the case of AIDS, experience teaches that the mechanics of "life," even at its simplest level, are enormously complex.

The "science" in many stories is often less obvious and harder to tease out than the superficial excitement associated with an unusual event. Much of the reporting on NASA's space shuttle flights illustrates this fact. The media seldom cover more than the launches and landings, even though most flights now are loaded with scientific experiments.

Such limited coverage leads to two misapprehensions: First, that shuttle flights are now routine, which they most certainly are not. Every one is fraught with uncertainty and great risk; the checklist before each launch runs to a million items. The shuttles are still very much experimental vehicles, and space is still an extremely hostile environment.

Second, viewing the flights as routine leads to the perception that nothing new is happening in this area of space exploration, which then means that only problems are newsworthy. While the difficulties encountered by the shuttle missions should be reported, they should be balanced with information about why the flights are made in the first place. It is very rare that NASA, or any other agency involved in cutting-edge endeavors, has an unqualified success. The Mars Pathfinder mission, with every objective accomplished, is very unusual.

Science stories may be complicated; they may require more time and effort than run-of-the-mill stories, but science reporting can be the most satisfying of all beats. Keep in mind E.L. Doctorow's advice for difficult situations: "It's like driving a car at night. You never see further than your headlights, but you can make the whole trip that way."[9]

Seeking out sources

Many survey respondents who would like to do more science stories complained about the accessibility of scientists. Some complained that researchers are arrogant. "Too often they are protected by a wall of PR officials …,"wrote Jerry Bohner of KTOK radio, Oklahoma City. Another journalist said they only want to talk about their "successes." Much of this is changing.

The *Post*'s Sawyer notes that "the end of the Cold War has been a great boon to us science writers, because scientists are getting the message slowly but surely that they have to talk to the public. The public has to be able to understand what they're doing or they won't get funding. Now, without the Evil Empire over there, they have to have some other rationale for asking for tax dollars. So they're loosening up."

In fact, the survey results indicate overwhelming agreement by scientists that communications with the media and the public should be improved. This fact, coupled with the large number of scientists who say they have rarely or never talked with a journalist,

indicates a lot of fertile territory for reporters.

Dr. Harry Jacobson of the Vanderbilt University Medical Center suggests a way to start: Organize informal, informational meetings between the scientific community and journalists who might never have covered a science or medical story. "The university," he says, "as a community resource, can provide the forum for continuing education of people from media, in terms of science and emerging issues—like new infections and so on."


Giles

Robert Giles, former publisher of *The Detroit News* and now head of the Media Studies Center in New York City, says nothing is more important today than educating journalists about major R&D issues.

"A critical element" in the lack of good communications, he says "is the failure of many journalists, and their editors or news directors, to have a fuller understanding of the complex nature of science and technology. To a considerable extent, this parallels the inadequate preparation for coverage of another difficult topic: economics. The intellectual shortcomings of journalists and their news organizations in these specialties have significant consequences, both in public mistrust of the press as an institution and in public misunderstanding of important issues involving science, technology and the economy. One way to address the problem is to educate journalists who are covering and making news-play decisions about these specialties. Only two institutions currently provide significant mid-career educational opportunities in science and technology: The Knight Foundation program for science reporting at the University of Maryland and FACS, which offers extensive educational programs in science, technology and economics."

FACS, or The Foundation for American Communications, was established by *The Detroit News* and the San Diego Supercomputer Center. It not only conducts media seminars but maintains an excellent web site designed to help journalists cover science and technology, as well as a host of other complex issues.[10] It provides access to background papers and links to other useful Internet sites. The person or organization responsible for maintaining each Internet resource is identified, and FACS provides names, e-mail addresses and phone numbers for sources, including scholars, government official, and people from the private sector.

The indispensable Internet

In fact, the Internet is one of the most useful tools for both experienced as well as new science writers. Robert Lee Hotz of the *Los Angeles Times* says the Net has now become almost indispensable.

"There is nothing that I do as a reporter that is not directly affected by the new technology," he says. "There are 31 different web sites I routinely tap into as a part of keeping track of what's going on [with earthquakes]. I also cover research on the human brain. There are 28 web sites—including an interactive whole atlas of the human brain maintained by the Harvard Medical School—that I routinely use. And I don't think anyone who covers astronomy or space flight today would willingly do it without taking advantage of the graphics capabilities offered by the web to tap directly into the images from the orbiting Hubble Space Telescope or from one of the several planetary probes being maintained by the Jet Propulsion Laboratory."[11]

A very helpful web site is EurekAlert, maintained by the American Association for the Advancement of Science (AAAS). It provides searchable press releases from universities, companies and labs either announcing the results or progress of research efforts. Some of the work available here is work in progress and

not peer-reviewed, but the site is a good place to begin researching up-to-the-minute developments. Often it will contain press releases from institutions throughout the country. Usual contact numbers are provided.

EurekAlert also features calendars and locations of scientific meetings and conferences and a huge database of links to most major scientific research organizations, including universities, hospitals, think tanks, societies, publications and associations. Links to peer-reviewed journals, science media and journalism groups are on the site, as are links to other sites offering graphic images to complement science stories.

A caveat is in order here: Experienced science writers warn newcomers to the field that the Internet also is full of bad and/or misleading information. *Science Friday*'s Flatow says, "You have to be an informed consumer of news and know your sources … probably more so than in the past, so that you know what to listen to and what not to listen to."

The FACS web site offers good advice: "For newsgroups, forums, and e-mail discussion lists, start by treating all information and quotes much the same as you would random interviews on the street or as a conversation overheard on the subway. First of all, you have no way of knowing who the person 'speaking' is, what credentials he or she has, or even if the person posting the message is really who he or she says she is. These places are starting points only. They may provide leads to more substantive source material. In some cases, you may want to telephone the person, exchange personal e-mail messages, and take other steps to verify the source."

The same caution also should be exercised with documents and graphics. Anyone with a computer can set up an authentic-looking web site loaded with bogus information. Anything downloaded should be verified. FACS says, "Treat it as you would any other elementary school project, fraternity prank, or scam—all of which are on the Internet. Journalists have always had the ultimate responsibility for verifying sources, validating documents, and otherwise testing the veracity of all they report. That responsibility has grown in a world of global computer networks."[12]

The training question

The one topic eliciting numerous comments from survey respondents is the amount and nature of scientific training reporters ought to have. Many writers, editors and producers said no special training at all is needed if the journalists are competent; covering science stories is no different than covering politics, crime or sports, they said. A general-assignment reporter is trained to be objective, to ask the right questions, to sift through complexity and to write or produce an understandable, interesting and informative story.

"I can competently cover science/technology stories if I start out by admitting my ignorance and not being scared to ask 'dumb' questions," wrote Chuck Crouse of Pennsylvania radio station WLMI. The scientists on the receiving end of this openness, Crouse said, have been "generally helpful once they perceived that I wasn't a know-it-all or shoddy craftsman."

The truth is "that some of the best writing of our day focuses on the subject of science," even though it's not called science writing, says Jon Franklin. "I might mention, sort of offhand, Tom Wolfe's *The Right Stuff* and any number of pieces by John McPhee. But we don't call them science writers, do we? No, we don't, any more than we would call Hemingway a war writer, or Steinbeck a poverty writer, or Mark Twain a children's writer."[13]

It is true that many fine "science" reporters—John Noble Wilford and Kathy Sawyer are two—have never had any formal science training. And in the case of the general assignment reporter covering an occasional science and technology story, such extra training may not be worth the effort and cost. However, if a news organization intends to establish a science beat or to move into serious and sustained coverage, it will enter the arena crippled unless its reporters have adequate

training and/or experience.

Scientists will not forswear their jargon or other forms of linguistic shorthand overnight. It will probably never disappear completely. (Two phrases destined, no doubt, to remain forever are "order of magnitude" and "by a factor of 10" or some other number.) Moreover, science relies heavily on math, statistics, probability and other related disciplines. Without proficiency in these and other related fields as well as the sciences, journalists will waste enormous amounts of time just getting up to speed on every story they write or produce.

Where do media organizations find experienced science reporters? And how can general-assignment reporters be trained?

Dorothy Brown, health and science editor of *The Philadelphia Inquirer,* says that her paper, "has an extraordinary commitment to science and technology.

Brown

"Aside from daily and Sunday coverage, we have a Health & Science section on Mondays and a Tech Life section on Thursdays. We have earned the respect of our medical and science communities by hiring some of the best reporters, who have depth in their fields and who can translate complex science into very readable stories. We do not have a communications problem with scientists. Clearly the bigger problem is when the media 'doesn't get it.'"

In smaller markets, hiring and training will be more difficult. "At a medium-sized newspaper," says Saul Shapiro of the *Waterloo* [Iowa] *Courier*, "it is hard to develop a science beat, attract a good candidate and retain him or her. We've had two good ones and several suspects," Shapiro noted on his survey form.

Freelancers and retrofitting

There are some experienced science reporters available. Many good ones are freelancers. They write many of the best stories in major magazines like *Scientific American* and *Discover*. Some want to remain freelancers, but many others are looking for full-time work. The National Association of Science Writers (NASW) is a good place to start.

For staff journalists who want to move to the science beat, continuing education programs for journalists are valuable, if designed correctly.

The primary problem here is that many media owners, managing editors and news directors fear that a reporter sent off to a fellowship program may return to the middle-market newspaper or TV station not better educated and ready to wow the local audience, but armed and prepared to move up to a bigger market.

The fact is, journalists have been moving up and down in markets forever. The good ones will rise to the top no matter what. In the meantime, it's important to seek out the best training for those who are filling the local pages and airwaves now.

Editors, publishers, news directors—the media gatekeepers—should attend scientific seminars themselves in order to become acquainted with researchers, to become familiar with the issues, and to put the competence issue to rest. Scientists see the benefit of this interaction.

Vanderbilt University Medical Center's Jacobson notes the irony of the situation. "We [scientists] want to convey a message to this society, using messengers who we distrust …" That distrust, he said, "is based on the perception that their competence is insufficient to match our competence. And this leads, obviously, to a very inappropriate interpretation of the very important issues."

Science training for journalists

Since science and technology have become such all-pervasive elements of modern life, no future journalist should ever graduate from journalism school, or from any other school in preparation for a reporting career, without a grounding in these subjects.

Dr. Paul Agris, a biochemist at North Carolina State University, says he "spent 13 years on a campus with a world-renowned school of journalism and was never asked to participate in the education of the school's students.

"Little time was given to encouraging these students to take science courses.

"None were required for the degree. How can these students keep up with the fast pace of science and technology when they have neither knowledge of the fundamentals nor experience of the process?"

Professor Robert Bandurski of Michigan State goes even further in his recommendations. "Science news reporters should have at least a B.S. degree is some aspect of hard science," he said on his survey form.

There is a middle ground: a college training program that would essentially be an interdisciplinary major—half science, half communications.

To be effective, a science journalist should be comfortable with a variety of scientific disciplines, as well as with engineering. His or her education should include experience in the laboratory, where the ambiance of the scientific research process can be felt and learned. The curriculum should combine training in science and engineering with courses in mathematics, including probability and statistics, balanced by coursework in communications, writing, history, economics and political science.

Vanderbilt University has initiated such a course of study expected to begin in the fall of 1998. It will initially offer undergraduates the opportunity to design specific curricula and will include internships to expose students to both research and media organizations.

The combination of science and journalism backgrounds has produced many of the country's best science writers. Rensberger of *The Washington Post* is a good example.

"As I often tell people, I started out in college wanting to be a scientist but chickened out after discovering that researchers must specialize in some very tiny sliver of a field. I was much too interested in all of science to settle for a small piece of the whole," he says. "So I switched majors to journalism to become a science writer.

"I've never regretted it. For me, science writing is a lifelong, self-directed process of continuing education. I can call up top experts in any field of knowledge that intrigues me and ask for private tutorials. And, I am amazed to find, the scientists almost always oblige. They do so not for my personal amusement, of course, but because, like the others who stuff our mailboxes, they want the public to know, to understand, and to be on their side in a world too often given to ignorance, fear and superstition."[14]

Journalism training for scientists

Several universities have developed programs for training scientists as journalists, among them Boston University, New York University, Johns Hopkins and the University of California at Santa Cruz. The UCSC graduate course is directed by John Wilkes, an English literature professor. Each year he accepts 10 Ph.D. scientists from varied backgrounds. They go through three 10-week semesters, learning the basics of news reporting—from crime and the courthouse, through feature writing for newspapers and magazines, then finishing with opinion pieces and essays.

Wilkes

'Late Night Thoughts' from the Late Dean of American Science Writers

Alton Blakeslee, the dean of American science writers, died of cancer at age 83 in May 1997.

From 1952 until 1978, Blakeslee covered science for the Associated Press. During his career, he won the George Polk Award, the Deadline and Distinguished Service Awards of Sigma Delta Chi, the Lasker Medical Journalism Award (three times), and the American Heart Association's Howard Blakeslee award (twice). (The latter is named for his father.)

Alton Blakeslee's death was marked by elaborate obituaries, including one in The New York Times *written by John Noble Wilford, who noted that "Blakeslee was the middle generation in a family line of science reporters. His Pulitzer Prize-winning father, Howard, was the AP's first science editor; his daughter, Sandra Blakeslee, is a regular contributor to* The New York Times*."*

Wilford chronicled the reporter's sometimes whimsical detachment: "Besides being a former president of the National Association of Science Writers, Blakeslee was a co-founder and the president of the American Tentative Society, an organization conceived over late-night drinks with two science-writing colleagues. They mused that all knowledge, especially in science, is tentative and subject to revision as research uncovers new facts."

Blakeslee, Wilford wrote, spoke often of the obtuseness of scientists.

"The first error is failing to talk in simple, common language," he said. "Our knowledge does not become a communicated idea if it must push through a briar patch of sticky words."

Not long before his death, Blakeslee wrote a primer for budding science writers, titled "Late Night Thoughts about Science Writing (With Guidelines That Will Also Be Helpful to People Who Write About Other Things)." Following is an excerpt.

(The entire article is available on the World Wide Web at www.facsnet.org, the web site maintained by the Foundation for American Communications (FACS).

The following so-called guidelines are designed to help woo readers. (The numbering is not necessarily in order of importance. We just need numbers sometimes.)

1. Push your enthusiasm button when you begin a story. If you are not interested, or interesting, can you interest anyone else? "Chore" shows through stories written as a chore. Is there some lilt in your story?
2. Think what your story means and how best to say it. Thinking is the hard part. Distill your facts and purpose to the core of meaning. As Clare Chung, a young student in a journalism class, rephrased it: "Get all your facts together, and then squeeze all your brain cells to come up with a lead."
3. Regard readers not as being ignorant but, more likely, innocent of your topic and its jargon. Write for them, not at them. (Some will always misinterpret, like the lady who wrote, "Dear Dr. Blakeslee: I read your ad in the paper. Please send me some of your drug." Another reader objected to deep-sea drilling programs "because a hole might punch through the earth's crust to the center of the Earth, which is hollow. All the water in all the oceans would go slurping down the hole, and then where would we be?")
4. Explain technical terms immediately if you must use them, and you often must. Then you can use them again in the same story. But not in subsequent ones with probably a different audience, until the term comes into common ken. It took weeks after *Sputnik* before we could stop defining "orbit" each time.
5. Explain the unfamiliar by comparison with something familiar. Make numbers meaningful. The King Ranch in Texas embraces 1,500 square miles. The size of Rhode Island? Who knows that? Better, a strip of land half a mile wide stretching 3,000 miles from Maine to Los Angeles.
6. Put yourself on the other side of your computer or word processor and ask yourself—and then answer—all the questions that might occur if you'd never heard of the topic before.

7. Do not put all the "logs" of attribution and identification in the same sentence just to get rid of them. Be more solicitous of your reader and the people who deserve credit, by sprinkling them through your story. You don't want to be known as the author of something like this:

   "Two scientists from the University of California in Los Angeles made an unscheduled appearance today before the American Society of Bacteriologists, convened in Atlanta in its annual meeting, to announce that an extremely virulent virus of plague-like power had escaped from their laboratory, and could kill up to two million people within a few days. "

8. Look for gems of detail or expressions that can make a story sparkle. Dr. Helen Taussig of The Johns Hopkins Hospital told of a few people who got "rare two-way tickets to Heaven" when killed by lightning but revived by quick CPR. And a Swedish physician campaigning against tobacco said, "Smoking creates an itch in your lungs, and you want a cigarette to scratch it. "

9. In developing a story, there is no such thing as a dumb question. If in doubt, ask. Don't be embarrassed. Who knows everything? A Washington reporter assigned to cover a hearing about "orphan" drugs—those that would benefit only a few but cost the usual $50 to $100 million to develop—didn't ask. He said the hearing was "about diseases orphans get." His copy desk passed it.

10. Don't be afraid to use periods liberally. And avoid putting two unfamiliar technical points in the same sentence.

11. Look for different-from-ordinary ways of expression. But don't be silly about it, like an author who, apparently weary of clapping foreheads, said a man "socked his eyebrows."

12. Give your story a focus, a place to go, then quit.

13. Wring out the "water" of excess verbiage. A story about a big brush fire said "Twelve rescue ambulances stood by to rush injured persons to the nearest hospitals. "Jack Cappon, an AP editor, did the surgery on this in his book, *The Word*: "Eight of those 12 words are drones. Ambulances are rescue vehicles; they don't dawdle; they always carry the injured, not the hale and hearty, and they rarely search for remoter hospitals. Four words were all that were needed—twelve ambulances stood by." (And that gives more space to explain the science story.) A detective could have saved nine of 14 words when he said, "We are questioning several witnesses who were present at the time of the incident."

14. What you leave out of a story can be as important as what you keep in. Otherwise the reader may drown in minor detail. "Erasure is as important as writing," Quintillian observed in the first century A.D.

15. Never let a story go without taking a second look. Is there some stronger verb, better comparison, livelier expression? Quintillian (again) advised putting one's writing aside for a time, coming back to look upon it as "another man's work," and not regarding it "with the affection we may lavish upon a newborn child." Even if you have only seconds, the Second Look can improve copy.

16. Avoid starting a story with a question, except in unusual circumstances. Is it just a lazy approach? Instead, answer the question.

17. You needn't worry about your second graf, unless your first graf grabs readers and makes them want a second one. Your lead sentence, whether between-the-eyes, or soft and seductive, counts hugely. "'Oh, Hell', said the Queen," is my favorite, rarely if ever useable. But enticing. Broken fingernail? The King misbehaving again? Spanish armada approaching? Or: "I never understood nuclear physics."

18. Seeking how to begin a puzzler, it helps to tell someone verbally what the story is about, what you want to say. The verbalizing may put you on the track.

19. Your first draft is not written in concrete. It should be the first draft of all you want to say, in one place, so you can examine and rearrange, to suit better. So let that first draft flow. Don't interrupt for some detail or name that can be inserted later. You are engaged in telling a flowing account.

20. Digest your material. Relax, and write.

Wilkes says the three most important qualifications for a science journalist are (1) a science background; (2) a gift for writing; (3) a fire in the belly to write.

Wilkes' specialized course began in 1975 after he noticed that some of the best writers in his literature courses were scientists. "If they can write this well about literature they can certainly write about science," he concluded. About half his graduates freelance, says Wilkes. Most end up in public information offices, about 10 times the number that find jobs in journalism.

chapter endnotes

[1] Poll taken for Minnesota News Council in 1996.
[2] Pew Research Center People and the Press Survey conducted by Princeton Survey Research Associates, 1996.
[3] Pew Research Center People and the Press Survey conducted by Princeton Survey Research Associates among a nationwide sample of 1,211 adults, 18 years of age or older, during the period Feb. 20-23, 1997.
[4] "1996 Media Effectiveness Study," Corporate Research, Gannett Co., Inc.
[5] Carl Sagan, "Science vs. Pseudoscience," *U.S. News & World Report*, March 18, 1996.
[6] Carl Sagan, The Demon-Haunted World (New York: Random House, 1995).
[7] 1-800-223-1730.
[8] Boyce Rensberger, "Science and Certainty," *Washington Post*, September 11, 1996.
[9] E.L. Doctorow quoted in *Writers at Work*, George Plimpton, ed. (New York: Viking Press, 1988).
[10] http://www. facsnet. org
[11] Robert Lee Hotz, "The 21st Century: The Multimedia Age: 4th Annual Cal-Tech Symposium, May 1, 1997.
[12] Randy Reddick, *Promises and Pitfalls for Journalists on the Information Highway* (Foundation for American Communications).
[13] Jon Franklin, March 17, 1997.
[14] Boyce Rensberger, "Covering Science for Newspapers," *A Field Guide for Science Writers*, eds. Deborah Blum and Mary Knudson (New York: Oxford University Press, 1997), p. 9.

CHAPTER TWELVE

Conclusion

When people generally are aware of a problem, it can be said to have entered the public consciousness. When people get on their hind legs and holler, the problem has not only entered the public consciousness—it has also become a part of the public conscience. At that point, things in our democracy begin to hum.

—Hubert Humphrey, 1911-1978

Many people have asked us—and we have often asked ourselves: What would we like to see at the end of our work, when the study is complete and the results published? It's a simple question with a complicated answer. We both consider ourselves good citizens and want what is best for the nation, as well as for our professions. But we also know that both scientists and journalists probably will look on us as being a little suspect, perhaps each co-opted by the other side. We'll risk that, because we both believe that everyone can work harder, ourselves included, to improve things.

What's improvement? Well, to begin with there's a huge part of the American scene that is not being covered adequately by the news media: those incomprehensible scientists who are doing all those theoretical things. Everyone seems to know that what they are doing is somehow important to society, to the economy—making us richer, healthier, longer-lived—but precious little of it is becoming a part of our culture in a meaningful way. It's just something "out there" that somehow gets incorporated into our lives without noticeably passing through our brains.

We'd like to think that with proper news media attention, a lot of what's "out there" can be explained and shared with everyone. We'd like to think that, as a profession, journalistic organizations still see their jobs as a "higher calling," not just as profit-making ventures.

Improvement, we think, also is a scientist's duty, if he/she really believes that "the scientific method" and the "truth" are paramount. Is there evidence that a scientifically literate society is better off than one that plods on willy-nilly? Is an afternoon curled up with *Science* magazine more important than a vigorous round of golf. Is discussing the latest DNA research or quasars around the dinner table more important than the sex life of a Hollywood star or the peccadilloes of a politician?

It's quite obvious that some scientific matters are more important than others; not every discovery will make the front page of *The New York Times*, or even the college newspaper. And we believe that "science" as a profession should make every effort to help the rest of the world, through the media, understand what the really important discoveries are. If scientists really believe (as many have told us in the survey) that journalism is not covering their work wisely or well, then it is incumbent on them to reach out to improve matters. Journalists may be many things but they are not mind readers.

Science should not simply proffer the "peer-review" process, expecting journalists and everyone else to understand that there is good science, as well as rubbish masquerading as good science. Just as scientists expect journalists to improve the quality of their reporting and to root out charlatans, so should scientists name their own who are frauds for hire—or to be more charitable—those who can find "significance" where none really exists. It's called "junk science," and every good scientist knows about it.

We all think everyone will be much better off in the long run if we are better-educated, more conversant with new science discoveries, and better able to incorporate them into our everyday lives. But we also want a discriminating public. We are worried about a lot of pseudo-scientific nonsense that is around to-

day. There's quite enough relevant material to be absorbed without having to filter out the tedious and ultimately immaterial.

One thing we've discovered is there is a lot of good science that is both fascinating and relevant. Also, there is an abundance of information about new discoveries available to reporters and editors. The big problem is, it's scattered and disorganized. Moreover, much of the newest, cutting-edge research is indecipherable. A way needs to be developed to bring it all together in a coherent, timely and dependable fashion.

In the previous chapters we have spoken of the need for scientists to increase their communications skills and activities and for journalists to increase their understanding and training in science. One basic challenge is to link the science community more efficiently to the media—to both writers and gatekeepers.

One major obstacle to comprehensive science reporting is the near impossibility of tracking ongoing developments. Even the best and most diligent science writers have a hard time keeping up with what's new—and maybe more to the point, with what's significant.

A web-based clearinghouse

The science community could do itself a big favor by helping journalists sort through the maze of research projects, papers, presentations, conventions and publications. A framework for this already exists.

Nearly every science discipline has an organization of some kind that publishes its papers and organizes its meetings. Most have web sites. If only one layer could be added to the existing structure—a journalist-friendly component—the job of bridging the gap between science and the public would be greatly simplified and expedited.

Journalists, especially those tracking a wide range of topics, could use better, clearer marked, and more convenient roadmaps. The existing web sites maintained by the individual disciplines are ideally suited to provide them. If these sites could be expanded and written largely in English, then integrated with proper links, an extremely useful network for the rapid dissemination of science information could be created.

For this to work, the science community—each discipline—must create its own public communications arm, responsible not only for the web site but for all initial media communications, including liaison between journalists and the principal investigators. Beyond that, scientists in each discipline should choose spokespeople who can and will speak for the group as a whole.

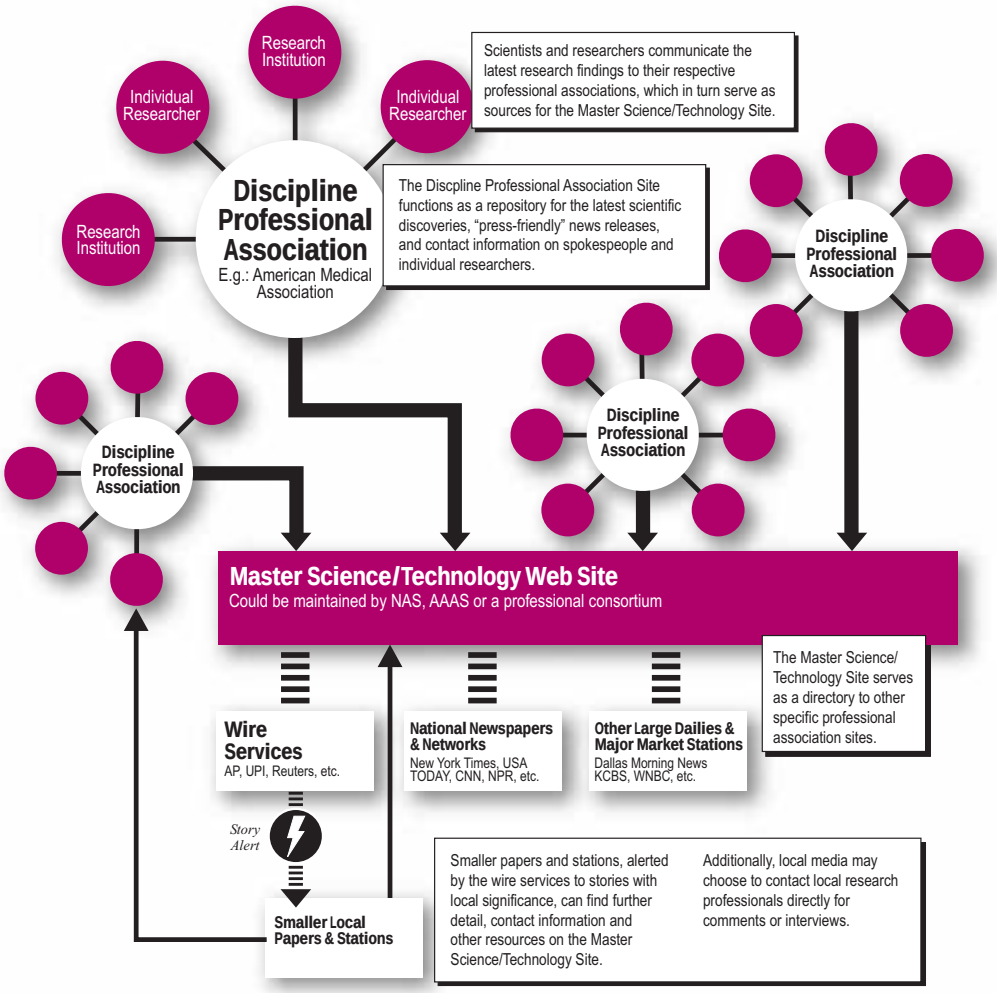
The disciplines should identify the peer-reviewed journals which they use to publish their work with an indication of the relative rank order of use by the members. As part of the publication process, the scientists should furnish additional information regarding the relative importance of the work. This should be plain-English text aimed at journalists and the public. The plain-English discovery/importance statement should be peer reviewed along with the paper.

All of this information, original paper, references and plain-English text should then be placed on the discipline web site immediately.

The overall science web site would be operated by either the American Association for the Advancement of Science, the National Science Foundation, the National Academy of Sciences, the National Academy of Engineering, or perhaps a consortium. This master page should carry a continuously refreshed list of major scientific discoveries from throughout the nation or the world. The umbrella web site should oversee the different discipline web sites to assure uniformity and continuity/linkage.

Any journalist could then access the master science site to initiate, aid or assist the reporting process. This one-stop-shopping approach would provide a regularly updated service that would include full-text articles, plain-English summaries, context, and contacts.

A network-wide system of e-mail notification should be available for any news organization that desires it. By using this model, or



some variant of it, the science community could keep the news media current on developing research it considers important. And the writers and editors could be assured that the product they receive is not junk science, advocacy science or pseudoscience, but the best objective information available.

A key role for the National Academies of Science and Engineering should be the identification and honoring of those scientists and engineers who distinguish themselves as communicators of science and technology to the public.

The consequences of inattention

James Bryant Conant, a renowned chemist, a pioneer researcher whose work led to an understanding of how both chlorophyll and hemoglobin worked, and who was later president of Harvard University, said 50 years ago at the beginning of the explosion of science and technology in America, "There is only one proved method of assisting the advancement of pure science—that of picking men of genius, backing them heavily, and leaving them to direct themselves."

Why Everyone Needs To Understand Science

By Jared Diamond

First, science isn't something arcane, intended only for the few. Every one of us—whether a poet, janitor, or nuclear physicist—has to be able to think scientifically, and to understand some science, to get through our lives. Every day we face decisions that hinge on science, such as whether to smoke, what to eat, with whom to have sex, and what protection to use (if any). Even for decisions that don't depend on specific scientific facts, science remains the proven set of best methods for acquiring accurate information about the world.

Second, some of us end up as policy-makers in government or business. These individuals make decisions that fundamentally affect the well-being of everyone, and most of them know no more about science than does the rest of the general public. Yet they are called upon to decide what to do about (and how much money to spend on) nuclear reactors, global warming, environmental toxins, expensive space programs, biomedical research, and applications of biotechnology. It's nonscientists, not scientists, who have the last word on whether the milk we drink can safely come from cows treated with growth hormones. To make such decisions wisely, the decision makers have to be drawn from a scientifically educated public.

Third, as voters, we all bear the ultimate responsibility for those decisions, because we are the ones who decide which candidates and which ballot measures will prevail. We need enough sense about science to select the decision makers who will make good choices when faced with scientific questions.

Fourth, even if science were irrelevant to the lives of ordinary Americans, a strong scientific enterprise is essential to our economy, educational system, and society. That requires lots of young people to become excited enough by science that they resolve to become professional scientists. Good communication by scientists to the public is essential to spark that excitement.

Finally, scientists themselves should be interested in promoting public understanding of science for a selfish reason: their salaries and research grants depend on the nonscientists who hold the purse strings in Congress, state legislatures, and private foundations. Those money givers reach their decisions based on how important they think science is.

For the most part that is what we have done for a half century. Has that worked? In many cases, certainly. Has every researcher made significant contributions? Certainly not. But the larger, grander effort has contributed to the creation of the wealthiest, most technologically advanced society in the history of the earth. However, many in the science community are now seriously concerned that the nation is turning its back on that, in part through its failure to understand the connections between what happens in their domain and the rest of society.

Dr. Harry Gray is a is an avuncular, slightly overweight, fidgety Caltech chemist on a crusade. His mission has two parts—first to prove that not all chemists are "boring," then to demonstrate that he and his colleagues in all branches of science have something important to say to the larger society. And he is not above a bit of blatant flattery to make his point, which is that it is absolutely essential that the gulf that separates America's premier science establishment from the public that supports it be closed.

During a Caltech symposium in the spring of 1997, Gray poured on the flattery. He said there are many "brilliant" science writers on the scene today, and "this is an enormous opportunity for scientists and great journalists to get together." He is especially worried that the gulf-sized disconnect between science and the taxpayer will halt basic research. Gray believes that science for science's sake, and the nation's, must be properly funded.

"Almost everything that we have come to know as scientific advancement has come about because of real, curiosity-driven research," said Gray, "people just exploring, just following their noses, not trying to *do* something, not trying to *work* a specific problem. That's the part of the funding of our government that worries me the most. Not the overall number, but the number that's allocated to scientists who are just going to follow their nose." And, that kind of research, he confidently predicted, "that's for sure going to lead to the new discoveries."

Gray added that the United States, "has been the only country in the world that has ever really consistently supported curiosity-driven research."

What are the consequences if we don't listen to the likes of Dr. Gray? There is a threefold danger, we think—made up of philosophic, material and spiritual considerations.

First, philosophically (and by this we refer to the political aspects of a democracy), the populus needs as much information as pos-

sible to act wisely and vote intelligently—whether it's about high technology or garbage collection. The world is getting more complex, not less. The future will usher in a whole new set of unknown complications, perplexities and uncertainties.

Life today is markedly different from even 25 years ago when J. Robert Oppenheimer said, "We think that the future will be only more radical and not less, only more strange and not more familiar, and that it will have its own new insights for the inquiring human spirit."[1] It is a media cop-out to say that readers and viewers don't know or don't care about things that might be a little hard to grasp. Like it or not, science and high-technology are part of the fabric of modern life, and will become more so along a predictable curve.

"Keeping our laypersons ignorant of scientific concepts and of the nature and implications of technology transformations will result in a dysfunctional society," says Dr. Manuel Gómez, director of the Resource Center for Science and Engineering in Puerto Rico. "We can ill afford to sustain this state of affairs [the fissure between scientists and the public], especially in view of the fact that science, both in its intellectual as well as technological implications, has become a dominant element of modern cultures."[2]

We think such knowledge is not the sole domain of an elite or that it should be withheld solely because it is sometimes arduous. Nearly 200 years ago, Thomas Jefferson said, "I know of no safe depository of the ultimate powers of the society but the people themselves; and if we think them not enlightened enough to exercise their control with a wholesome discretion, the remedy is not to take it from them, but to inform their discretion."

Losing America's future

Second, if not informed, the nation stands to lose its material preeminence created in large part by the great scientific and technological achievements of the past.

"International, global competition is driven by science," says Dan Goldin. "Today one in 20 people earn their living in information intensive technologies and it's projected in two generations, one in two Americans will. So we're about to lose a whole class."

"It's nice that we're transitioning out of the Cold War," Goldin says, but we now find ourselves in a Catch-22—Americans are isolated from science, yet it's so important to their lives. Most people "don't understand about long-term investment in America's future. And this is why I speak with such a passion."

Daniel S. Greenberg, editor and publisher of *Science & Government Report*, a Washington newsletter, and a frequent contributor to the op-ed pages of *The Washington Post*, says "The risk now is that in the headlong political stampede to balance the federal budget, a great wealth-producing national resource will be allowed to wilt just to save a few bucks."[3]

It's also more than just the economic future. It's where we live now. According to NSF head Dr. Neal Lane, "We have long since passed the point where we could say—if we could ever actually agree to such a thing—all right, let's go back to the farm and live at a peaceful, pastoral level. You can only sustain something like a half a billion people on the planet with that sort of technology. And the only way to do that would be to go to the other 5.5 billion on the planet and tell them, 'I'm sorry, you're just awfully inconvenient. You're just going to have to go away right now.'"[4]

Third, there is an undeniably inspirational, almost spiritual aspect to the ongoing march of science and technology.

"If you go back in America 50, 60 years ago, before the Cold War," says Goldin, "Americans were much closer to science, because they were much closer to the land, because many of them lived in areas where you had no background light and you could see the heavens—where many people grew food, where most of the young men, not the young women, unfortunately, but most of the young men, understood how to take cars apart [and] put them together. … Science and technology were basic

elements in their life, and they weren't isolated from nature."

Isolated though we may now be, science and technology are still viewed almost as unstoppable forces, forces with the power to make over entire societies, "just about the only aspect of contemporary life in which the notion of old-fashioned, earthshaking progress still thrives," says Edward Rothstein.[5]

Must every person become an expert in science to partake of this wonderment? No, far from it. Scientists themselves can barely keep up with developments in their own fields. Frank Close, vice president of the British Association for the Advancement of Science, takes issue with the notion that the average citizen even needs to "understand" science.

"Understanding is like a game of Dungeons and Dragons," he said, "where there are many doors and windows opening onto greater vistas, deeper levels of truth. Pass through to the next level and you discover that there are still deeper levels to which you may progress."

Close, a Fellow in Public Understanding at the British Institute of Physics, says, "Rather than understanding, it is public 'awareness' of science that we are dealing with."

Awareness is a much simpler concept than understanding.

"Show the unaware that behind the high wall there is a beautiful garden that can be entered through a gate with a guide. Once inside, and with the right map, they can then begin the journey on the eightfold way to enlightenment along with the rest of us. But do not attempt to claim that one will find understanding. Understanding is where the rainbow ends, where parallel lines meet, always in sight but receding as fast as you travel towards it."[6]

The human cost

In a period of retrenchment, budget cutbacks, and tax reductions, what is the real cost of maintaining the U.S. lead in basic research? "Actually, if you talk about the amount of funds that are devoted in the United States from the federal budget to frontier research," says Dr. Lane, "the total amount of money we're talking about is actually really quite tiny. It's only something like $10 billion out of a current federal budget of $1.6 trillion. That's way less than one percent."[7]

There was an especially poignant reminder in the spring of 1997 of what tiny, flat or declining expenditures for R&D mean in human loss. It first came to our attention in an article expertly written by Bruce Finley of *The Denver Post*. It was about astronomer Alan Hale, co-discoverer of the Hale-Bopp comet.

"Monday night," Finley wrote, "he presented a third slide show to a sellout crowd at the Denver Museum of Natural History, where he signed autographs for awestruck young boys with telescopes who want to be astronomers, too.

"What most fans don't know is that Hale's friendly, unassuming smile masks major frustration and sadness about a career that has never paid the bills."

Hale told the reporter, "I'm a scientist who, like a lot of scientists, couldn't get a job in my field."[8]

Hale, 39, graduated from the U.S. Naval Academy with a degree in physics, and earned a Ph.D. in astronomy from New Mexico State in 1992. Since then, he has not been able to find a good-paying job. In early April he went public with his lament. He posted an electronic letter on the Internet.

"Due to my current 15 minutes of fame resulting from the discovery of Comet Hale-Bopp," he wrote, "I believe I have an opportunity to raise some awareness of this issue, and possibly to get things turned around a little bit."

Hale said he "was inspired by the scientific discoveries and events taking place during my childhood to pursue a career in science, only to find, after completing the rigors of undergraduate and graduate school, that the opportunities are limited at best and are what I usually describe as abysmal."

Hale blamed the situation on "scientific illiteracy" in our society and said that "unless there are some pretty drastic changes in the

way our society approaches science and treats those of us who have devoted our lives to making some of our own contributions, there is no way that I can, with a clear conscience, encourage present-day students to pursue a career in science."

Hale might also have been inspired by the news only a week earlier that 39 cult members had committed suicide in Rancho Santa Fe, Calif., thinking they were going to meet an alien spaceship that was tagging along behind the comet. Hale had publicly scoffed at such a notion weeks earlier. As a result, he told *The New York Times* that he had received hundreds of "vicious hate letters."[9] Needless to say, the comet came and went, but no alien ship appeared.

We think Hale is right about the scientific illiteracy of the American public, but there is a paradox. While many wanted to believe in the alien ship, Hale was lecturing to sellout crowds and signing autographs for people who were much more fascinated by the real thing—real science. And, again, it raises the question of the media's role.

Three months after the suicides, and after a lot of handwringing about where the cultists got such a dismaying idea, reporters and camera crews were in Roswell, N.M, chronicling the gathering of UFO devotees. Some of the reporting, without a shred of evidence, lent credence to people who, also without a drop of extraterrestrial protoplasm in hand, believe the earth has been, or is being, visited by or maybe is even under the control of aliens from another galaxy. Mercifully, real science came along just in time—the Mars Pathfinder landing on Independence Day—and drove editors back to their senses and the alien hunters off the screen.

Little love for the media

"How many polls does it take to get the message across?" asked syndicated columnist Deborah Mathis in the spring of 1997. "Americans don't like the news media. They don't trust us. They think we are sensationalist, politically and socially biased, self-serving, elitist, swift of feet but slow of brain. And, at least for the TV folks, obscenely overpaid …" A little hyperbolic, perhaps. But perceptions count in the perception business, and it ought to be enough, as Mathis wrote, "to give our business the shakes."[10]

The idea of examining the way the media covers science and technology originated with the idea that public support for research would dwindle because of media inattention. As our study progressed, however, we became just as concerned about the media itself—why public support and confidence in journalism was dwindling. And it was hard to escape the conclusion that the trend toward tabloidization, trivialization, sensationalism and dumbing-down was not only producing a less-informed populace but driving away readers and viewers.

It's more than just science news. Mathematician John Allen Paulos notes that more than 50,000 books are published every year, yet precious few of them are ever mentioned in the nation's newspapers.

"Every baseball, basketball, and football game, whether at the professional, college, or high school level, is lavishly reported with statistics of every imaginable sort. Every gritty detail of murders, drug deals, and other abuses makes the paper. Every TV program on every cable channel has a brief synopsis in a weekly or monthly guide. Every minuscule variation in the stock price of hundreds of penny-ante companies is right there in the papers every day. I can't believe the readership for a daily stream of nationally syndicated, very brief reviews of new books would attract fewer readers than these features do. Besides, newspapers have a vested interest in a more literate reading public," Paulos wrote.[11]

As for television news, Ellen Hume believes the trite and the trivial will ultimately fail. "[Q]uality news cannot be designed to win the channel-surfing contest. It must expect instead to be selected, as a special niche that loyal viewers visit for good reason. Some channels

choose all-news formats so that they become the logical place to go for news. As the surf gets crowded, consumers will want to know where they can go for real news. They won't want to waste time getting there."[12]

Physicist Leon Lederman, who is tireless in his campaign to expand and improve science reporting, believes firmly that public scientific illiteracy is part of a cycle—a news establishment that believes the public is disinterested, a public that is unaccustomed to critical thinking, both perpetuated by an educational system that treats science as something apart from the fabric of life.

In one of our roundtables, he said: "In a history class, you learn about the history of England, and you learn about all the kings and what they did to their wives and all that stuff, and you never learn about [Michael] Faraday. Faraday did more to change the lives of people on this planet than all the kings of England rolled up into one—and throw in Genghis Khan and Napoleon.

"He discovered electricity, but you don't learn that in a history class. I think until we can change our education and break the barriers between the two cultures and get science in history and history in science, and merge them in some way, we're not going to get the gatekeepers to be interested. [They'll] say, 'This isn't news.' I mean, suppose there is a news bulletin: 'Napoleon Escapes From Elba,' (I don't know if these times are right), or 'Faraday Discovers Electricity.' Which one makes the six-o'clock news? You know, it'll be Napoleon every time." [13]

NASA Administrator Goldin told the same roundtable audience that education reform was paramount. He described changes he's making in the space agency. "First, we said, we're no longer going to have public relations, we're going to have public education. That's a very significant change, because it is not the job of a government agency to try and tell the public why what we're doing is good so they should fund us. That's almost like a self-licking ice-cream cone. What we need to do is say that the American public basically is smart and understands, and we'll provide materials to them"

We think Dr. Gray, the Caltech chemist, is a model for the whole science community.

"It's true that support is going down," he told the Caltech media/science symposium, "but you cannot stop the tremendous excitement of discovery that scientists all feel, all of us—chemists, physicists, biologists, astronomers—you can't stop us. You can't beat us down, there's no way.

"And so we're going to keep going. We're going to keep inventing things—more and more that are going to improve the quality of life. And what we want is some kind of interaction through modern technology with the brilliant people in science journalism so that we can get these stories out right, [so] that we can help write these stories, [so] that we're part of these stories, not just detached. We have enormous opportunities and we're looking forward to working with great journalists in the next century."

An educated public, well-schooled in science, Carl Sagan maintained, "is an absolutely essential tool for any society with a hope of surviving well into the next century with its fundamental values intact—not just science as engaged in by its practitioners, but science understood and embraced by the entire human community. And if the scientists will not bring this about, who will?"[14]

Goldin says he has told NASA scientists that the American public is paying for what they do and they "have a contract" to take the time and to speak clearly. Science Foundation head Neal Lane said other institutions and universities must be supportive of scientists going public.

"There's a certain reward system that will need to respond, will need to change in order to make this happen," he said. "It doesn't mean every single scientist has to do this, but as many as possible should, and if you can't, please support the person who can."

It is our feeling that the message has gone out to the science community, and that it has been sensibly received. The old adage in the academic world—"publish or perish"—might

soon be replaced with a new one: "Explain or expire." We urge the news media to reach across the gulf in a similar effort.

Much earlier, we made the point that journalists, like scientists, consider the whole universe their "beat." Yet at the same time, it seems to us that that view is narrowing in many quarters, that the once expansive and all-inclusive dogma of what is "news" is contracting—that sensation is replacing substance and entertainment is crowding out enlightenment. It is the primary mission of daily newspapers, local television and radio news to keep their audiences informed about things that directly and immediately sway their lives. But we have come to believe that that shouldn't mean the news media should ignore less-direct and longer-term issues.

"We cannot cheat on DNA. We cannot get around photosynthesis," wrote Barbara Ward nearly a quarter century ago in her book *Only One Earth*. "We cannot say," she said, "I am not going to give a damn about phytoplankton. All these tiny mechanisms provide the preconditions of our planetary life. To say we do not care is to say in the most literal sense that 'we choose death.'"[15]

Hubert Humphrey said it about as well 30 years ago: "As we begin to comprehend that the earth itself is a kind of manned spaceship hurtling through the infinity of space—it will seem increasingly absurd that we have not better organized the life of the human family."

Bottom line: What would we really like to see? We would recommend a rational, reasonable, and balanced enlightenment of the people about matters of seemingly unequal weight—phytoplankton and city hall, DNA and dogcatchers. Do they mesh? Why not? We think that under enlightened and aggressive leadership, which the gatekeepers should provide, they can. They must.

Earlier in this century, G.K. Chesterton, the English essayist, biographer and poet, grumbled about people who could not muster the courage to do what they knew was right and proper. "I do not believe in a fate that falls on men however they act; but I do believe in a fate that falls on them unless they act," he wrote.

We would add that professionals, whether scientists or journalists, who fail to deliver and interpret the news of their age, fail as well. And their fate is ultimately ours.

chapter endnotes

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12 Ellen Hume, *Tabloids, Talk Radio and the Future of News: Technology's Impact on Journalism* (Washington, D.C.: The Annenberg Washington Program in Communications Policy Studies of Northwestern University, 1995).
13 Dr. Lederman, speaking extemporaneously at a Freedom Forum Roundtable, was only off slightly. Napoleon escaped from Elba in 1815. Michael Faraday demonstrated the first crude electric motor in 1821.
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Survey Data

First, we want to know what you think about some important national institutions and how you feel about relations between scientists and the news media. Because your responses will be kept confidential, please be as open as possible. There are no right or wrong answers; we are just interested in your opinions.

First, we are going to consider some major institutions in this country. As far as the people running these institutions are concerned, would you say you have a great deal of confidence, only some confidence, or hardly any confidence at all in them?

How much confidence do you have in ...	Group	Hardly any	Only some	A great deal
Major companies	Journalists	10	75	15
	Scientists	19	67	14
Organized religion	Journalists	12	66	22
	Scientists	38	49	14
Education	Journalists	13	66	21
	Scientists	8	51	42
The executive branch of the federal government	Journalists	24	70	6
	Scientists	19	68	13
Organized labor	Journalists	50	47	2
	Scientists	45	51	4
Press	Journalists	4	61	35
	Scientists	22	67	11
Television	Journalists	27	61	13
	Scientists	48	50	2
Medicine	Journalists	3	47	50
	Scientists	3	43	54
United States Supreme Court	Journalists	2	50	48
	Scientists	5	40	55
Scientific community	Journalists	2	47	51
	Scientists	1	25	75
Congress	Journalists	38	59	2
	Scientists	32	64	4
Military	Journalists	20	60	20
	Scientists	24	59	17

Next, we want to know how you rate **overall coverage** by the different news media. We are interested in your **general impressions**, not detailed judgments. Think of the media—the newspapers, television channels, news magazines and radio stations—that you turn to most often for news. Tell us whether you think their coverage is excellent, good, fair or poor.

How do you rate...	Group	Poo	Fai	Goo	Excelle
The national television news program or channel you watch most often (ABC, CBS, CNN, NBC, MSNBC, Fox, etc.)	Journalists	3	26	55	16
	Scientists	12	38	41	10
The national newspaper you read most often (New York Times, USA TODAY, Christian Science Monitor, Wall Street Journal, Washington Post, etc.)	Journalists	1	7	54	38
	Scientists	3	16	49	33
The national radio news broadcast you listen to most often (NBC, CBS, CNN, Mutual, etc.)	Journalists	1	20	51	27
	Scientists	6	23	41	30
The news magazine you read most often	Journalists	3	20	58	19
	Scientists	6	33	45	16
The local television news program you watch most often	Journalists	28	32	28	12
	Scientists	28	42	25	5
The local radio station you listen to for news most often	Journalists	31	31	26	11
	Scientists	17	37	32	14
The local newspaper you read most often	Journalists	8	23	48	22
	Scientists	21	39	33	7

How do you rate the **general coverage** of **science and technology** in these same news media?

How do you rate...	Group	Poor	Fair	Good	Excellent
The national television news program or channel you watch most often	Journalists	10	40	43	7
	Scientists	30	46	21	3
The national newspaper you read most often	Journalists	4	26	48	22
	Scientists	15	33	33	19
The national radio news broadcast you listen to most often	Journalists	15	35	36	14
	Scientists	14	39	34	14
The news magazine you read most often	Journalists	4	28	53	14
	Scientists	18	43	33	7
The local television news program you watch most often	Journalists	49	32	15	4
	Scientists	51	37	11	1
The local radio station you listen to for news most often	Journalists	59	24	14	3
	Scientists	41	37	17	5
The local newspaper you read most often	Journalists	17	43	33	6
	Scientists	37	40	19	4

Scientists, engineers and others engaged in technology and science sometimes disagree with the news media and vice versa. Here are a number of things each group might think about the other. Please tell us whether you strongly agree, agree somewhat, neither agree nor disagree, disagree somewhat or disagree strongly.

Do you...	Group	Strongly agree	Agree somewhat	Neither agree nor disagree	Disagree somewhat	Disagree strongly
The news media are more interested in negative stories about the failures of science and technology than in telling positive stories about scientific and technological advances.	Journalists	2	11	8	30	49
	Scientists	11	25	26	28	10
Scientists waste taxpayer money on unnecessary research.	Journalists	2	21	18	35	23
	Scientists	2	10	8	27	53
The top managers of the news media are more interested in selling newspapers or increasing viewership than in telling the public what it needs to know.	Journalists	10	27	7	29	27
	Scientists	49	39	7	4	0
The news media are just as necessary to maintaining the technological superiority of the United States as scientists.	Journalists	14	31	26	18	11
	Scientists	8	24	18	26	24
The news media underestimate the public by assuming that the public wants stories about scandals instead of stories about major challenges confronting science and technology.	Journalists	9	31	8	33	19
	Scientists	26	45	14	12	2
Most members of the public are so ill-informed that their opinions about science and technology don't mean anything anyway.	Journalists	3	19	17	36	25
	Scientists	11	39	16	25	9
The news media are honest when dealing with issues about science and technology.	Journalists	27	49	17	7	1
	Scientists	4	37	31	24	4
Scientists are often afraid that news stories about their work will embarrass them before their peers.	Journalists	12	42	36	7	4
	Scientists	7	34	24	23	12
Scientists often do not speak out and refute news coverage that is biased or inaccurate	Journalists	11	40	30	16	4
	Scientists	23	51	11	12	3

Do you...	Group	Strongly agree	Agree somewhat	Neither agree nor disagree	Disagree somewhat	Disagree strongly
When a story about science or technology emerges, the public wants only news that is positive, not negative reports about science and technology.	Journalists	1	6	14	48	31
	Scientists	3	17	31	41	9
Few members of the news media understand the nature of science and technology, such as the tentativeness of most scientific discovery and the complexities of results.	Journalists	23	54	5	15	4
	Scientists	52	39	5	5	0
Most scientists are so intellectual and immersed in their own jargon that they can't communicate with journalists or the public.	Journalists	13	49	12	20	6
	Scientists	9	41	11	27	12
Most members of the public do not really care about science and technology.	Journalists	1	15	9	48	28
	Scientists	6	22	14	39	19
There is a professional code among the news media that ensures high standards in journalism.	Journalists	13	40	14	22	11
	Scientists	1	20	26	31	22
Strong competition among the news media improves their performance in covering science and technology issues.	Journalists	9	34	20	30	7
	Scientists	3	14	24	39	20
Members of the news media rarely get the technical details about science and technology correct.	Journalists	2	18	19	46	16
	Scientists	15	41	21	22	2
Most science reporting is biased against scientists, engineers and other members of the profession.	Journalists	0	2	9	29	60
	Scientists	1	8	27	47	17

Which of the following best describes your attitude toward independent journalistic verification of scientific stories:

1 **Journalists should usually attempt to independently verify scientific stories because the news media must make judgments about the truth of the news.**

2 **Journalists should rarely attempt to independently verify scientific stories because they often lack adequate knowledge and are likely to make mistakes.**

	Should verify	Should not verify
Media	81	20
Science	79	21

Again, please tell us whether you strongly agree, agree somewhat, neither agree nor disagree, disagree somewhat or disagree strongly.

Do you...	Group	Strongly agree	Agree somewhat	Neither agree nor disagree	Disagree somewhat	Disagree strongly
Most members of the news media have no appreciation of the need for funding for basic scientific research and development.	Journalists	3	25	19	35	18
	Scientists	17	37	21	24	2
Science reporting centers too much on personalities and not enough on the actual findings.	Journalists	1	12	18	53	17
	Scientists	10	39	23	24	4
Most members of the public do not understand the importance of government funding for research in science and technology.	Journalists	10	50	15	22	3
	Scientists	40	40	9	10	1
Most members of the news media are more interested in sensationalism than in scientific truth.	Journalists	5	17	9	35	34
	Scientists	30	46	12	12	1

Do you...	Group	Strongly agree	Agree somewhat	Neither agree nor disagree	Disagree somewhat	Disagree strongly
Members of the news media who cover science and technology concentrate too much on trendy discoveries rather than on the basic research and development.	Journalists	13	54	14	15	4
	Scientists	31	48	13	6	1
Most reporters who cover science are not well enough educated to cover news about scientific and technological affairs.	Journalists	7	33	18	35	8
	Scientists	16	42	24	17	2
Most scientists who allow themselves to be interviewed for stories are just seeking publicity.	Journalists	1	4	14	48	33
	Scientists	2	11	20	44	23
The relationship between scientists and reporters has gotten steadily worse over the last five years.	Journalists	1	6	60	22	11
	Scientists	2	8	62	21	7
Most journalists covering science introduce their own selective perspective rather than reporting objectively.	Journalists	1	12	15	47	24
	Scientists	6	38	31	22	2
Most science reporters give a positive view of scientists, engineers and those in related professions.	Journalists	7	51	35	6	1
	Scientists	9	60	25	5	1
The biggest problem with science reporting is that it only tells a small part of the whole story.	Journalists	16	47	24	12	1
	Scientists	33	42	15	9	2
Most journalists only want to report the positive results in stories about science and technology.	Journalists	2	9	17	55	17
	Scientists	5	26	36	31	3
The news media are unwilling to pay enough to hire good reporters to cover science and technology.	Journalists	21	36	16	19	8
	Scientists	8	23	58	10	1
Most members of the public have no appreciation of the need to fund basic scientific research and development.	Journalists	9	46	18	24	3
	Scientists	34	41	8	16	2
Reporters who cover science and technology should be more aggressive.	Journalists	13	46	34	6	1
	Scientists	5	19	54	19	3
Members of the news media face a hopeless task in explaining the complexities of science.	Journalists	2	17	10	43	28
	Scientists	3	16	9	42	30
Members of the news media try to verify scientific results unnecessarily.	Journalists	1	3	24	47	26
	Scientists	1	3	29	45	22
The news media have overblown the risks of consuming many substances or partaking in many activities, unduly alarming the public.	Journalists	9	36	12	28	15
	Scientists	20	41	19	15	5
The American public is gullible about much science news, easily believing in miracle cures or solutions to difficult problems.	Journalists	14	54	12	16	5
	Scientists	32	50	9	7	1

Do you...	Group	Strongly agree	Agree somewhat	Neither agree nor disagree	Disagree somewhat	Disagree strongly
One reason the news media do not cover science more often is because they are afraid to offend religious readers or viewers.	Journalists	1	2	5	23	69
	Scientists	3	15	33	32	17
Most members of the news media never allow their scientific sources to read stories before publication or broadcast.	Journalists	42	30	19	7	1
	Scientists	17	27	43	12	2
Most scientists could care less if the public knows about their work.	Journalists	2	11	23	43	21
	Scientists	3	16	9	40	32
Most members of the news media have no understanding of the processes of scientific investigation.	Journalists	6	40	12	34	8
	Scientists	18	51	13	17	1
Scientists prefer to avoid members of the news media because they are suspicious of their motives.	Journalists	9	47	32	10	2
	Scientists	7	36	29	23	6
Scientists are honest when dealing with the news media.	Journalists	7	35	44	13	1
	Scientists	20	47	24	9	1
Most members of the news media do not understand probability and statistics well enough to explain the results of scientific research.	Journalists	14	49	13	22	3
	Scientists	35	47	11	6	0
Most members of the news media make major mistakes when they attempt to independently verify science stories.	Journalists	2	10	43	33	12
	Scientists	8	22	51	18	2
Most members of the news media do not understand the connection between scientific research and development and the economy.	Journalists	4	26	22	38	11
	Scientists	13	38	24	24	1
The news media do not cover science better because they are interested in instant answers and short-term results.	Journalists	7	45	12	24	12
	Scientists	26	49	15	9	1
Most scientists are insulted when members of the news media attempt to verify their results unnecessarily.	Journalists	7	28	53	10	3
	Scientists	4	14	42	30	10
The American public is cynical about the benefits of science and technology.	Journalists	2	21	22	45	11
	Scientists	7	32	18	31	12
Most reporters have no idea how to interpret scientific results.	Journalists	9	39	18	28	7
	Scientists	23	43	17	17	1
Scientific research often produces contradictory findings, thus confusing the public.	Journalists	23	56	13	6	1
	Scientists	25	53	12	8	2

How interested do you think the average news consumer is in science and technology?

	Very interested	Somewhat interested	Rarely interested	Never interested
Journalists	17	77	7	0
Scientists	11	72	17	0

We are faced with many problems in this country, none of which can be solved easily or inexpensively. We are going to list some of these problems, and for each one I'd like you to tell me whether you think we're spending too much money on it, too little money, or about the right amount.

Are we spending . . . on:	Group	Too little	About right	Too much
Improving and protecting the environment	Journalists	56	37	7
	Scientists	57	36	7
Improving and protecting the nation's health	Journalists	62	34	4
	Scientists	45	47	7
Solving the problems of the big cities	Journalists	56	33	11
	Scientists	60	33	7
Space exploration program	Journalists	30	52	19
	Scientists	23	53	24
Halting the rising crime rate	Journalists	40	49	11
	Scientists	38	51	11
Improving the nation's education system	Journalists	73	21	6
	Scientists	75	22	3
Basic scientific research and development	Journalists	51	47	2
	Scientists	72	26	1
The military, armaments and defense	Journalists	6	43	51
	Scientists	4	36	60
Welfare	Journalists	12	43	45
	Scientists	14	51	35

If America's leaders and people do not understand science, who is most to blame?

	Scientists	The news media	The public
Journalists	39	16	46
Scientists	43	18	39

About what percentage of journalists are knowledgeable about the procedures of scientific method, in your opinion? (Scientific method includes definition of hypotheses, empirical testing, objective analysis, peer review, and incremental learning and theory development.)

Media	Mean = 23
Scientists	Mean = 16

About what percent of the total federal budget is devoted to scientific research and technology development?

	Less than 1%	1% to 10%	11% to 20%	> 20%
Journalists	42	50	7	1
Scientists	30	65	5	0

How often are you allowed [or do you allow sources] to read the stories you[they] have been interviewed for before publication?

	Always	Sometimes	Rarely	Never
Journalists	1	16	32	50
Scientists	4	26	28	42

What priority do you think news organizations should assign to the following subjects as news stories?

What priority . . .	Group	None	Low	Moderate	High
Medical research	Journalists	0	5	39	57
	Scientists	0	1	32	68
The environment	Journalists	0	7	42	51
	Scientists	1	3	37	59
Astrology	Journalists	68	29	3	0
	Scientists	83	12	4	0
Space exploration	Journalists	2	23	57	18
	Scientists	1	9	59	31
Genetics	Journalists	2	22	50	25
	Scientists	1	6	52	42
Creationism	Journalists	45	44	11	1
	Scientists	69	25	4	2
Extrasensory perception	Journalists	47	45	7	1
	Scientists	57	35	7	1
Geology	Journalists	7	49	39	5
	Scientists	1	18	62	19
Evolution	Journalists	22	50	26	3
	Scientists	3	23	52	22
UFOs	Journalists	38	51	10	1
	Scientists	59	35	5	1
Military research	Journalists	5	35	51	9
	Scientists	5	32	53	11
Astronomy	Journalists	6	30	54	10
	Scientists	1	8	57	34

What kind of community are you now working in?

	Rural town	Small Town	Suburb	Med. City	Large City	Metro
Journalists	0	14	4	41	11	29
Scientists	1	18	7	19	13	42

What is the last grade in school you completed?

	High school grad	Trade school	Some college	College grad.	Some grad study	Master's	Doctorate
Journalists	1	0	7	61	13	17	2
Scientists	0	0	0	2	2	9	87

Which of the following age groups describes your age as of your last birthday?

	18-24	25-29	30-34	35-39	40-49	50-64	65+
Journalists	1	5	8	17	46	22	1
Scientists	0	3	8	12	23	36	18

Are you of Hispanic or Latino origin or descent?

	Yes, of Hispanic origin	No, not of Hispanic origin
Journalists	2	98
Scientists	2	98

Do you consider yourself white, black, Asian or some other race?

	White	Black	Asian	American native	Other or Mixed
Journalists	96	2	1	1	0
Scientists	92	1	6	0	1

What is your gender?

	Male	Female
Journalists	77	23
Scientists	90	10

Special Questions for Scientists

How willing would you be to take a course that would help you communicate better with journalists and the public?

Very willing	**31**
Somewhat willing	**50**
Not at all willing	**20**

How willing would you be to have a continuing series of visits and conversations with a member of the news media?

Very willing	**45**
Somewhat willing	**44**
Not at all willing	**12**

How often have you been interviewed or written about in a science news story?

More than once a month	**1**
About once a month	**3**
Several times a year	**12**
Once a year	**14**
Every few years	**45**
Never	**26**

When you have been the source or subject of a news story, in general how satisfied have you been with the coverage?

Very satisfied	**9**
Somewhat satisfied	**40**
Neither satisfied/dissatisfied	**10**
Somewhat dissatisfied	**14**
Very dissatisfied	**3**
Not applicable	**24**

How would you rate the general knowledge of the journalists that covered the story or stories you have been involved in?

Very knowledgeable	**4**
Somewhat knowledgeable	**43**
Not very knowledgeable	**29**
Not at all knowledgeable	**10**
Not applicable	**13**

When you have been interviewed for news stories, were you likely to profit financially because of the coverage?

Always	**1**
Sometimes	**2**
Rarely	**6**
Never	**91**

Which broad area of science best describes the area you work in?

Physical sciences	**59**
Biological sciences	**32**
Chemical sciences	**3**
Human and social sciences	**2**
Other	**3**

Which best describes your area of work and research?

Pure or basic science	**55**
Applied science	**45**

Special Questions for Journalists

Now, we want to know to what degree you believe scientists have established the evidence for certain findings that have been in the news. In your opinion, has science amassed solid and convincing evidence for the following issues?

Has science established that . . .	Yes	No	Don't know / no opinion
Cigarettes cause cancer?	97	2	1
Lead causes mental impairment?	85	4	10
Cholesterol causes heart attacks?	78	14	7
Radon causes cancer?	36	38	26
Coffee causes pancreatic cancer?	3	57	40
Cold fusion is possible?	13	44	43
Saccharin causes bladder cancer in humans?	11	47	43
Silicone breast implants cause connective-tissue disease?	34	36	30
Silicone penile implants cause connective-tissue disease?	7	41	52
Asbestos causes cancer?	82	8	10
Margarine is more dangerous than butter?	7	58	35

How often do you attempt to independently verify the truth of science stories before they are printed or broadcast?

Always	**21**
Sometimes	**40**
Rarely	**32**
Never	**7**

How accessible do you generally find scientists, engineers and members of allied professions?

Very	**15**
Somewhat	**78**
Not at all	**7**

Which category best describes your job?

Newspaper journalism	**48**
Television journalism	**36**
Radio journalism	**15**
Magazine journalism	**0**
Free-lance writing	**0**
Free-lance television/radio	**0**
Other	**1**

How many full-time journalists does your organization have covering science and technology news?

Average = 1.6

Which of the following best classifies your current position?

Operations or financial executive	**6**
Editorial executive	**77**
Reporter or correspondent	**18**

How many total years have you worked in news?

Average = 20.3 years.

Have you ever reported on or been responsible for news coverage of science or technology?

YES	**50**
NO	**50**

If "**Yes**," for how many years

Average = 8.1

How often do you use the following sources of scientific information?

How often. . .	Often	Sometimes	Seldom	Never
Scientific American	6	27	28	38
Discovery	7	28	30	35
Nature	7	25	31	37
Science	8	25	26	41
Popular Science	2	20	31	48
National Geographic	10	33	29	27
JAMA	33	28	14	24
Lancet	9	19	22	50
New England Journal of Medicine	36	33	13	18
Other	27	16	11	47

If college graduate or higher, did you major in science for one or more of your degrees?

Yes	**62**
No	**94**

If "**Yes,**" what general field of science is that degree in?

Biology	**23**
Chemistry	**17**
Physics	**13**
Space & Earth Science	**2**
Other	**45**

METHODOLOGY

An initial mailing of questionnaires was sent to 2,328 journalists drawn from editors, managing editors, and science correspondents or editors identified in the *Editor & Publisher* yearbook as working at newspapers with circulations greater than 50,000. All 1,292 active members of the Radio-Television News Directors Association were also surveyed. Among journalists, 762 responded, a rate of 33%.

For scientists, 2,002 names were drawn randomly from the list of medical researchers of the American Medical Association and the membership lists of the American Geophysical Union, the American Physical Society, the Federation of American Societies of Experimental Biology and the American Astronomical Society. That meant approximately 400 names were compiled from each list. Of these scientists, 670 produced usable questionnaires, a rate of 34%. Forty-two scientists and 22 journalists chose to respond through a special World Wide Web site instead of by mail.

All respondents were sent an initial questionnaire printed in booklet form with a stamped return envelope. A follow-up postcard was mailed a week later. Non-respondents also received another questionnaire a month later.

No attempt should be made to generalize to all journalists or all scientists from these data because of the selective nature of the mailing lists and the selective response. The data do, however, represent a broad and impressive array of opinions from highly trained, highly active and important individuals. The survey results should thus be given the full force of the more than 1,400 opinions represented.

Because this study consisted of combined groups of censuses and samples rather than a single random sample, calculation of margins of error is not appropriate.

Sputnik: 40 Years Later

Science, the News Media and the Future

The following transcription is from a panel discussion on the topic of the relationship between science and the news media, held at The Freedom Forum World Center in Arlington, Va., on Oct. 3, 1997. This session, which was broadcast over C-SPAN, was part of a two-day event held in conjunction with the 40th anniversary of the launch of the Sputnik satellite.

ALAN McGOWAN Good morning, ladies and gentlemen.

Welcome. My name is Alan McGowan, and I'm the director of public understanding of science programs at the American Association for the Advance in Science, one of the organizations which is co-sponsoring this conference.

McGowan

There are too many people to thank to do it in public, particularly on air, but just let me say that the staffs of the First Amendment Center and the Academy of … National Academy of Sciences and the Freedom Forum World Center here have been magnificent in helping us pull this together.

We're addressing a topic which is both new and old. It has been with us even before Sputnik was launched. …

You know, whenever you have the decimal anniversary, one is supposed to celebrate it. We are celebrating and investigating what has happened since the launch of Sputnik 40 years ago, and what we're going to find—and you'll hear some interesting presentations—is some things have changed and some things have not changed.

We are faced with some of the same problems with lots of different attributes to those problems, lots of different aspects of those problems. We have a whole electronic revolution that has taken place since the launching of Sputnik, which either makes it harder or easier to do science reporting and talk about science to the public, depending upon your point of view.

But it's a pleasure to welcome you here and to thank the co-sponsoring organizations for helping us at the A.A.A.S. carry out our mission—or one of our missions—which is to develop programs to inform the public about the scientific enterprise, to celebrate the scientific enterprise—not uncritically, because we do have to look at aspects of the scientific enterprise that are having an impact on society.

I think most of the impact on society is positive, but there have been some negative impacts, which we have to recognize. But in any event we need in the next 40 years a better-informed public on science, a more attentive public to scientific developments. As you'll hear later on in the morning, there are going to be many developments which affect a great many people that have already started and will continue.

So thanks, and on behalf of Rich Nicholson, executive officer of the A.A.A.S., who could not be here, and Shirley Malcolm, head of the Education and Human Resource Directorate, who will be here tomorrow, I welcome you and thank you for coming. And it's a pleasure now to turn the podium over to Bill Colglazier, who is the executive officer of the National Academy of Sciences and the National Research Council.

BILL COLGLAZIER Let me also welcome you on behalf of the Academy Complex, which includes the National Academy of Sciences, the Institute of Medicine, the National Academy of Engineering and the National Research Council.

We're pleased to be joining The Freedom Forum, the First Amendment Center and the American Association for the Advancement of Science in sponsoring this anniversary celebration.

I think it's fitting that, in this anniversary of 40 years after Sputnik, we highlight the issue of science in the media. The Academy Complex has put this as one of our top-priority issues. We have a great deal of respect and admiration for science journalists. We feel that the media is the main communication channel between the scientific community and the American public.

The American public now, we think, has an appetite for even greater amounts of science journalism, and we feel the science media is the community that can do that well.

… Thinking back on the anniversary of Sputnik: I was about 12 years old at the time, and in my generation there were three events, most of them tragedies, which you sort of remember exactly where you were when they happened. Of course, the assassination of President Kennedy, the Challenger accident. The same is also true in the 1950s with the launching of Sputnik.

I looked this morning in the *Encyclopedia Britannica,* and it described the atmosphere in the U.S. at the time of the launching of Sputnik as "an orgy of self doubt." It was at the height of the Cold War, as you all remember, that the Soviet Union demonstrated this remarkable scientific and technological prowess. And for once, the American public and American leadership felt that they might be second best.

And the fear, of course, led to a rapid outpouring of American investment and military might, but it also led to a number of other things, very positive outcomes, one of which was, of course, the American public's interest in science and technology.

It led to the launching of the Space Age. NASA was created in 1958. It also led to a massive rethinking of the American educational system. In fact, the renaissance in terms of educational reform occurred in the 1960s, precipitated by emphasis on education following the launch of Sputnik.

So, many good things actually came out of the fear and paranoia that existed when the American public was faced with the launching of Sputnik in 1957. I think today we're seeing some of the same renaissance that occurred then: the emphasis on educational reform, a greater interest by the American public and the media in science and technology.

So I think it's fitting at this time that we emphasize in this forum the issue of science and journalism, and I might also mention that the Academy Complex tomorrow is sponsoring another event which is focusing on the issue of educational reform.

So we're very proud to be here.

The president of the Institute of Medicine, Ken Shine, will be speaking in the next session, and Bruce Alberts, the president of the Academy of Sciences will be in one of the afternoon sessions.

Let me introduce next Kenneth Paulson with the First Amendment Center, and he will extend his welcome.

KEN PAULSON Good morning. I'd like to welcome you on behalf of the First Amendment Center at Vanderbilt University and The Freedom Forum.

It's a special pleasure for us to be able to participate in today's conference.

Each year at the First Amendment Center, we bring together two distinguished scholars who come from different disciplines, and we ask them to explore a particular facet of American society and its relationship to the media.

We are privileged this year to have Jim Hartz and Rick Chappell join us for an extensive study of the relationship between scientists and journalists and the implications for coverage of science news.

Jim is a veteran television and print journalist, the host of *Innovation* on PBS and formerly the co-host of the *Today* show, and a respected military and aerospace reporter for NBC News.

Rick Chappell is the associate director for science at NASA's Marshall Space Flight Center in Huntsville. He's a scientist and an astronaut who joined NASA in 1972, and he was mission

scientist for Space Lab I and has had extensive experience talking to the press and public about the space program.

In a moment you'll hear from both gentlemen about an interim report they've prepared, assessing the relationship between journalists and scientists.


Paulson

I know firsthand the benefits of those two groups working together in a constructive and positive way. Before joining The Freedom Forum, I'd spent four years as the executive editor of *Florida Today*, which is the newspaper closest to Kennedy Space Center, and it was the one newspaper where police reporters would have to check the shuttle schedule before they were allowed to take a vacation.

It was the one newspaper where a city council story was a local story but so was a space walk. And it was in that environment that I developed even greater respect for the scientists of this country and the public's appetite for science journalism.

I discovered there that when a community cares about science, and the press is ambitious about science, and the scientists take the time to clearly communicate with the press and public, there are winners all around.

Here to examine that potential: Jim Hartz and Rick Chappell.

JIM HARTZ Thank you, Ken, and let me add my welcome to all of you for being here with us in this two-day conference and express my thanks also to The Freedom Forum and to Ken and especially to John Seigenthaler, my old friend, for inviting me a year ago to become a part of this study.

And it's been a wonderful time for me and a chance to get to know a new friend, Dr. Chappell from NASA, and to have one deadline for a year instead of one or two a day for what's been much of my career.

We are releasing this morning an interim report. It is the results of a survey that we commissioned not quite a year ago at the beginning of our study. We asked approximately 2,000 scientists and approximately 2,000 journalists to assess the issues that oftentimes divide them but oftentimes bring them together. We asked them to look at certain aspects of the society at large. We asked them to look at each other, and we asked them to look at themselves.

Out of the 4,000 or so surveys that we sent out, we had a return of approximately 30 to 40 percent on both sides, which we are told is typical of a national survey. The only people among scientists who are not represented … I think we asked the American Chemical Society for their mailing list, and they, for one reason or another, didn't want to give us that. So for those of you who know chemists, you can allow for any discrepancies that might appear in the results brought out by the scientists.


Hartz

We had a chance to analyze the results very carefully and I think …The title we picked for the report is *Worlds Apart: Gauging the Distance Between Science and Journalism*. That title—and we've tried to be topical with a picture of Mars and Earth there—came when we looked at the results that we obtained from this survey and compared them to surveys that the First Amendment Center had done in prior years in previous reports, which covered such things as the media and the military, the media and religion, the media and medicine, the media and politics, and so on.

This survey showed the widest divergence between the media and the portion of society that that media covered in terms of the way they looked at each other, the way they did their jobs, and sort of delineating the gulf that exists between them.

Now, on top of that was a very interesting second layer, and that was that the gulf that seemed to exist there was not born of hostility. In other words, in some of the previous surveys the people who were covered by the press seemed to feel that there was a hostile relationship between them.

In this one what we found was kind of more sadness rather than hostility. A lot of the scientists, and I'll let Rick talk about this in a minute, were complaining oftentimes about the job that the—let me be careful here to say, the majority—of the press did in terms of getting the story right in terms of the details and several other facets that we delved into that you'll be able to see in the survey.

This is … we don't want to get into the details of it at the moment. You'll have a chance to look at it yourself, but what we found was that while there was an unhappiness amongst scientists, there was also an agreement by both sides that a much better job could be done and ought to be done. Both sides recognize the importance of science and high technology to this country and both sides felt that they each could do a lot better job in improving this communications gulf that exists now between the two sides.

It was interesting, and one question we asked: Who's really to blame for the public's inability to understand a lot of the science and technology? And the scientists, by a rather large majority, said, "It's really our fault. You know, we don't do a very good job oftentimes of communicating." And the scientists in the second place said, "It's really the public's fault."

And this was another underlying theme in the survey: that both groups felt that science education in this country and scientific literacy overall was not really very good, and the scientists at the end blame, by not a very large number, the media itself.

When we asked the media the same questions, the answers were almost the same. They said, "It's the scientist's fault" first, and "It's the public's fault" second, and "Not us."

But then a very interesting thing happened.

I was the one assigned to read all of the comments that came along with the surveys. … A lot of the journalists in the comments said, "Yes, we need to do a lot better job of reporting on this vital area to America. A lot of it is our fault, and we need better training. We need to spend more time with it" and so on.

The final [point], I guess, is that, while the ways in which scientists and the media view themselves, each other and many things are worlds apart, there is an agreement that they can do a better job, that it is not an insurmountable problem, and that we should be doing a better job because it really is vital and it really is important to this country's economic well-being.

So we see a great deal of optimism, finally, at the end of this survey, as well as recognizing that there are some significant differences in the way that we view things.

Rick, you want to talk about some specifics from the scientist's point of view?

RICK CHAPPELL Thanks, Jim. I'll just make a couple of comments.

I do want to very strongly thank the First Amendment Center and Vanderbilt for bringing us together.

I think in some of these previous studies a hostility has surfaced not only between the journalists—the journalism side—and that segment of society being looked at, hostility has even developed between the two people who were doing the study. Such has not been the case with Jim and me.

And we have from the beginning had the same goal in mind, which was to figure out a way to help adjust the process to identify the things that make communication of science through the media to the public more difficult—to find the ways to make that better.

And the report that we are developing will have those recommendations in it. He and I have been very much on the same wavelength all the way through, and, in fact, from my viewpoint it has been tremendously valuable to have his insight into how the media works, so that I can sort of pour out my heart with respect to how scientists try to do their work and how they want the public to understand. And then

we can match that against the reality of how the media … the deadlines, the things that the media has to deal with.

And the survey is a very good basis for that.

I would just comment that the survey brings out from the scientists the hesitation about talking to journalists based on a concern about: "Will they get it right?" and "What happens to me as a scientist in my career if they don't get it right?"


Chappell

There's a concern that it reflects on me as a scientist. My colleagues don't know—if they read something in the paper that I said—they don't know whether I said it wrong or whether the journalist just didn't get it quite right. And it's a concern for me that it may reflect on my career; it causes me to hesitate to talk. And so there are a number of issues related to journalists getting it right that are of a concern to the scientists.

The positive point is that both sides feel that the complexity of science really can be dealt with by journalists, and there's not an intractable difficulty here.

The other thing that is very heartening to me is that … and this represents, I think, a tremendous change in the scientific culture: More than 80 percent of the scientists who were surveyed said that they are willing to take time to be trained on how to communicate better with the public. This is a tremendous shift away from an attitude which, for many, many years, said: "We really don't have time to do this. We're trying to do our research. We want to do what we're getting paid to do and not take time away to try to communicate things that are very difficult."

There's a significant shift in that that also bodes very well for our future in being able to build this bridge.

So there is a common ground. Even though there are differences, and they are worlds apart, there is a common ground that can be built upon—that can bridge between the science community and the public through the media.

And I think the forcing function is going to be this increasing need to know on the part of the public. In order to be informed citizens in this country, we need to understand science. [Moreover,] science is not only extremely important to the public but is thrilling to the public, if it's written in the right way.

So we have a lot of optimism about the future possibilities, and the survey helps us understand where the common ground is and helps us show the areas that need work.

Jim, do you want to close with any comments?

HARTZ Well, one kind of larger part of the umbrella that we were operating under that we felt was important in this issue … was that oftentimes scientists were covered as a specialty by the media in this country.

In contrast, one of the ways that we looked at it was that it was such an integral part of our society. We spend $70 billion a year in government funds on basic research and development and another $100 billion or so in private and university funds.

It is a huge segment of our society that is covered by specialists in a fairly small number of publications, and so a question has sort of floated in our mind as to whether we should urge newspapers around the country to devote space to science by developing science sections—in some cases, that's been tried and was not successful; other places it's done very well—or whether [science] should be treated as general news.

I'm kind of inclined toward the latter and kind of inclined to urge my colleagues to treat it that way.

Oftentimes we've been very good in our history at covering politics and that sort of thing, and have developed many very good sources over the years in certain areas. Not many of us have taken the time to spend a lot of time with science and scientists and developed that as a source of continuing fascinating and interesting news.

One of the questions that we asked—and I'll close with this—the scientists was: "How often have you talked or do you talk with reporters?"

And we found a very small number—3 or 4 percent—who said, "I talk with a reporter maybe as often as once a month." Then we found a huge number—Rick, you might help me on this—60, 70, 80 percent, something like that, who said they had talked to a reporter maybe once every few years. And then we found something like 25 percent of the scientists we surveyed said they had never talked to a reporter. So there is a wide gulf here.

And my favorite was, in one of the comments in going through this, one of the scientists in answer to that question said that the last time he had talked to a reporter was in 1959. And then we had right below that, "Can we use your name and quote you in our report?" and he wrote emphatically, "No!"

To my mind, that was a guy who really got burned a long time ago and had never forgotten it. So I would like to, at least from the journalist side, hold out an olive branch to those scientists who in the past have had a bad experience and urge the scientists on their side to come and accept that, and try to at least emulate what we've been able to do electronically and technically and mechanically and reach out across the vast space to Mars. And what we're seeing is a wonderful relationship and material and data and so on that's coming back from there. Maybe we can do the same thing metaphorically between the journalists and the scientific community.

And I agree with Alan McGowan . It's an issue that's been around for a long time, and I think right now it's time that we really knuckle down and try to solve some of these difficult issues.

Thank you.

ANNOUNCER Our panel is just about seated now and we'll be turning things back over to Ken Paulson, the vice president of the First Amendment Center in Nashville at Vanderbilt University.

PAULSON Thank you. Our first panel of the morning is about to convene and moderating this discussion is a gentleman who is the founder of the First Amendment Center. He's a highly respected editor, publisher and chairman emeritus of *The Tennessean* in Nashville, the founding editorial director of USA TODAY, and also past president of the American Society of Newspaper Editors.

In founding the First Amendment Center five years ago, John Seigenthaler held strongly that there needed to be a place where different aspects of society get together to talk about the press and the public and their collective role in society.

The study you just heard about from Dr. Chappell and Jim Hartz was developed at the First Amendment Center. The concept of teaming scholars was John's.

You can read a John Seigenthaler's own take on the subject in the beginning of the project here in the foreword of today's publication. There are additional copies for everyone who wants these.

So to begin today's session: John Seigenthaler.

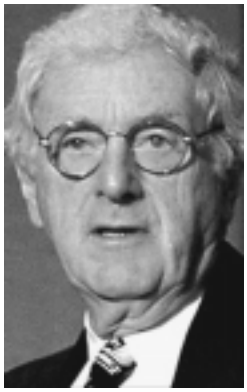
JOHN SEIGENTHALER Thank you very much, Ken. I'm delighted to have an opportunity to be here with all of you today and to welcome this distinguished panel to talk about, in general and specific terms, the relationship that exists between science and journalism, on the one hand, and science—in the larger sense—and the public, and the need that society has to understand more about an area of life that affects all of us and that also, both in the public sector and the private sector, is the focal point of billions of dollars in expenditures each year.

We have a distinguished panel, and I am honored to introduce, first of all, Shannon Brownlee, [who] for most of the last decade, has been with *U.S. News & World Report,* where she is a senior editor. She is acknowledged as one of the most knowledgeable and distinguished journalists whose work in science has won notable national awards.

Her work on Alzheimer's disease won the Sigma Tau Foundation Prize. She has been a Knight Fellow in journalism. She won the

American Institute of Physics Award.

She has, in her educational background, a bachelor's degree in biology and a master's in marine sciences from the University of California at Santa Cruz. Prior to coming to *U.S. News*, she was a journalist with *Discover* and with *Sports Illustrated*, and it's a great pleasure for me to see her and welcome her here.



Seigenthaler

Robert Fri is director of the National Museum of Natural History at the Smithsonian. He's a senior follow emeritus at the Resources for the Future. He's the director of the American Electric Power Company and Haggler Bailey, Incorporated, and holds a number of other directorships with corporations and institutions around the country. He has been an adviser to the Aspen Institute, to the Gas Research Institute.

He became the first deputy administrator of the U.S. Environmental Protection Agency in 1971, was appointed by President Ford as deputy administrator of the Energy and Research and Development Administration in 1978, and '82 through '86, he headed the Energy Transitions Corporation.

He is one whose interest in science and ability to communicate that interest are widely recognized, and it's a pleasure to have Robert Fri here.

Dr. John H. Gibbons serves as assistant to the president of the United States for space and technology. He is also director of the Office of Science and Technology Policy.

From 1979 to 1993, he directed the Congressional Office of Technology Assessment and was, before that, appointed first director of the Federal Office of Energy Conservation. He spent a decade and a half at the Oak Ridge National Laboratories, where he studied atomic nuclear structure and pioneered the use of technology for energy conservation.

Gentry Lee is chief designer of RAMA, the award winning CD-ROM adventure game. As some of you will remember, he was the sole partner of Carl Sagan on the *Cosmos* TV series from 1976 to 1980. He is a distinguished novelist as well as a scientist. From 1968 to 1976, he was director of science analysis and mission planning on the Viking mission, and from 1981 to 1986—after those years with Carl Sagan—he was engineer for Galileo's mission to Jupiter.

And finally, Kenneth Shine.

Kenneth R. Shine is clinical professor of medicine at Georgetown. Prior to that he served as dean and provost at UCLA in the field of medical sciences. He also has a background as a cardiologist at UCLA, was chair at the Department of Medicine, director of coronary care, and from 1985 to 1986 he was the president of the American Heart Association.

All of the detailed biographies of our panelists are in your folders.

I'd like to begin this discussion by recalling with all of you that 40 years ago this week, the nation's interest and conscience and concern were focused not on space but on Little Rock, where the screams of angry white mobs and the footfall of marching federal troops accompanied the entry of African-American students into Central High School.

In the Defense Department, Secretary Charles Wilson had announced that he would retire, and Neil McElroy was due within the coming week to succeed him.

As was stated earlier by Alan, we were in midst of a Cold War with the Soviet Union and suddenly the national attention, because of something called a Sputnik, was indeed focused on space. And we were frightened; we were shocked; we were concerned; we were behind in the race in this Cold War; we were behind in a space race that we did not even realize existed.

Even though he was going out of office, Secretary Wilson rushed to Huntsville, Ala., and met with Wernher von Braun, the German space scientist who had been instrumental in creating those buzz bombs that shook London during World War II. And von Braun was rather relaxed about the whole thing. He said,

"We have the firepower to do this. Nobody has paid much attention to us. Nobody has indicated that there was much of a push on it to get this done."

And within a short time, we proved that we could compete, and gradually the nation came together, and there was a commitment of talent and funding to enter the race, to catch up in the race to dominate the race for space.

And how ironic it is today that our Cold War enemies now are with us on a project in space, and there are doubts and questions in Congress about the advisability of that current enterprise. But that encapsulates in very brief terms how we were then and raises questions about how we are today.

I think that some of the answers that are posed in the Hartz-Chappell report *Worlds Apart* will be touched on as we approach this subject today.

And I'd like to begin this panel discussion by first of all asking Jack Gibbons: How much did it matter, one, that Sputnik was up there? How much does it matter today that we were threatened and challenged enough by it to enter into this massive commitment of money and talent and energy?

JACK GIBBONS John—First of all, I hope everyone's noticed John's tie. It's been hiding behind your sign, but it's a loud, extraordinary tie.

SEIGENTHALER I'll just step out. [Steps out from behind podium.]

GIBBONS I don't know if the television can get that in the picture or not. And I'm delighted …

SEIGENTHALER It's a message tie, Jack.

GIBBONS It's wonderful. I'd love to steal it from you.

Your question is cogent, as usual.

It seems to me that the shock wave of Sputnik was a classic example of what Adlai Stevenson III once said. He said that one characteristic of Americans is that we never see the handwriting on the wall until our back is up against it. It takes that kind of shock therapy, and I think Sputnik was the kind of shock therapy that gave us a signal that we at least had a virtual wall, and our back seemed to be up against it.

And, of course, that called forth a very productive response—some people think maybe an over-response to that event—but it is one of those attention-getting mechanisms that does shock us.

Our lives are like evolution. We go along at a steady rate but every now and then, it's punctuated by an event that is as important as the underlying wave itself.


Gibbons

And in the years since that time, I think we have seen an enormous number of things happening, but I wouldn't want to put the Sputnik event in greater proportion to other things that were happening at that time. We were in the midst of a Cold War. Our whole defense and notion of the public support of science was engendered largely because it was seen as the mechanism that would enable us to avoid being overwhelmed by the forces of darkness.

And we were also at a time in which, as you recall, the great wondrous achievements of science that had helped us win World War II had led us to a notion of science as a great cornucopia for our future. And then we had a disillusioning time that preceded Sputnik—but about the same time as Rachel Carson's *Silent Spring*—of atmospheric testing of nuclear weapons and other things that put a tarnish on this notion of how generally science contributes to our lives.

So I think there were a number of things that were happening then, and Sputnik was one of the more gripping events that laid the way for the future.

And since that time, we've come from the notion of the support of science for national defense reasons to the support of science to enable a great array of capabilities for our future security and that of our children and our grandchildren.

At the same time, if you think about that dynamic in science, there was a big dynamic in journalism. That is, the reporting—We've gone from typewriters to laptops. We've gone from radios to real-time, live, worldwide news networks, and the world has just shrunk to fit our living room in very, very real terms.

So it's been an extraordinary time, and Sputnik, I think, is a good choice as one of those kinds of events that bring us up sharp and help us focus our mind on the future.

I'd say the bottom line is that—It's a little bit like Ben Franklin said. He said that we must hang together or we'll surely hang separately. I think science and journalism have that same kind of relationship—an enormous interdependence and an enormous charge, as it were, to use both of these extraordinary institutions to help the American people fulfill what James Madison said to us.

He said, if we want to be our own governors, we must equip ourselves with the power that knowledge gives us. And if we intend to remain a democracy, science—which is so increasingly pervasive now—and journalism—which is the translator, the teacher of science—must act together to help people retain access to power, which in turn will give access to knowledge, which in turn gives them the power to be their own governors.

SEIGENTHALER You know, I remember the trip that outgoing Secretary Wilson made to Huntsville. At that time Huntsville, Ala., was in the circulation area where I was a working as a reporter in Nashville, and I was sent down to cover that meeting as an experienced general assignment reporter who had absolutely no background in science.

Because von Braun was an excellent communicator, it was very easy for those of us who were there to get the drift and sense of what he was saying.

But I've thought about it since. It occurs to me that what happened was almost a shotgun marriage of convenience. Journalists who knew nothing were thrown together with scientists who knew everything, and the public interest was only going to be served through a mutual relationship.

And that honeymoon that grew out of that shotgun marriage went on, I think, for a couple of decades. As long as our dominance was not assured, it seems to me, Susan, that we were concerned and journalists made a commitment to science.

Many organizations have given up that commitment. *U.S. News* has not, and you are there. What's your take on the relationship as it has evolved?

SHANNON BROWNLEE I think that one of the things that Sputnik did is that it provided journalists with a really great story.


Brownlee

There's a reason that the things that we produce and put on pages are called stories—not because they're fiction, because they're filled with a lot of facts. But they're packaged in the form of stories, and stories thrive on conflict. They like horse races, and what Sputnik did was, it provided this wonderful sort of conflict and it was larger than a conflict between two countries. It was the conflict between good and evil.

So for journalists, I think, to sort of be aligned or to write about the people that were on the side of good in America was probably very exciting. I think, as you say, there was an alliance. There was a very strong relationship, but to my mind to a certain degree it was a bit of an unholy alliance, because I think science journalists forgot their other job.

One of their jobs is conveying information and their other job is to shine light into dark corners. And in this 40 years since Sputnik, science has gone from a cottage industry to a big bureaucracy, a $70 billion bureaucracy, with lots of really great work and a certain amount of corruption, a lot of waste. I mean, it's just like any other large unwieldy industry.

And what science journalists forgot in that time was that they should be scrutinizing the entire endeavor, as well as conveying the information.

I think some of that has changed. The first sign was a story that, whether or not you agree with it, was an important sort of landmark, was an investigative piece by a man named John Crewdson of the *Chicago Tribune*, and he investigated Robert Galileo. Now, it turned out that a great deal of what he said was wrong-headed but it was a flag for a lot of journalists that they needed to look at scientists just the way they looked at politicians, just the way they looked at the Department of Agriculture, in the way that they looked at lots of different kinds of public servants.

So I think the relationship has changed, but I think to a large degree science journalists are still doing an awful lot of cheerleading and that is not necessarily the only role that we should be playing.

SEIGENTHALER Let me ask Dr. Shine—It seems to me that a case can be made today that the health of the nation is as important to the people of the country because it's a life-or-death question, first of all, and beyond that, because it touches very deeply on funding and much of it tax funding.

I don't have a sense—and I'd like your reaction to this—I don't have a sense that journalism's commitment to medical research, health research, or coverage of trends in health, comes close to the commitment that we had for two decades, and in some ways still have, in the area of space exploration.

KENNETH SHINE Well, it's interesting that most of the conversation up to now has described the defense environment, the national-security environment. I just want to remind you that when Sputnik went up, hundreds of thousands of people were either dying or being scarred by smallpox, that three years before, Salk had introduced the vaccine, but elimination of polio really didn't become feasible until Sabin's vaccine, which was three years later.


Shine

I was a college undergraduate at Harvard the year before and took a seminar from a tall, gangly fellow named Jim Watson, who was telling us about this double-helix stuff. And he told us—and we all agreed—that probably by the end of the decade, we'd begin to understand, and by the end of the century, we'd fully understand the genetic code.

And the notion that we would have at that time predicted the human genome project or the biotechnology industry, and so forth, I think, was out of our mind at that time.

So I think it's important to recognize that Sputnik occurred just at the very beginning of an extraordinary explosion of knowledge and understanding in the biological sciences that has been going on ever since.

The interesting thing is, the public interest in all of this remains very high. I mean, after all, the $70 billion federal R&D budget is $30 billion of D and only about $40-$42 billion of research—of real research. … The rest of it's development, and of that $43 billion, a third is health-science research: $15 billion.

So this country does make an enormous investment in public awareness, and I think the journalists' commitment to health has been very high.

I think the defect, the problem, is that the connection between health and science has not been so well done. That is, *ER* can attract an enormous audience with regard to the emer-

gency room and the problems of health, but I've often thought wouldn't it be fantastic if science teachers that week had an opportunity to talk about electrical conductivity, the movement of ions in the heart, and why defibrillators work?

That is, we've missed, in my view, enormous opportunities outside of perhaps the genetic revolution to connect the advances and the opportunities in health to the understanding of science, and many people equate those two.

Let me make one final point. With all due respect to Sputnik, Wernher von Braun was absolutely right, because most of the science required to put a man on the moon we knew. It was technology that was important. It was how to use that science. One could write the equations. A schoolboy could write the equations as to what you'd have to do in order to get something into orbit. And we blurred this margin between science and technology in an extraordinary way.

And the reason that this is an important observation, in my opinion, is that from time to time we've tended to try to look at biology in the same way. Whether you talk about war on cancer or war on AIDS or whatever, there's a tendency to believe that there are actually equations for that, and there aren't. We don't have equations for life. We don't have equations for how cells actually work.

And although we're coming closer, and although for the first time real opportunities in mathematics and physics are presenting themselves, I think that when we get into this business of Manhattan Projects and health, or moon projects and health, we forget that we still don't understand a lot of the science and that many of the advances— including the ones that I've made reference to—were results of good, basic science research not predicated on any preconceived understanding of what the science was that was going to be necessary to improve health.

SEIGENTHALER Let me ask Bob: Much of what Rick Chappell and Jim Hartz have found suggests that there is a void of knowledge among the citizenry of the country, the voters and taxpayers, a void of knowledge, and in some ways, in many ways, maybe in most ways, since the media is responsible for communicating what has happened, the media has some responsibility for that.

I wonder … I know that the Museum of Natural History must get a high degree of interest … the people who flow through there communicate with you. It occurs to me, that very probably reflects a higher level of interest than journalists and the media are willing to acknowledge or address. What would you say to that?

ROBERT FRI It's true, John, we struggle with that issue, and …. I'm involved with an organization called Science Service, which publishes science news, and we struggle with the issue of how to relate science.


Fri

But let me introduce a slightly different ... slant on this, because being the only non-scientist and non-journalist on the panel, I was desperately trying to think what in the world could I say to be useful. And I thought, you know, what is a great science story that people are going to be spending time with over the next month or two?

And it's going to occur on Monday. The president is going to hold a teach-in about the climate change. That's the biggest science story that's going to take place anytime soon.

And going to your point, John, he says in his letter of invitation: "The goal of this conference is to help improve understanding of climate change among all aspects of American society."

So here you have a case where understanding of science is not so much understanding of the content or the substance of science and its role in economic competitiveness or in international bragging rights, but rather science as a basis for personal decision: "Now, should I pay more for gasoline so that we have less carbon dioxide

spewed into the atmosphere so that the temperature won't go up?"

Now, communicating that story creates a kind of a problem, it seems to me, for journalism, because it's a story about the process of science, not about the content of science.

And I just had a chance to look very quickly at some of the polling results in the study, but I noticed most places journalists and scientists tended to agree, given a certain set of statements about things. But one they disagreed pretty substantially on was: "Do journalists understand the process of science?" And the journalists said, "Of course, we do," or at least half of them did, and the scientists said, "Of course, they don't."

But it is really important because, for example, [Shannon], it's not a question of conflict. I mean, truth does not lie someplace between what two scientists say. There are not two sides to the scientific story, so you can't approach it in just exactly the same way.

So let me just throw out the notion that, in addition to these other subjects, which are terribly important, there's a kind of new dimension to what public needs to understand about science and the challenge for journalism that we might want to spend some time with.

SEIGENTHALER It strikes me, as I prepare to ask Gentry Lee a question, that members of the panel probably—since I have noted them nodding and shaking their heads yes and no and taking notes—that there might be something you'd like to say to interact, and the more conversational this discussion is, the better the moderator will like it. But before I ask you all to answer …

GENTRY LEE Wait 'til I get done. There'll be a few questions.

SEIGENTHALER I don't know anybody alive who has done more to popularize science and to make it understandable to and through the mass media than you have, to make it understandable to the public, to make it fun for young people and old people.

Hartz and Chappell find, on one hand, scientists really are nervous about communicating with the media. Nervous, I take it, about communicating with the public. On the other hand, they find the journalists have a lot to learn about how to communicate these complex questions in a way that makes news and is understandable.

How do you react to that?

LEE Well, I have a lot of reactions to it. I think that one basic trap we all fall into is, we feel like we're all limited in what we're capable of doing.

I have seven sons, for those of you who are interested, and I sometimes conduct a mini-forum in my house before I come to one of these things. And my 11-year-old said to me as I was heading out the door, "Why is it important that science and the media be in tune with one another?"

SEIGENTHALER He should be the moderator here today.

LEE And no one's even addressed that question yet, and I think the one-line answer is: Because lacking understanding of science in the 21st century in a democratic nation is a prescription for disaster. And it's that blunt, and we have to do something about it.

So if you don't mind, what I'm going to do is, I'm going to deal with what I think are the three biggest problems and give you three quick solutions …

SEIGENTHALER Have at it.

LEE … and then we'll go from there.

The three biggest problems in understanding science and technology … And I want to make sure that difference is made: Science, to me, is the process of gathering the knowledge, and technology is the process of taking that knowledge and diffusing it into the society.

So here are the three biggest problems:

No. 1 — With all due deference to David Perlman and other people whom I know, most reporters don't know beans about science, OK?

No. 2 — Most scientists are terrible communicators.

No. 3 — There's a high degree of scientific illiteracy, ranging from 80 to 90 percent, depending on your point of view, in the general public.


Lee

If you don't solve all three of those problems, you won't solve the issue that this conference is set up to deal with. Solving the first two is a little bit like patting each other on the back. If you leave the public scientifically illiterate, you won't have made any progress whatsoever.

So what do you do to deal with these things? No. 1, you make the educational process of scientists have a stiff board in it that requires that they learn to communicate.

I told a leading Southwestern institution that all defenses of masters and doctorate degrees in science and engineering should be conducted in front of a lay audience, and they should decide whether or not the person gets the degree. How do you how think that those people responded?

No. 2, you make sure that communications departments around the country and the universities have a decent science minor or an equivalent science major. Not just something that's puffy, but something that is really where the scientists themselves interact with the communication schools, so that we don't have 10 or 12 or 16 people who understand science journalism, but a whole lot more.

And No. 3, and most importantly, we have got to make sure the educational system is overhauled. Not slightly changed, but overhauled to make literacy include knowledge not necessarily of the "hows" of science but of the "whats" of science. And that should be done in terms of at least a one-year course taken by every single person who graduates from high school on what is science all about, and what are the major planks in what science is contributing to society.

SEIGENTHALER Is that … Susan.
BROWNLEE Could I comment?
SEIGENTHALER Shannon. Sorry.

BROWNLEE It's true that scientists can't communicate, and an awful lot of reporters don't know science, but I think really the biggest point is that the public doesn't understand science, doesn't like science. Kids don't like science, and this is really a tragedy because every child comes into the world a natural scientist.

LEE Absolutely.

BROWNLEE And so it can't start at high school. It's got to be in elementary school, and we've got to make efforts to get teachers who are really turned on by the process of learning how the world works.

It's really got to start early. It's not my job to be the only teacher of science. I think this is something that science assumes: that I am the conduit to the public. I'm supposed to be the purveyor of their fascinating information.

Well, I love science. I have been asked to be a reporter in any number of areas and I always refuse. Because I don't want to report about politics. I don't want to report about anything but science, because it's exciting to me. But it's not my job to be the only teacher of science.

So we've got to do something.

LEE I completely agree with you. I should have said something about the elementary schools, but see that requires an overhaul of the way teaching is done, because the people who can teach science and, you know, give it the sense of excitement and wonder that those of us who do it feel, are not working in education.

And the educational system has a barrier that excludes people like you and me from going into the classroom and teaching the kids about science.

SEIGENTHALER Shannon, would you acknowledge that you are rare among journalists you know? That your commitment to science coverage is not shared by many working reporters and editors?

BROWNLEE Editors, for the most part, and political reporters and the majority of journalists see science as a backwater. They see it as an amusement and not as an integral part of what's going on in our society.

SEIGENTHALER And, of course, if they were educated from elementary school through high school through college—not necessarily to have a bachelor of science, as you do, or a masters in marine sciences, as you do—it would go a long way, I suppose.

I saw …Doctor.

SHINE I wanted to comment about this public understanding for a moment.

Bruce Alberts, who's the president of the National Academy of Sciences, will probably say more about this this afternoon, because the National Research Council and the academies and the institutes are very interested in this whole area.

But I will just make two points: One: in fact, I think, Gentry, the problem is not in the elementary schools. The elementary schools are moving, in many parts of the country, effectively to help kids with inquiry-based learning.

I think the problem is in high school, and I think it's based on the notion that individuals have to prepare for college and SATs and similar kinds of exams on the basis of an approach to science which is not how science is done, and is not discovery, but it's just memorizing a bunch of facts.

And the American public has a big responsibility—as well as higher education—because most parents want their kids to score high on those tests. As long as universities have tests which test that way, that's the way the high school's going to function.

And I submit to you that the movement in K through 8, although there's still a long way to go, is very exciting. The movement in high school is not, and I think that's where a good deal of the attention has to go.

The other point I want to make is that … this goes back to the comments about the White House conference on climate change.

One of the … some of the fundamental issues that the public clearly doesn't understand which are critical to both policy and science are, one, the concept of risk and secondly, the notion that scientists, particularly as individuals, rarely know the truth: that science is, in fact, about different results and different studies creating a body of knowledge over time.

And the press tends to pick up a particular report as if it's the answer to cholesterol in the diet or some other activity, and then when another report comes out that's slightly different, the public seems to be very confused.

So I would suggest that among the themes in terms of your science literacy is the whole notion that any given report is only part of the development of science and how the public perceives that and the way the press treats it.

I mean, right now we've got the gene of the week. Every time you pick up the paper another gene's been … Sooner or later the public's going to say, well, what is … how come nothing's happened?

We've got innumerable genes identified. We're 10 or 15 years away from any really significant gene therapy, but in fact what's going to happen is the public is going to eventually say, "Why are you doing this? Why do you come up with another gene?"

So I think these are issues that the press in collaboration with science can do a hell of a lot to put into perspective so the expectations are not unrealistic, and so people can understand, when issues like mammography come along, why there's a controversy about age 40 to 50 as opposed to believing there's a simple answer or that we know the truth and all we've got to do is apply it.

SEIGENTHALER Twice now the White House conference has come up and Dr. Gibbons needed time to … you mentioned … I just

wanted to give you an opportunity to say something about it now, since you probably know more about it than any of us here.

GIBBONS John, the president since he came to office was bound and determined to try to get our deficit down as a legacy for our next generation instead of borrowing from them. And the other thing he's been trying to do is to think about the challenges of the next century and what we ought to be doing again to invest so that we have the option to live our full lives in a free society.

Now, if you think about the challenges in the 21st century, again more and more of the challenges and the opportunities come back to science and technology. And one of the greatest challenges is the now very—to me—very clear and rapidly clarifying issue of what people are doing in their daily lives, in their personal, their industrial lives, in affecting the composition of our atmosphere around the entire planet, and what the indications are of that activity—mostly the burning of fossil fuels.

And the president has looked hard at this. This vice president looked even harder, because he took a course under Roger Revelle many years ago that got him really interested in science, and the numbers are there.

And I think as Bob Fri maybe pointed out, it's a real challenge to us all—to the science community, to the journalism community and, in fact, to our whole society—to think about what this evidence says for us in terms of our choices.

And what the evidence says is that we are now able to discern a course of events that is not so much clear in our daily lives, but right out there or right in front of us. It's sort of like the lights of a car where the car is yet to come over the top of the hill.

And are we ready to accept this information and look carefully at what it says about our future and then take actions based on that?

Albert Schweitzer, before he died, said that he felt that mankind had lost its—our—ability to foresee and therefore to forestall. I'm afraid that's the situation we're in now. Are we able to foresee what's happening to us and take action early enough to forestall it in a very positive and productive way?

That's the reason for the Monday conference. That's the reason for a White House conference two days ago with meteorologists and weather forecasters.

It's to try to get the facts as we know them out on the table, so that the American people have a better chance to understand what we do know and what the implications are.

FRI Let me just pick up on one of Jack's points. He said, "Get the facts as we know them out on the table."

Now, the question is: How do scientists know what facts are?

And, I would submit, that's a hard question.

GIBBONS That's just the very process of science.

FRI Yeah. I mean, to sort of over …

SEIGENTHALER Many people, Bob, put the same question to journalists: How do journalists know what facts are?

FRI This is true. But consider that science is a process, a phenomenon vastly oversimplified. A phenomenon is observed, hypotheses are created about what causes that phenomenon, and scientists go to work to try and disprove enough of them so that they have a pretty good idea what the correct answer is. Well, at that point in time, there are lots of very reputable scientists around with completely different ideas about what's going on.

And so here comes the press. You can pick any story you want from a perfectly reputable scientist, because that's the way the process of science works. And unless we all understand that and interpret it correctly, you know, people are going to have a hard time figuring what the facts are, as scientists know them.

GIBBONS And to separate facts from opinions. I think Sen. Pat Moynihan once said that we can each have our own opinions, but we

can't each have our own facts. I think it's sorting out that business that is before us.

The whole process of science is that of propositioning, measuring, weighing the evidence, asking questions, challenging the results—trying it a different way.

It's inherently one in which you have people almost trying to disprove … trying to test these ideas. And ultimately out of that is winnowed a consensus like, let's say, Newton's laws for nonquantum mechanical systems.

No one challenged—well, not very many people challenged—that. I'm sure there are some flat-earth people around somewhere. But I think it's important for us in the science community and in the journalism community to indeed understand the process of science and make sure that all of us understand that it inherently contains conflict of the most productive sort.

The concern you have is when that conflict is misinterpreted or misused as it is more and more frequently these days. And that's our problem.

SEIGENTHALER Shannon.

BROWNLEE I'd like to respond to that.

One of the problems with the reporting on global warming has been that journalists have sort of reported one side and then the other side. This is a very typical sort of journalistic tool to get a story across where there's a lot of conflict of opinion.

And one of the failures has been that scientists have tended to report their findings and their position, but they haven't put it into the larger context of what the conflict really means. And so one of the messages that has been missed in global warming, for example, is that there is fairly broad consensus that something is happening; it is probably global warming, but the magnitude and the timing of it are what is largely in question if I'm interpreting things correctly.

And scientists very rarely step outside their own laboratory and their own way of thinking about a particular problem to rise above it and think about what their research really means and where it is in the context of the larger question.

GIBBONS And scientists naturally will put a caveat on almost everything they say.

BROWNLEE Yeah. So we never listen to it, so …

GIBBONS So when the results of a broad consensus come out with a range of numbers, let's say it's on when we're going to have a rise of sea level—that range of uncertainty is taken as a weakness rather than as …

BROWNLEE That's right.

GIBBONS … a concession …

BROWNLEE That's right.

GIBBONS … of the area of consensus.

BROWNLEE And this is how different groups then are able to use that, those caveats, to make a wedge in the validity of the information so a particular industry may come along and say, "Well, these guys can't agree, therefore it's not really necessarily going to happen. Why should we jeopardize American industry and American wealth for something that's such a great uncertainty?"

GIBBONS But let me also follow up just for a second on that.

I was appalled when the Mir Space Station was having problems, when its central computer went out and it was no longer able to lock onto the sun. It was described in much of the press as—and responsible press, I hate to say, if I remember right—as an instrument that was spinning wildly out of control.

Now, what does that …what kind of image does that give you?

BROWNLEE It's on its way to Mars.

GIBBONS When the facts were that its maximum rotation rate during this time was a revo-

lution every six minutes.

Now, a revolution every six minutes, to me, is not spinning wildly out of control. It's this kind of sensationalism that can be extremely counterproductive in getting the real messages across.

SEIGENTHALER Well, you know …

GIBBONS It's a story, but it's not representing the truth.

SEIGENTHALER So often it is the sensational, as we all know, that attracts the media's attention.

Before I left the hotel this morning, I saw Matt Lauer on the *Today* show, talking about the so-called SIDS [Sudden Infant Death Syndrome] story which now is in the news. It's a very hot topic.

I guess 20 years ago, *Pediatrics Journal* published an article that identified SIDS. And now, after all this time, the editor of that journal says, "We made a tragic mistake and some of these cases—perhaps not many of them, but some of them—clearly were murder."

He acknowledges this on the part of science. But my question as a journalist is: Where were we during these 20 years that we've been telling people what those scientists told us was correct?

Shannon, if we were more involved—I say "we," generically speaking of journalists everywhere—if we were more involved in meticulous coverage of science—I mean, if you read journals, you really can't understand much of what's in them—but would society be better off if we were onto that story more in terms of investigating, challenging, questioning?

BROWNLEE Yes, I think we would be. In that particular case, it would have been a very difficult one to really track down. It took a lot of people a long time to come to that conclusion.

SEIGENTHALER Let me give you a set of circumstances and ask the panel to react to it, too.

One woman, according to the report I heard this morning, had multiple deaths of children in the family identified as SIDS. I think, as a good police reporter, I should have dug that out, had it occurred on my beat.

It's that sort of thing. I mean, if you read Hartz and Chappell, they find that many, many scientists trust journalists. They have great doubts about what they're doing, and they lack confidence in many ways in what they're doing, but it's not their ability to get onto the story and to dig out the story that they doubt. Large numbers of them say they're [journalists are] qualified.

But my question is: Isn't there almost an obligation for us to look more closely, because who knows how many other errors there have been in how many other journals?

BROWNLEE Sure. But you'd need a lot more science journalists to be able to cover the waterfront.

I mean, I am overwhelmed with the amount of information that I have to cover, and I'm one of about eight or nine science journalists at *U.S. News,* which is a very large proportion of the staff. It's almost equal to the political reporters, and I'm still absolutely overwhelmed with information.

If we were really going to, you know, catch every little flaw there would have to be a lot more of us. So I don't think we can really expect that, but we certainly can try harder to be the skeptical inquirers that we're supposed to be.

SEIGENTHALER Gentry.

LEE That goes back to one of the planks I was talking about earlier: about having a broader sense that the journalism curriculum or the communications curriculum should contain a major portion of science and develop people who are going to be science reporters.

I want to jump in on a couple of phrases here. One is this "global warming" thing.

I also suspect that, because of the ignorance about science, there's a major management of the facts, knowing that both the reporters and the public will not know the right questions to ask. Let me just pick one that has irritated me about global warming, since it comes up.

The maximum deviations in the climate due to the changes that human beings are putting in are small compared to the regular, secular variations over a long period of time, and no one understands those, and so no one knows how they interact.

And I don't see this in any of the stories that come up. I don't see it coming out of the White House. I don't see anybody acknowledging this very simple fact, which is something that disturbs me.

When information starts being managed …

I'm a systems engineer. I will tell you that Mir is dying, OK? It's not going to survive a whole lot longer, no matter what anybody does to it. I've designed spacecraft all my life. I know the signs of something in deep trouble.

Now you can patch it for political reasons. You can say you need to keep going up there for one reason or another, but sooner or later somebody's going to have to pull the plug, and no one wants to stand up and say that sort of thing because it's not "politically acceptable."

GIBBONS Well, that's wrong because it's already …You know that the entire plan on that is that [Mir is] to be walked away from in less than a year.

LEE OK. I myself would not want to go up and be on something that was going to be walked away from in less than a year.

Now, if I'm allowed to say that, fine. If I'm not, too bad. That's the way I feel about it.

SEIGENTHALER I think, according to the First Amendment Center, you'd be allowed to say it, Gentry.

Bob, can you as a lay observer react to the proposition I put to Shannon a moment ago: that there may be more out there that we need to know about, that society needs to know about, indeed that science may need to know about, that journalism—if it put it under the microscope—could find out and communicate?

FRI Well, I suppose the answer is yes. Let me respond to the question this way, John.

It seems to me that in science there is a process by which scientists are supposed to be looking for those kinds of anomalies. I mean, there are supposed to be scientists out there who don't agree that everybody else has it right.

If you understand that process, you might be able to find a lot of helpers. But—and this may go back to Gentry's point—it kind of depends on how perhaps the journalism schools—and I don't know how they do it, because I've never been in one—teach the coverage of science.

But there are probably some differences between how you cover science or the process of science and how you might cover something else. Certainly, in terms of breaking news, it's not just what do two scientists with opposing views think. The truth is probably something that brackets the truth. I mean, they're probably both wrong.

But if you can approach it as putting scientists to work to help you find these anomalies, maybe you can make some serious progress.

SEIGENTHALER Let me just follow up on that by reading an excerpt from a recent column by Dave Barry, who is a syndicated columnist for *The Miami Herald*.

And I don't know how many of you …

LEE And a well-known science journalist.

SEIGENTHALER Yes. He says … and I'm not going to read the whole column, but there are several paragraphs that seem to me pertinent. Although Barry is well-known to be a journalist in this country whose tongue is constantly in his unscientific cheek, he says:

"We have an old saying in journalism: If you don't understand something, it must be important. This is why we media people get so excited about science in our scientific education.

"We got as far as the part in biology class where they gave us a razor and a dead frog and they told us to find the pancreas. Right then we started thinking about two words, and those words were 'English major.'

"So we quit studying science, which is why we do not begin to understand—to pick one of many examples—how electricity works.

"We believe that electricity exists because the electric company keeps sending us bills for it, but we cannot figure how it travels inside wires.

"We have looked long and hard at wires. Some of us have tried blowing into them, and we cannot begin to figure out how the electrons or amperes or whatever managed to squeeze through there to get into the TV set or how, once inside, they managed to form themselves into complex, discernible images such as the Pillsbury Doughboy."

He says, "We in the media are especially impressed with space. We cannot comprehend how anybody could get a rocket to land on another planet. Many of us cannot consistently parallel park.

"This is why we get so excited about the recent Pathfinder mission, which day after day resulted in exciting front-page headlines like: 'Rock Found on Mars' and 'Another Rock Found on Mars' and 'Mars Apparently Covered with Rocks.'

"We in the media believe that Mars rocks are important because scientists tell us so. We will cheerfully print without question pretty much anything scientists tell us."

Well, that sort of makes the point, I think, that Hartz and Chappell spent a year making.

Maybe we should have called Dave Barry before we began.

But you know, we laugh about it, but in fact it's not really funny.

Doctor.

SHINE It would be very interesting if, at the same time [they] were featuring some of the rocks on Mars, the media [were] spending some time on the way elementary-school teachers are teaching electricity using mystery boxes, where they give kids in groups a box which has some combination of batteries, bulbs and wires in it and have them figure out what's in the box.

And when you watch how kids can learn, how they can teach each other, how the background that they bring disappears because they're problem-solving and it's OK to make a hypothesis and to make a mistake, that's exciting. And there's a lot of that going on that nobody's paying any attention to. And I think if Dave Barry went to one of those courses, he might even find out something about how electricity works.

I would also want to emphasize that scientists themselves clearly have been very reluctant to accept the notion about scientific misconduct, about the notion that things can be done wrong, and so forth.

Many of us have been very clear that examining aberrations, examining misconduct, finding … being responsive to critiques about studies which don't seem to hang together, is an important thing for science to do. I believe that in the last five to eight years the training programs for scientists, the attitudes of institutions toward looking at potential problems, have improved dramatically.

And I submit that in the situation in which there was a strong potential genetic predisposition to SIDS, it would have been a hell of a difficult problem for a science writer to necessarily find out what was going on in those SIDS cases.

But that's the nature of progress in science as well as in society. You keep your eyes and ears open. And I would just want to emphasize to you—you said it in passing— I've dealt with SIDS families, and I'm quite convinced that although there may have been some individual examples of murder, if you will, that those are very uncommon. I think that the publicity about all of this stuff is going to cause another whole ripple effect.

I've seen what a SIDS death does to a family, and it's a devastating event. And I just hope that this hoopla about what is almost certainly a very small proportion of those cases does not continue to wreck more and more families where SIDS death occurs.

SEIGENTHALER Well, I should say, having raised the question of what was on that program this morning, that the *Today* show did put on a very eloquent and articulate spokesperson for the SIDS Foundation …

SHINE Good.

SEIGENTHALER … who spelled it out, in terms not quite as forceful but very understandably, for those who are interested. Anyone who saw that program couldn't come away without two conclusions: One, there is a problem among a small number of cases, and the police need to investigate these.

And she said, "What we need is more investigation on multiple deaths, but look very closely at every death."

And I take it that the media, now being onto this, will be questioning—would you not say, Shannon?—more and more cases that are identified as SIDS.

BROWNLEE I think there will be a small flurry. I think there'll be a time when people start making a big deal out of SIDS and then we'll move on to something else.

You know, our world changes so fast that we don't have time to stick to one thing for very long. And, you know, maybe that's part of the problem: that you don't stick with a story very long and so when stories are very complex you don't really get the full flavor of it.

The thing to come away with, I think, from this whole SIDS flap is that science is a human endeavor, and part of the problem with this particular case was that it was taking the word of individual scientists—it was actually individual doctors—as gospel.

We do this. We set people up in hierarchies, and we think that people who are at the top of the hierarchies—who are the Harvard doctors or the very high-prestige people—must know the truth. And that's the thing that all scientists have to question and all journalists have to question.

It doesn't matter if you're the big cheese. You might be wrong.

SEIGENTHALER Jack.

GIBBONS I'm just reflecting, Shannon, on the fact that the time to present an idea, especially in television, now has gotten so short even with the, say, USA TODAY format. It's getting down to smaller and smaller bites. I think seven seconds on television is a significant …

SEIGENTHALER Sound bite.

GIBBONS And to put thoughtful information into that kind of compressed condition is an extraordinary challenge and rife, therefore, with chances not to make it or to mislead. But I wonder if the. …What is driving us toward this extraordinary foreshortening of time to be able to tell a story?

BROWNLEE Markets. This is a business. Journalism is not just about purveying information. It's about selling newspapers; it's about selling advertising time on television; it's about selling magazines. And the market is telling us that people don't have very long attention spans.

GIBBONS Like five seconds?

BROWNLEE Well, I …You know, I can't say why television has done this. You should probably talk to some TV journalists and to TV marketers and executives. They're the ones who make those kinds of decisions.

But in a sense we are assuming that our audience has a very short attention span and isn't very bright. And I think it's a real disservice to the public, but maybe it's correct. I don't know.

SEIGENTHALER I should say that were Tom Curley here—and he was here last week. He's the publisher of USA TODAY.

He said last week that USA TODAY acknowledges that there are stories that need depth and that he is making every effort to provide more depth to some stories.

On the other hand, I think he would be first—the second—to say what Shannon said, and that is that 15 years ago when USA TODAY was created, we were beginning to get onto the idea many daily newspaper readers of a decade before—indeed many women newspaper readers who spent their time in the home—were

forced into the marketplace, or wanted to go into the marketplace, and that everybody had less time to read or to watch. And certainly that's another way of saying market-driven.

I want to invite our audience to enter into this with their questions and comments.

If you raise your hand I'll identify you and there is a hand mike.

If you would identify yourself and then address your question or comment to the panel.

BOB HERSHEY OK. My name is Bob Hershey. I'm a consulting engineer. I also do an occasional column in *The Washington Post* in the Horizon Section, which is called "How to Think," so I am on both sides of the fence on this.

I would note that the main job of journalists conveying science is to instill this skeptical inquiry that Shannon had mentioned: getting people so that they question things, so that they want to establish the cause and effect in their own minds by their own logic and so that they want to do the math themselves and find what the numbers are.

And I particularly like Gentry Lee's comment that the numbers on the global climate-change controversy do not support the conclusion that there's a manmade phenomenon, especially looking at the space data showing slight decrease in temperature.

And I think we have to get people —

GIBBONS That's false. Sorry.

HERSHEY … so that they …

GIBBONS You better read the literature better.

LEE That's not what I said, either.

GIBBONS That's not what Gentry said.

HERSHEY The data speaks for itself, and I think people have to look at the data, and that's what we ought to be instilling in them: to do the work, get the data firsthand and not try and just get a story based on a few seconds of casual observation and then a call to action.

We need people to be skeptical, to do the work like scientists do and think like scientists do.

SEIGENTHALER Jack, do you want to react to that?

GIBBONS Yeah. I'd like to respond, and maybe Steve Schneider, who's a global expert in this business.

This is a good example, I think, of a problem we have together: namely, apparently the people in the global climate-change science community and you have not gotten together. Because what you have just reported on is just plain wrong, and you need to get together. I would hope that you and Steve could talk before we get out of this room.

HERSHEY The data I'm talking about is NASA data.

GIBBONS NASA data is upper-atmosphere data. It is not Earth's data. I'm sorry.

HERSHEY It was presented at the Science Committee hearings, and there is considerable controversy within the scientific community of whether there is a manmade effect, and if there is one, how big it is.

SHINE John, I want to get into this.

SEIGENTHALER Sure. Everybody, I think, wants into this.

Jack, you, then Dr. Shine, then Gentry, and then Bob. I think that's the order in which you raised your hand.

Jack, did you want to continue or …

GIBBONS Well, I think we probably shouldn't spend too much time on this, but it is a good example of where a piece of information, technical information, has been misinterpreted and not fully clarified.

There's always a controversy, and the very heart of science is to challenge and to answer. That incident, that observation you've talked

about, as I understand it, has been fully resolved with the community in terms of why there seems to be a difference between upper-atmosphere temperature sensing and ground-temperature sensing.

But you need to look into it and get the facts straight or else you're going to lead people off in the wrong direction, honestly.

HERSHEY I think that is examined, and the models do not include this gradient between higher temperatures on the ground and lower temperatures higher up, and that is an area that needs more science.

SHINE John, with regard to the issue of skepticism about science: as one who was educated at Harvard but spent 25 years at UCLA, I can tell you that neither faculty, neither scientists, accept what the others say is truth. And, as a matter of fact, the higher the level of the academic institutions involved, the greater the skepticism, very often.

So I'm not too worried about people accepting pronouncements as being absolute truth. But what I am concerned about is that, in the skeptical reporting of science, the media not so thoroughly confuse the public that they can't figure out what the hell's going on.

SEIGENTHALER Well I …

SHINE And what happens is that, if one picks up a whole variety of issues which are simply not clear—and I'm not referring to global warming at all; I'm talking about a whole range of issues that have to do with everything from the use of antibiotics to your diet and cholesterol and so forth—and simply report with skepticism this or that, I think that furthers the confusion in the public's mind about what science is. I think it makes it much more difficult for them to evaluate it, and I would like to see responsible journalists spending more time in doing pieces which put together a number of reports instead of continuing to report on a particular gene sequence or a particular report and presenting those in ways so the public can understand what science is about.

And I'm not suggesting that journalists have a responsibility as educators. I've learned from talking to journalists that that's not the business they're in, but I think it is the business of bringing perspective. And I wonder whether there isn't some room for doing a better job in terms of looking at all parts of the elephant.

SEIGENTHALER Gentry.

LEE Yeah. Let me just do two things. First with Steven here, I've got to make sure that I'm not misquoted. My statement was that natural causes have caused greater variations than the ones that people are talking about with global warming.

But I want to pick up on …

SEIGENTHALER You're on C-SPAN, so you have a record.

LEE OK. Good. Now, I want to pick up on this issue of science not having the whole story.

On Viking, we ran a democracy [as] some of you may remember. After we landed on the surface, we allowed any scientist to talk to any reporter. David certainly remembers that. So one article in this newspaper said: "No life on Mars." Another article in this newspaper said there was life on Mars. And back and forth we went. So someone said, "What's going on here?" And I said, "Well, you know, it's because we didn't send the right set of instruments so that we could determine unambiguously whether or not there was life there."

Someone said, "Why don't you hold a press conference?" And so I decided I was going to have one on the epistemology of the scientific method. It was canceled because no reporters were going to attend.

SEIGENTHALER We have a question from the audience, but Bob, you wanted to say something about it.

FRI Well, I think basically I wanted to ask Shannon: You know, you watched this ex-

change. How does a journalist react to. . . .We have the science adviser to the president saying one thing and an engineer in the audience saying something else, and I just will remind you that as background—because it's related to something you said earlier—that Lord Rutherford in the late 19th century, who was sort of the Jack Gibbons of the time, said decisively that physics is a closed science.

BROWNLEE You mean, we'd figured it all out.

FRI We'd all figured it out. You know, no quantum mechanics.

SEIGENTHALER Well, I suppose the conflict is at least as old as Galileo, isn't it?

FRI How did … how do you …

BROWNLEE If you have time, you keep digging, and you keep digging, and you talk to more people, and you talk to more people and you hope that a few of them can get that perspective to sort out why NASA has one set of measurements and the ground measurements are different and … you know, why they don't agree, and you keep digging.

The problem is, you're not always given the time to do that. I'm often given a lot of time on a story, or—by sheer dint of having done it for a few number of years—I know how to try to sort these things out, but an awful lot of journalists don't have this time.

And as far as journalists having the background—I wanted to relate a little incident.

In the National Association of Science Writers newsletter very recently, a journalist, who is in fact a very high-level journalist, boasted that she had absolutely no science background and she thought that made her a better science journalist.

Everybody I know was outraged by this. Everybody—every science journalist I know—was outraged, because we in fact believe that you really need to understand the material. And understanding science is not like understanding how the legislature works; it's a lot more complicated.

SEIGENTHALER Just on the question of global warming, my own … one of my great weaknesses is that I devour as many newspapers as I can every day and listen to as much of the media, and I … one of my failings is that occasionally [I] listen to Rush Limbaugh.

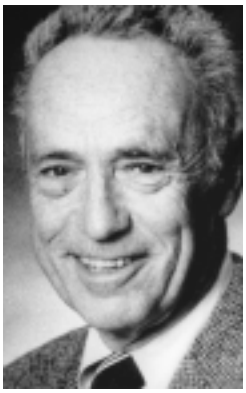
He has absolutely no doubt about the problem of global warming. It's not a serious problem; it is only the sun. And if we can solve the problem with the sun with a little cloud cover, it would all go away.

You had a question.

DAVID PERLMAN Yeah. I'm Dave Perlman from the *San Francisco Chronicle*, and as a daily newspaper reporter who has been covering science for a long time, I think a couple of things that have been said here focus on an area of science journalism that many reporters don't pay attention to. And that is the political implications of scientific uncertainty.

And here we have the global-warming controversy. We also had mention of SIDS. In both of those cases, there is an enormous overtone or underlay of political interest.

Now, a lot of us have covered the climate change. I won't call it global warming, because I'm a neutral newspaperman. All we know is that something is going on that's changing the climate, apparently.


Perlman

And you can identify scientists—John, you've used the word "reputable" and I'll use it too—you can identify reputable scientists and get to know them and get to understand a political point of view that they represent. And it's very difficult for us as newspaper reporters to bring that question in without sounding like propagandists, but it's extremely important, and it makes us investigative reporters.

The easiest thing to do is to cover a story out of *The New England Journal of Medicine,* where at the end of the article it points out a conflict of interest between the scientist who is representing himself as delivering a new concept in medical science and then it says that he represents the vice president of—I don't know—Boehringer-Engleheim, if it's an AIDS story.

Those things are important for journalists to remember, now: that not all science is neutral. Much of science that goes on has either policy implications or outright political implications. Right, left, up, down, Republican, Democrat—it doesn't matter.

But that's a function of science writing that has come more and more into the foreground in the last 20 years, I would say, than it ever had before.

… Once upon a time, we all believed anything that appeared in a peer-review journal. Not necessarily anymore. [We] have to look further.

SEIGENTHALER Question.

STEVE SCHNEIDER Yes. I'm Steve Schneider. I'm the Steve they were referring to earlier who was apparently going to settle the global-warming dispute.

I won't settle the global-warming dispute here, because we're still in dispute over details. But I think it's very important for us to distinguish between those aspects of not just this problem, but any kind of complex sociotechnical problem where we have a large consensus on a component: [i.e.,] where there's a component we have a fairly good understanding of, [although there's] some uncertainty. [Then, there are] those components that are highly speculative. The problem is that they get all lumped up. … As a result, you're going to find a skeptic out there—and I think it's appropriate to cover skeptics.

When climate change from humans first started and I was in this business 25 years ago, I was the skeptic, because the conventional wisdom was what Gentry Lee said: It was a natural phenomenon. And we … even though we weren't sure about warming and cooling, that was skeptical.

So now, I'm "mainstream," because I think humans are a good part of the story. But the question is, there are still aspects of that which are very uncertain. But when we lump them up, people are confused.

So in the process of covering skeptics—which is completely appropriate—if you don't tell the lay audience that this represents a current minority opinion, it's very unlikely they'll know that for themselves.

And while we must all of us applaud the Galileos of the world and the Copernicuses who come along and turn the paradigm upside down, the truth is that most science is what we call "normal" science.

Most science is probably going to come out fairly close to the conventional wisdom. And the reason we remember the ones who turned it upside down is because it's so rare.

So as a result of that, while, yes, we must cover the skeptics, we also have to let people know … where people sit in that general balance, so that we don't have paralysis 'cause the average person thinks, "Gee, if those experts don't know, how do I know?"

So by exaggerating the contention that exists, by forgetting to report the consensus, we therefore are miscommunicating—not just reporters, but scientists as well—miscommunicating where the general spectrum of knowledge is.

Now, in the global-warming issue in particular, we heard a debate about whether facts were right or facts were wrong.

Actually, we were both right. In a sense, it was a question of how to interpret it. Indeed, the earth satellites that have been used since 1979 have shown very little trend in the average temperature change in the atmosphere, but this is largely a measurement that goes from … the upper atmosphere right down to the surface. The top and the bottom are mixed up.

When there are clouds around, you don't get exactly the right answer. When there's snow around, you don't get exactly the right answer. It's very difficult to interpret exactly what you're looking at, plus the satellite record only goes back to 1979, whereas the surface thermometers

go back over 100 to 200 years.

So the fact … that global warming has occurred: what that means is that the surface thermometers of the world have shown us about a one-degree Fahrenheit rise in a century, a century and a half. That's not disputed by virtually anyone knowledgeable.

The fact that mountain glaciers have receded and sea levels have risen, that is global warming. That's a fact.

The debate is over whether or not this is a natural accident or whether we did it, and … I would argue the bulk of the community thinks that it's unlikely to be just natural.

There are a few people who still adhere to that. But the question is: At what probability? And the probability that comes from the mainstream is that it's much better than even that we're at least part of the story and that there's a discernible signal. And then the political side is, who can—[Shannon] brought up risks—how do you want to take risks?

I mean, how do you weigh the risk of investing present resources that you could use for other good things in hedging against something that might happen, versus do you want to leave posterity biologically poor and having to adapt to potentially dangerous climate change? That's a value judgment every person's competent to make, if they know what that game is.

So our job is to make them understand the game. And it's so easy to get confused in the mistakes between the details about what satellite says and what surface says. And that's why science is a community. That's why we have a National Research Council to try to sort this out. That's why there's an intergovernmental panel on climate change.

It's very difficult to do that in public fora.

SEIGENTHALER Ken Shine and then Shannon.

SHINE Mr. Perlman, I think appropriately, … raised the problem of politics and science. We've just been talking about some of the science politics, if you will.

We've not addressed at all another set of major problems that I think the media and science will have to increasingly address.

First, the capacity since Sputnik, in terms of what we can do with technology, has gotten to the point where it raises a whole series of ethical and economic issues that we've never had to face before, including who do we transplant, under what circumstances, for how long?

And secondly, the whole issue of information technology and its implications for privacy, for health insurance and all the things that are related to that.

And even more interesting, it seems to me, than some of the current articles in *The New England Journal* is that … 40 to 50 percent of the health dollars [are] spent on illnesses that are related to behavior. All of the issues of research in the social and behavioral sciences, I would predict, will be major elements of the agenda for the first part of the next century because, in fact, that's where a good deal of the next … advances are going to take place.

And I'd be very interested in people's notion as to whether, in fact, scientists on the one hand are really prepared to deal with these kinds of issues—ethical, social, moral issues of … cloning of humans is perhaps the most recent example of that—and on the other hand are the media prepared to deal with the potentials for ideology, theology and a whole variety of other things to enter into science in a way that nobody argued about with Sputnik?

I mean, there was no Religious Right to argue about whether we should try to get a 12-pound ball to go around the earth in 1958, but there are a lot of issues now in these areas, and I wonder how people feel about our capacity in the media to deal with these.

SEIGENTHALER Before I call on Shannon, I'd just say one of the roundtables that Hartz and Chappell conducted was in this room, and Leon Lederman, who's here, was on that panel and raised the same question about journalists' view of theology that you raised today, and I think it's a legitimate one, from a scientist's perspective.

I wonder how a journalist committed to science deals with that issue.

BROWNLEE With religious issues?

SEIGENTHALER Yeah. With the whole question of …

BROWNLEE As rarely as possible. In fact, I think my comment about what Steve was saying went into Ken's comment.

You just gave an extemporaneous version of exactly what I'm talking about is really needed from scientists, which is the ability to put information into perspective, to say what that mainstream point of view is, to say where the conflict is, and to then say what some of the implications are of what the mainstream is concluding and what the implications are of where the disagreement is in science.

What scientists do so much is that they. … When they talk to me, they imagine that they are talking through me to their peers. They are not talking to a lay audience.

And I don't mean that they have to talk down to me, but what they need to do is they need to start thinking about these larger issues when they talk about something. I mean, in some arenas and some findings you don't need bigger issues.

When I talk to Thomas Eisner, a wonderful scientist at Cornell who does work on insects, it's just a really cool finding. It's not something that has to be put into some grand perspective.

So scientists themselves need to learn to talk in those ways, and journalists need to start asking those larger questions and trying to get scientists to think in those ways.

LEE But they may have to do it together. This whole issue of perspective. … Earlier you raised the issue of why don't the scientists put things in perspective. Sometimes they're just not equipped to do so.

BROWNLEE They don't do it. They sit in their labs ….

LEE Sometimes they can't. They need help, and that's why the two have to get together.

We have a little game that we play in our house. [At] the end of each month we try to figure out what's the most significant thing that happened in this last month, from the point of view of long-term history.

Remember, I have all these boys to raise, and I'm trying to get them to think—not always successfully.

The end of last month, everybody voted for Diana, and I said, "Nope. It's not Diana's death. I'm sorry. What really is the most important thing that happened that will affect every person on this planet is IBM's discovery that they can use copper on silicon in chips. That will revolutionize everybody's life five years from now." And they said, "Well, how did you figure that out?" And I said … Because it wasn't in the newspapers. It wasn't in the stories they read and so forth.

And that's where …

BROWNLEE It will be now.

LEE What … And I was very disappointed, Shannon, in the stories that I read about that announcement, because the reporters didn't get it. IBM would have appeared to have been self-aggrandizing if they had come forward and said, "Look, folks. This is going to mean such and such and such."

So we've got to do it together.

SEIGENTHALER We've just heard from three journalists who are committed to coverage of science, and they make the point, I think, extremely well. I mean, you can't tell the story in six paragraphs, as Jack says, or in a sound bite.

It takes the time to address the issue, to deal with arguments on both sides and to come to some informed conclusion about what the facts truly are. And sometimes there …

There's a question in the back of the room.

LOU VILLADSEN Yeah. We are talking about, you know, these grand needs … .

SEIGENTHALER I'm sorry. Would you identify yourself, please.

VILLADSEN I'm Lou Villadsen. I'm from UCLA. I'm getting a nod from Dr. Shine.

You're talking about scientists and journalists putting things into larger perspectives of politics and of the larger body of science. I would make a plea, as the educated lay reader, for putting things into context in the story.

Mr. Lee made a comment about the Mir spinning wildly out of control, and it's rotating every six minutes.

SEIGENTHALER He said it, but …

VILLADSEN OK. I don't know if six minutes is spinning wildly out of control or not, because I don't know whether the Mir's normal rotation is six days or six hours or six years, so I have …

LEE Six minutes is hardly spinning at all. We shouldn't have mentioned it.

VILLADSEN But that's the point. [Say, for instance,] this particular information [is] about cholesterol doubling our risk of this particular type of cancer. What does that mean? Compared to what?

And you can put that in one line in every single story. Even *The Economist*—which I think is one of the best weeklies—fails to put context in most of its articles. And it's so simple, and it would add so much to the discourse for those of us who do read, do pay attention and are trying to make sensible conclusions out of all of the information that we get.

SHINE I'm trying to convince people to develop a new index, which I would call the "Lightning Index." One lightning unit would be the odds that you were hit by lightning. Then you could express a whole variety of other issues—like the probability of death from cancer—in so many lightning units.

LEE We did that on Galileo about the probability of having radioactive plutonium scattered everywhere, and apparently that got lost. It hadn't been done for Cassini. We did it in lightning units.

SEIGENTHALER Leon Lederman had a question. Here's a microphone, doctor.

LEDERMAN I'd like to come back to your cogent article by Dr. Dave Barry.

SEIGENTHALER Dr. Barry of *The Miami Herald*?

LEDERMAN Yes. I think we could dismiss that. To show you what we're up against, I just happen to have here a similar column, but it's not by Dave Barry. It's by the president—former president—of the University of Chicago, Hutchins—you might remember him—who wrote … I'll just read a few little things:

"I do not know much about science, but I know a lot about scientists. Though I do not know much about the professional politics, I know about academic politics, and that is the worst kind.

"Not only is academic politics the worst kind of politics, but scientists are the worst kind of academic politicians."

He goes on from there to get a little more lurid, and to finish he says, "It is clear that the behavior of professors is questionable at best. Scientists are worse than other professors, because they have special problems. One of these is that their productive lives often end at 35.

"I knew an astronomer who contributed"—probably Dave Schramm—"to international journals at the age of 11. Compare that with the difficulty of contributing at a similar age to an international journal on, let us say, Greek law.

"The scientist has limited education. He labors on the topic of his dissertation, wins the Nobel Prize, and by the time he's 35 has suddenly nothing to do.

"He has no general ideas, and, while he is pursuing his specialization, science has gone

past him. He has no alternative but to spend the rest of his life making a nuisance of himself."

So we have the spread from Dave Barry to the president of the University of Chicago in what I think is an almost obscene view of science. Here's the man who never questioned what this 11-year-old said or what the Nobel Prize winner [did] that might have been exciting, might have changed … the way the world works.

There's your problem.

SEIGENTHALER Leon, would you hand the microphone to Alan, please.

McGOWAN Whatever standing I have left in the scientific community I'm probably going to lose after this comment, but I. …You know, part of my reaction to the negative response to Dave Barry, and even to Leon's, is: Come on, folks.

Scientists want to be part of the American life. They want to be part of the American culture, and along comes a very humorous columnist poking a little bit of fun at the pompous scientist—of course, [none] of us knows any pompous scientists, but there are some out there—and then we criticize.

I think we're going to have to understand that when we get out there and are part of the fabric of American thought, we're going to get poked fun at a little bit, and that's the good news.

LEE I don't think he's poking fun at us. I object to his making it *au courant* to be intellectually stupid.

That's what I object to, and that's what that article suggests: that you're resonating with the society if you don't understand all of these things. I deal with it every day in every way. With my children, it is not "in" at their schools to know things. It is better to be ignorant.

And I'm sorry. This is something [about] which I'm very passionate and very obsessed. It is not campy or cool to be stupid. Sorry.

SEIGENTHALER Alan.

McGOWAN Well, I must say I have not read Dave Barry before this, and so he may have … But that column that was read did not indicate to me that it was cool to be stupid. What it indicated to me is that there's a little bit of humor in this thing called science. There's a little bit of humor in people sort of pretending to know everything, and it deserves being poked fun at every once in awhile.

LEE I completely agree with that, that it …

McGOWAN OK.

LEE We deserve to have fun ...

McGOWAN And it tells people also—is a signal to people—that science is important, because important things get poked fun at. If it's not important, it doesn't get poked fun at.

So I think we ought to lighten up a little bit and recognize that Dave Barry or even Shannon Brownlee or anybody who reports science is not the only place that people [learn] about science.

People are smarter than they're often given credit for; they absorb information from a variety of sources. Sometimes we actually don't want that which we say we want. Because when there's controversy in the public and in the media about science, a lot of scientists don't like it because they're sort of washing the laundry in public. But, in fact, that teaches a great deal about the scientific process, and it teaches a great deal about what science is actually about, which is looking for the flaws in an argument.

Now, we have a problem, as Ken pointed out, that we sometimes have difficulty explaining the nuances of a particular issue. And sometimes the media goes overboard, like in the SIDS case, and causes great harm. That's a problem.

We have to deal with that problem, but I think we ought to recognize that we're moving into the spotlight of the American public, and that's the good news, although it [brings] with it some problems.

SEIGENTHALER I should say that … To make the other side of the point, I asked our staff at the center, before I came today, to dig into some of the scientific journals for articles that might make the point that scientists can be unintelligible. I brought along a half-dozen articles—which I'm not going to inflict upon you—but let me say, I don't have to make the point.

If you just read the articles, you will understand why journalists frequently—even the best—don't understand.

Ken.

SHINE ... First of all, I think, let's separate the Dave Barry article from the Hutchins article.

Dave Barry raised a number of important issues, and I think what we're saying is that … My response to that was, it would be nice if he had an opportunity to experience different ways to learn.

My concern is, I don't believe in caricatures, whether you're caricaturing teachers or scientists or anybody else. I think the caricature of the scientist, which is conveyed in the media, on television, and a whole variety of places, is wrong. There are a spectrum of people who do science. They are, as Shannon pointed out, a human …

SEIGENTHALER When you say "wrong," do you mean stigmatizing? Dr. Strangelove … Is that the caricature?

SHINE The whole range of being isolated, of not understanding what's going on in life outside of their …Whatever terms you want to use, there are a whole series of stereotypes that are not appropriate, are not accurate. I just want to just remind this group that my mentor retired on June 30th after 36 years in science. He was a world-famous cardiovascular physiologist who for years has been helping kids in a school in Los Angeles, a minority school, to learn science and understand science.

And when he retired, he took a portion of his retirement fund at the University of California and created seven scholarships for kids in that school to go to college.

And not only was he successful in doing that, but Hughes Aircraft matched them with seven more and his retirement dinners … Instead of giving him money for gifts, he asked people to give money for the scholarship fund, so they got several more scholarships.

Now, is he the average scientist? No. Most scientists don't have the resources to leave a portion of their retirement for this purpose.

But there's a huge spectrum in science, and I think this notion of doing caricatures … I would suggest that President Hutchins needs to go back and spend some time in some science labs to find that there are young people who have very broad, very intense interests, not only in what they do but in the implications of what they do for society. I think we're giving them a bad rap.

SEIGENTHALER You have the floor.

DAVID SCHRAMM What I was going to do is go back and pick up on this point … We were talking about Dave Barry. Now, he's a humorist rather than necessarily a great intellectual.

But I think a problem in American society—and, in some ways, it's more in American society than in some other countries—is that people who are the so-called intelligentsia of American society—the columnists, the anchormen and so on—will pride themselves on not knowing science. Yet they claim to be intellectuals. So they will make statements like "I can't do arithmetic," yet they would be embarrassed to say they can't read.

But they would be … They're perfectly happy and they're not embarrassed to say they can't do arithmetic or they can't understand science. I think that's a real problem that American society has.

You don't see that in, for example, the French intelligentsia or the Japanese, where you will not see a leader in that society say they can't do arithmetic. But you will see it in American society.

SEIGENTHALER Shannon, I saw you nodding your head. Do you want to comment on that?

BROWNLEE I'm agreeing that there is this sort of anti-science attitude among the intelligentsia quite often, and editors are part of that group. But I was also sort of disturbed when you say that anchormen are part … are, you know, among the intelligentsia. That's a scary thought.

SCHRAMM I would agree with that. But, unfortunately, they are the purveyors of what information we have to the bulk of society.

SEIGENTHALER Well, I know that … I hate to say this. I know that many of [the scientists] would not acknowledge that they can't write, but I tell you, if you read the journals, you come to the conclusion that there are many of them that have problems with writing understandably. You can make the point, I suppose, that some journalists do, too.

Jack, do you want to respond to Ken Shine's suggestion that the media stigmatizes you?

GIBBONS I …

SEIGENTHALER "Caricaturizes" is a more accurate thing for a journalist to say.

GIBBONS I have … I once ran the Office of Technology Assessment, and we always developed two "hands" on everything. They were ["on] this [hand"] and [then "on] the other [hand]."

But I enjoyed the Barry quote, because I took it as a wonderful sort of humorous presentation that, in fact, draws attention to the reality that most people don't know where that stuff comes from. They don't connect cause and effect.

And in [not] doing so, they not only are less able to operate as informed citizens, but they also don't get to enjoy life—the extraordinary excitement that comes from thinking about where things come from and where they go.

So I enjoyed that one. But I feel that what we've returned to here in the last few minutes is where C.P. Snow left off sometime back when he talked about the gulf between cultures. His was social science, but I think you can talk about current-day cultures in another way.

You can talk about the gulf between the cultures that think in long-term perspectives versus those that think in short-term perspectives.

In the political world you usually think in terms of the next … Well, let's see, our morning staff meetings mostly are about today, and rarely do we get to the next month.

On the other hand, in the halls of science you really worry about things in the next century, because you are dealing with the pulse that has a naturally long time constant to it.

So it's bridging these … It's identifying and bridging these cultures between not only our disciplines, but the way we see the world, that is really a challenge for all of us.

LARRY WITHAM Yes. Larry Witham from *The Washington Times*. I'm covering this event today, so I'll have to be careful [to] just ask a question.

I don't cover science as a specialty, but I ask scientists about social issues frequently. My question is about the public perception of scientists.

On one hand, [the public] love[s] to learn how computers work or how you genetically engineer insulin. And they're sometimes interested in funding—how much of their tax dollar will go to your projects. But then they meet the occasional scientist who says "science is a way of life" as [in] "skepticism is a way of life."

So you falsify everything in the lab, but then you go home—well, you try to falsify to see if it's true—but then, when you go home, [you] even question what your parents say, question what the religious leaders say, and you know all. Carl Sagan's last book, *Candle in the Dark* … skepticism is a way of life. And then the American public draws back and says, "I don't want those scientists teaching my children."

How do you respond to their concerns?

SEIGENTHALER Anyone. Ken.

SHINE Well, first of all I …

SEIGENTHALER Gentry. All right. First Ken and then Gentry.

SHINE Yeah. First of all, again, I would argue there that this is an oversimplification of science and who scientists are. There are a full range of belief systems among scientists. There are scientists who have written about, for example, how to rationalize the Bible with science.

These are fundamentally important questions, and scientists don't have any better access to the truth about a number of these issues than others. But I think what you're seeing is that they are increasingly concerned about what the impact of what they do has on the rest of society.

After all, that tall, gangly guy that I mentioned who I took the seminar from—Jim Watson—was the one who invented the ELSI program so that the … ethical, social, and legal issues in the genome project—in terms of their implications for society—were funded as part of that activity.

So, I think, (a.) I would not want to oversimplify this particular aspect of things and (secondly) … again, you know, we talk about jargon … As somebody who's criticized lots of my colleagues in science for their shortcomings, I want to emphasize that people who cover financial markets have a hell of a lot of jargon they have to understand about the financial market, and those people have a certain value system. And they—the investment bankers on Wall Street … we don't sit around arguing about what they have to say about social issues when they go home at night.

So I think we ought to be a little bit careful as to, again, what type of stereotypes we place upon what a scientist thinks about a number of value systems.

SEIGENTHALER Just in fairness to what Dave Barry wrote: The bottom line of that column was that he doesn't understand the stock market either. He twice said he was dumb. He said journalists are dumb, twice.

Gentry and then Shannon.

LEE I've been dealing with what scientists are about for many, many years with Saturday morning cartoons. That's where it gets started. I don't know if any of you've ever watched them, but the scientists in real life are never as bad as they are on the Saturday morning cartoons.

This issue about science—scientists having the only way to live and the only way to approach truth—is one that has bothered me for a long time. Most scientists that I know—and I think that the doctor will agree with me here—accept that there are arenas in which science has an epistemology to gain answers and that there's another in which there're no answers that can be gathered by science today—and perhaps not ever.

The single biggest epiphany I ever had—and I'll share this with you right now—was when I realized what Goethe proved really meant that there does not exist a mathematical structure in which all theorems can be proven. There will always be some theorem that cannot be proved.

And when you sit and think about what that means from the point of view of science, you have to accept that there always exists something that you will not be able to use your technique to solve.

Now, I wasn't trying to become too esoteric here. But the point is, most scientists that I know do not regard science as a way of life and apply it to everything in their life.

SEIGENTHALER Shannon and then Bob.

BROWNLEE Dr. Shine and Dr. Lee, I'd like you to remember who your audience is for a moment, and explain who Goethe is and explain what ELSI is.

LEE Thank you, Shannon.

SHINE I actually tried to define it. It's (E)thical, (L)egal, and (S)ocial (I)ssues, and it's the por-

tion of the genome project which funds projects to look at these ethical, social and legal issues.

And, I guess, before you define Goethe, I would want to …

LEE He was a guy.

SHINE Yeah, I know … or identify him—you know, again, the thing, one of the things—reasons—why this is particularly poignant to me is because of our interest in interesting young people in science, particularly minority kids. And I've spent more than a little time in—again—real-life situations with these youngsters.

The notion that a youngster in a minority environment is labeled … a nerd [because he or] she's … interested in mathematics or might be interested in science or. … It compounds the problem that being serious about school is also something that they shouldn't do. And I think that we need to be very much aware that Saturday morning cartoons, in fact, communicate to kids in inner-city schools [what] the value systems are.

And I'm very, very concerned about the fact that, if we're ever going to achieve any kind of economic advance for that sector, that segment of the population, in a society in which science and technology will largely determine what your income is—except for those people who bet on it on Wall Street—those stereotypes, I think, are critically important in terms of the future of those kids.

LEE Fifteen seconds: Goethe's a mathematician whose … Oh, OK. I know you know that. Everybody else knows that, too.

SEIGENTHALER Bob.

BROWNLEE I was just making a point that it's important to remember your audience.

SEIGENTHALER It's just a journalistic needle there, Gentry.

FRI This kind of goes back to Dave Schramm's comment, in light of the question.

You know, seems to me that you need to think of science as at least a part of the arsenal of critical thought in a modern society.

Now, that doesn't need to mean that a TV anchorperson needs to understand quarks in a lot of detail, and I think that's what kind of repels people. We'd like to attract more kids into science so that they'll understand more about quarks, but that's a different problem.

Helping the general populus understand science kind of as a liberal art, the same way we do history and English and so forth, seems to me to be the big challenge, and I would hate … to have those kinds of judgments made by anybody who doesn't at least understand, as a liberal art, as much as about science as they do about theology.

SEIGENTHALER We are about to run out of time, but just a couple of more comments from the floor.

ALFRED GOLDMAN My name is Alfred Goldman.

Ms. Brownlee said that she is overwhelmed by the volume of scientific information available to her. How does she decide what small amount to publish and, therefore, [what] large amount to leave unreported?

BROWNLEE I have a beat—which I don't stick to very well—but I'm supposed to be covering biomedical research. I also cover family issues—children's issues. I dabble in neurobiology and psychology.

But more important: How does the magazine decide what to cover? To a certain extent, what we decide to cover is predigested for us by the journals. *Science* puts out a digest of what the most significant papers are; *Nature* does. A number of the journals do this, and then we try to be a little more enterprising and go to the more obscure journals and look at what's being published there.

We also talk with scientists as regularly as we can to find out what's going on in their fields. So we're constantly having to make judgments about what stories to put in.

Now, there's a tension between what the science journalist wants to put in the magazine and what the editor thinks is interesting, and in some ways this is a good thing, because the editor is Everyman or Everywoman, to some degree. We have a number of editors who have a very fairly strong science background, and they tend to make different choices than the other editors. But there's this sort of weeding-out process that happens when you're trying to decide what to cover and what not to cover.

Now, I need people like Gentry Lee to say to me, "You guys really missed the boat. This stuff about copper on chips is really, really important." And that's where the value of having constant communication and real relationships with scientists comes in.

SEIGENTHALER You know, we've heard from scientists from diverse fields, and we have heard today from three journalists—all print. There is a television anchor from whom we're going to hear at lunch, Bill Curtis here. He is a television journalist who covers science.

Bill, before we break for lunch, I wonder if I could ask you to react to what you've heard. And don't bring up what you're going to say at lunch, but I … this has been a fascinating discussion for me, as a journalist.

Since [the phrase] "sound bite" has come up and the whole question of where the public gets its news—and it gets most of its information from television—would you just react to what you've heard?

BILL CURTIS First of all, I would say that to be included in the nation's intelligentsia was the nicest thing that anybody ever said about a television anchorman.

A couple observations: One is that there is a spectrum of journalism that ranges from tabloids and the paparazzi on the one hand to daily deadlines to more thoughtful scientific publications to television evening news and local news and documentaries within PBS.

And all of those have a different boss, a different editor, and, I guess, a different standard. So you can go from one who, I think, everybody … I was reading the survey too, and the scientists generally—and those that I come in contact with—do not like the press, but they do like the high end of the press, so I think we have to kind of break those down, when you really get down to it.

But I also think that what you're kind of dancing around is that scientists must be as concerned today with communication of their craft as they are with their own research. And that communication has to be—not dumbed-down—but made absolutely simple.

If I were doing an interview with Dr. Lee, I think I would say, "What is Goethe?" and "What are those words?" because they do fall into a category of jargon to the lay-person out there that we represent. We just don't understand, and you lose us. And the minute you lose us, then that's the problem of communication. And you lose children as well.

So I'm committed in the documentaries to absolutely coming down right to the basics and bouncing back and saying, "Do you understand that?" or "What is it again? Let's reduce that to the elementary level."

SEIGENTHALER Thank you very much, Bill.

CURTIS I'll save the rest for lunch.

SEIGENTHALER We've run out of time. I would like simply to say to any of you who would like copies of the interim Hartz/Chappell report, you may get it either by writing to The Freedom Forum here in Washington or to the First Amendment Center at Vanderbilt University in Nashville.

I would like to thank Shannon and Bob, Jack, Gentry and Ken for their contributions to this dialogue today.

I would like to thank this audience for its participation, and I would like to ask them to join in giving a round of applause to this distinguished panel.

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Acknowledgments

The inspiration for this enterprise originated with Joe B. Wyatt, Chancellor of Vanderbilt University. He was properly concerned that many Americans, perhaps a majority, are being deprived of adequate knowledge about the most interesting and exciting discoveries of our time—information they need in order to be informed citizens and to follow matters that are just plain fascinating. For his resolve, insight and encouragement we are indebted.

John Seigenthaler's persistence brought us together and his prudent counsel smoothed our rough edges. Ken Paulson's tenacity burnished the final product.

Our editor, Natilee Duning, endowed with infinite patience, a sharp knife and a large shovel produced cohesion and coherence. David Smith gave it visual pulsation. Tam Gordon coordinated it all with aplomb.

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—Rick Chappell
—Jim Hartz

About the Authors

Jim Hartz

Jim Hartz is a veteran television and print journalist. His credits include his role as host and chief correspondent of Innovation, the award-winning science and technology series on PBS; co-host of NBC's *Today* show (1974-77); and writer, director and narrator of such documentaries as *A Funny Thing Happened on the Way to the Moon* (on the early days of the U.S. space program) and *Red Ink Nightmare* (on the Grace Commission report).

As a military and aerospace reporter for NBC News, Hartz was the first journalist to fly in the U-2 spy plane and the F-15 Eagle. He was also the first reporter to go up in the SR-71 spy plane (at Mach 3 and 80,000 feet), an assignment he undertook for *Reader's Digest* magazine.

Among other honors, Hartz has received five Emmy awards and two Ace awards during his career. In 1990, he was named to the Hall of Fame in his home state of Oklahoma.

Rick Chappell

Charles Richard (Rick) Chappell, has been the Associate Director for Science at NASA's Marshall Space Flight Center in Huntsville, Ala., since 1987 and has directed research in solar terrestrial physics and served as principal investigator on several satellite missions.

From May 1994 to May 1995, he worked with Vice President Al Gore to created an innovative K-12 science education program known as GLOBE (Global Learning and Observations to Benefit the Environment). He founded the Aspen Global Change Institute in 1989, together with John Denver's Windstar Foundation.

Prior to that, he served as alternate payload specialist for the space shuttle mission STS-45, which was carried out in March 1992. From 1976 to 1985, he was mission scientist for Spacelab 1, a joint European/American shuttle mission that conducted investigations in material sciences, life sciences, space physics, earth observations and astronomy.

Chappell graduated magna cum laude in physics from Vanderbilt University and received his Ph.D. in space science from Rice University. He is a member of Phi Beta Kappa and has twice received the NASA Medal for Exceptional Scientific Achievement. He has recently joined Vanderbilt University as the Director of Science and Research Communications and an Adjunct Professor of Physics.

Authors Hartz (left) and Chappell

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