Chapter 7
Science and Technology: Public Attitudes and Understanding

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Highlights

- **Although Americans express strong support for science and technology (S&T), they are not very well informed about these subjects.** Many in the scientific community are concerned that lack of knowledge about S&T may adversely affect the level of government support for research, the number of young people choosing S&T careers, and the public's resistance to miracle cures, get-rich-quick schemes, and other scams.

Information Sources

- **Most adults pick up information about S&T primarily from watching television; the print media are a distant second.** This is true in both the United States and Europe. Several types of television shows play a role in communicating science to the public, including educational and nonfiction programs, newscasts and newsmagazines, and even entertainment programs. However, television (and other media) can be faulted for miscommunicating science to the public by sometimes failing to distinguish between fantasy and reality and by failing to cite scientific evidence when it is needed.
- **The Internet is having a major impact on how the public gets information about S&T.** According to the 2001 National Science Foundation (NSF) survey, the Internet is the preferred source when people are seeking information about specific scientific issues, an indication that encyclopedias and other reference tools have lost a substantial number of customers to the Internet.
- **Books about science influence popular culture and public debate on policy issues.** Beginning in the late 1970s, science-related books began to win more Pulitzer Prizes and appear more often on bestseller lists. Books by the late Carl Sagan achieved publishing milestones that indicate a growing interest in science among the book-reading public.
- **S&T museums are much more popular in the United States than in Europe.** Americans were nearly three times as likely as Europeans to have visited an S&T museum within the past year.

Public Interest in S&T

- **Evidence about the public's interest in S&T is mixed.** Surveys conducted by the Pew Research Center for the People and the Press found that S&T ranked only 9th of 13 categories of news followed most closely by the public in 2002. Yet science/health and technology ranked second and fourth, respectively, as categories of news sought online. The data also indicate that interest in S&T news seems to have declined between 1996 and 2002, along with interest in most subjects. The popularity of science museums and books suggests that people are interested in science even though they may not be following science-related news.
- **Very few Americans admit to not being interested in S&T issues.** Only about 10 percent of surveyed Americans said they were not interested in news about scientific discoveries or new inventions and technologies. In Europe, however, half of surveyed residents said they were not interested in S&T.

Public Knowledge About S&T

- **Neither Americans nor Europeans got high marks in a 2001 quiz designed to measure their knowledge of science.** Out of 13 questions, Americans answered an average of 8.2 correctly, Europeans 7.8.
- **Science knowledge in the United States and Europe is not improving.** Respondents' ability to answer most questions about science has remained essentially unchanged since the 1990s, with one exception: more people now know that antibiotics do not kill viruses. This may be attributable to media coverage of drug-resistant bacteria, an important public health issue.
- **More Americans now agree with the theory of evolution.** The 2001 NSF survey marked the first time that more than half (53 percent) of Americans answered "true" in response to the statement "human beings, as we know them today, developed from earlier species of animals." (In Europe, 69 percent responded "true.") Whether and how the theory of evolution is taught in public schools remains one of the most contentious issues in U.S. science education.
- **Most Americans (two-thirds in the 2001 NSF survey) do not clearly understand the scientific process.** Knowing how ideas are investigated and analyzed—a sure sign of scientific literacy—is important. Critical thinking skills are invaluable not only in science but also in making wise and well-informed choices as citizens and consumers.
- **Studies seem to indicate that not many Americans are "technologically literate."** In addition, the public's understanding of technology lags behind its professed interest in the subject.
- **Belief in various forms of pseudoscience is common in both the United States and Europe.** For example, 60 percent of surveyed Americans said they believe in extrasensory perception, and 41 percent thought that astrology is at least somewhat scientific. More than half of surveyed Europeans said they believe in astrology. Because society is heavily dependent on S&T, scientists are concerned about the persistence of beliefs that run contrary to scientific evidence.

- **A recent poll of scientists found that 42 percent engaged in no public outreach.** Asked why, 76 percent said they did not have time, 28 percent did not want to, and 17 percent did not care. Only 12 percent of the surveyed scientists said they were engaged in political outreach, and 20 percent were in contact with the media.

Public Attitudes About Science-Related Issues

- **Americans generally have highly favorable attitudes regarding S&T.** Attitudes are more positive in the United States than in Europe. For example, in 2001, 72 percent of Americans, compared with 50 percent of Europeans, agreed that the benefits of scientific research outweigh any harmful results.
- **All indicators point to widespread support for government funding of basic research.** In 2001, 81 percent of NSF survey respondents agreed with the following statement: "Even if it brings no immediate benefits, scientific research that advances the frontiers of knowledge is necessary and should be supported by the Federal Government." In Europe, 75 percent of those surveyed agreed with the statement.
- **Optimism about biotechnology actually increased in Europe between 1999 and 2002.** A similar trend occurred in the United States during the same period. However, antibiotechnology sentiments remain more common in Europe than in the United States.
- **Technologies based on genetic engineering are controversial.** Americans overwhelmingly oppose human cloning but are more divided on the subject of medical research that uses stem cells from human embryos. Support for the latter has fluctuated, but in 2003, 47 percent of the public expressed support for stem cell research, and 44 percent were opposed.
- **Americans continue to express confidence in the science community.** In addition, the events of September 11, 2001, seemed to affect the ranking of institutions based on public confidence, giving rise to a surge in ratings for the military and the executive branch of the Federal Government.
- **The public seems to recognize that S&T play a role in combating terrorism.** In one survey, about 90 percent of respondents said that scientific research is either extremely or very important to prepare for and respond to threats of bioterrorism, and more than 80 percent strongly or somewhat supported increased funding for such research.
- **Attitudes toward environmental protection have been shifting in recent years, according to a Gallup survey.** In 2003, 47 percent of those surveyed chose the statement "protection of the environment should be given priority, even at the risk of curbing economic growth," compared with 42 percent who chose its alternative, "economic growth should be given priority, even if the environment suffers to some exent." However, the percentage choosing the former has been declining since 2000, and the percentage choosing the latter has been increasing.

Introduction

Chapter Overview

The vast majority of Americans recognize and appreciate the benefits of science and technology (S&T). They are aware of the role new discoveries play in ensuring their health and safety and the health of the economy. They have welcomed a wide variety of inventions—automobiles, household appliances, and motion pictures, to name just a few—that have improved their quality of life and standard of living. More recently, Americans have enthusiastically embraced major advancements in communication technologies, including the Internet, cellular telephones, and DVD players.

The public is also highly supportive of the government's role in fostering and funding scientific research. According to a survey conducted at the end of the millennium, Americans believe that advancements in S&T were the nation's and the government's greatest achievements during the 20th century (Pew Research Center for the People and the Press 1999).

Although Americans are highly supportive of S&T, their knowledge is limited. Many people do not seem to have a firm understanding of basic scientific facts and concepts. Experts in science communication encounter widespread misunderstanding of how science works. Moreover, surveys conducted by the National Science Foundation (NSF)[1] and other organizations show minimal gains over time in the public's knowledge of science and the scientific method and suggest that belief in astrology and other forms of pseudoscience is widespread and growing.

According to a recent report (NIST 2002), many in the scientific community are concerned that the public's lack of knowledge about S&T may result in:

- Less government support for research
- Fewer young people choosing S&T careers
- Greater public susceptibility to miracle cures, get-rich-quick schemes, and other scams

Chapter Organization

This chapter examines aspects of the public's attitudes toward and understanding of S&T. In addition to data collected in surveys sponsored by NSF, the chapter contains extensive information from studies and surveys undertaken by other organizations that track trends in media consumption and changes in public opinion on policy issues related to S&T. (See sidebar "Data Sources.") One of these sources is the most recent Eurobarometer on "Europeans, Science and Technology" (European Commission 2001), the first comprehensive survey of residents in all European Union member states in nearly a decade.

The chapter is in three parts. The first part focuses on S&T-related information and interest. It begins with a section on sources of news and information, including a detailed look at the role of the Internet. It then examines several measures of public interest in S&T. (Level of interest indicates both the visibility of the science and engineering community's work and the relative importance accorded S&T by society.) The first part also briefly discusses the public's perception of how well informed it is about science-related issues.

The second part of the chapter covers knowledge of S&T. It touches on the importance of scientific literacy; indicators of the public's familiarity with scientific terms and concepts, the scientific method, and technology; and belief in pseudoscience.

The third part examines public attitudes about S&T. It presents data on public opinion about Federal funding of scientific research and public confidence in the science community. It also includes information on how the public perceives the benefits and harms of scientific research and genetic engineering.

[1]The most recent NSF survey was conducted in 2001.

Information Sources, Interest, and Perceived Knowledge

People get news and information about S&T from a variety of sources. However, in both the United States and Europe, most adults find out about the latest S&T developments from watching television. The print media rank a distant second. The Internet, although not the main source of news for most people, has become the main place to get information about specific S&T subjects.

Although most Americans claim to be at least moderately interested in S&T, few science-related news stories attract much public interest. In addition, few people feel well informed about new scientific discoveries and the use of new inventions and technologies.

Sources of News and Information About S&T

The number of people who watch the news on television or read a newspaper has been declining for more than a decade.[2] That does not bode well for news about S&T, which must compete with a host of other topics for the attention of the American public.

Although the percentage of Americans who regularly watch a nightly network news program has declined steadily since the late 1980s,[3] television remains the leading source of news in most households. In the 2001 NSF survey, 53 percent of respondents named television as their leading source of news about current events in general, followed by newspapers (29 percent). Television was also the leading source of news

[2]Although news consumption spiked after the events of September 11, 2001, the number of people who keep up with current events has generally been declining. Americans, especially young people, are increasingly likely to report that they did not watch or listen to the news or read a newspaper the previous day. Between 1994 and 2002, the proportion of people in this category doubled from 10 to 20 percent (Pew Research Center for the People and the Press 2002a).

[3]The proportion of Americans who said they regularly watched a nightly network news program declined from 71 percent in 1987 to 50 percent in 2000. The steady decline appears to have leveled off: in the most recent survey by the Pew Research Center for the People and the Press (2002a), 52 percent of respondents said they watched nightly network news.

Data Sources

Data from the following surveys are included in this chapter.

Sponsoring organization	Title/year*	Information used in the chapter
National Science Foundation	Survey of Public Attitudes Toward and Understanding of Science and Technology (S&T) (2001)	Various knowledge and attitude items, including public support for basic research, belief in pseudoscience, and interest in S&T
European Commission	Eurobarometer 55.2 Europeans, Science and Technology (2001)	Various knowledge and attitude items for European public, including support for basic research, trust in scientists, and views on mad cow disease
European Commission	Eurobarometer 58.0 Europeans and Biotechnology (2002)	European attitudes toward biotechnology
Bayer Corporation	Bayer Facts of Science Education (2003)	Public awareness of the relationship between S&T and national security
The Gallup Organization	Various ongoing surveys (2003)	Public attitudes toward the environment, cloning, space exploration, and biotechnology, and belief in pseudoscience
The Gallup Organization	What Americans Think About Technology (2001)†	Public attitudes toward and understanding of technology
Harris Interactive	The Harris Poll (2002)	Prestige of various occupations
Pew Research Center for the People and the Press	Various ongoing surveys (2002)	Media consumption and public attitudes toward technology
Research!America	Various ongoing surveys (2003)	Public attitudes toward funding health and scientific research
UCLA Center for Communication Policy	Surveying the Digital Future (2002)	Public attitudes toward and use of the Internet
University of Chicago	General Social Survey (2002)	Public confidence in various institutions and government funding of programs
Virginia Commonwealth University Center for Public Policy	VCU Life Sciences Survey (2003)	Public attitudes toward scientific progress and moral values, stem cell research, and genetic testing

*For ongoing surveys, most recent year is shown.
†Conducted for the International Technology Education Association.

about S&T (44 percent), followed by newspapers and magazines (each 16 percent).[4] Despite the growing popularity of the Internet, and the steady stream of technological advances that support the convergence of computer and television capabilities (Markoff 2002), relatively few respondents named the Internet as their leading source of general news (7 percent) or S&T news (9 percent). However, when respondents were asked where they would go to get additional information about a specific scientific topic, such as biotechnology or global warming, nearly half named the Internet (figure 7-1 and appendix tables 7-1, 7-2, and 7-3).

Television is also the European public's main source of news about S&T.[5] In the 2001 Eurobarometer survey, 60 percent of respondents ranked television as either their first or second most important source of information on scientific developments, followed by the written press (37 percent), radio (27 percent), school or university (22 percent), scientific journals (20 percent), and the Internet (17 percent) (figure 7-2). In general, there was little variation in these preferences across countries (table 7-1).

The following sections take a more detailed look at the various sources of news and information about S&T in the United States.

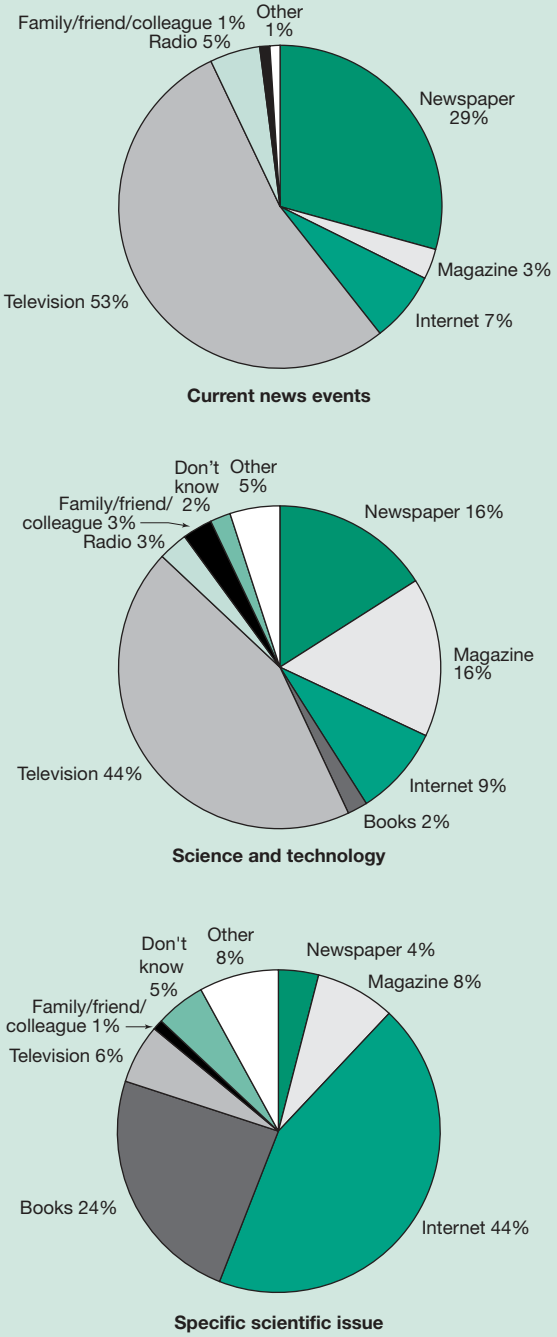
Television

Information about science is communicated to the U.S. public through several types of television programs. Educational and nonfiction shows promote science and aim to be both informative and entertaining. News programs, including national and local morning and nightly newscasts and newsmagazines, devote segments to science-related subjects and issues. In addition, entertainment programs occasionally include information about science.

[4]Only 5 percent of respondents named radio as their primary source of general news. Although only 3 percent said radio was their primary source of science and technology (S&T) news, National Public Radio probably has the largest science staff (about 20 editors and reporters) of any national news organization (Girshman 2002).

[5]Data for the United States and Europe are not directly comparable. U.S. respondents were asked to name their primary source of information; Europeans were asked to rank six sources, and their first and second choices were added together.

Figure 7-1
Sources of information in United States: 2001



NOTES: Categories with less than 0.5% response are not shown. Percents may not sum to 100 because of rounding.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Public Attitudes Toward and Understanding of Science and Technology, 2001. See appendix tables 7-1, 7-2, and 7-3.

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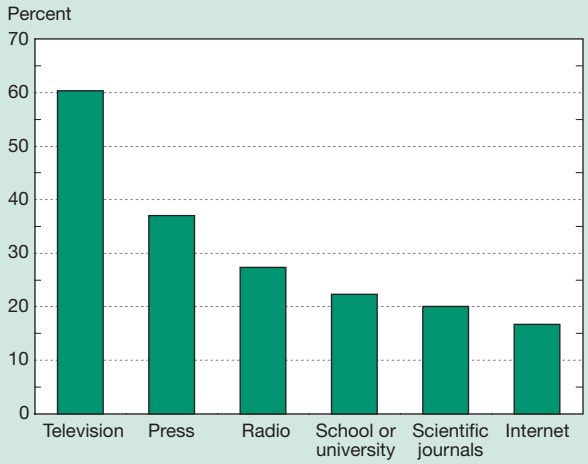
Figure 7-2
Leading sources of information on scientific developments in Europe: 2001



NOTE: Respondents were asked to rank six sources of scientific news, with 1 being most important and 6 being least important. First and second choices were then added together.

SOURCE: European Commission, Eurobarometer 55.2 survey and standard report, *Europeans, Science and Technology,* December 2001.

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A broad range of science-content programs are available on U.S. television, including Public Broadcasting Service (PBS) series (such as *Nova*)[6] and programs aimed at children (such as *Bill Nye the Science Guy*). Most U.S. households now have cable or satellite television and thus have access to the Discovery Channel and a growing array of options made possible by advances in cable and satellite technology. These include an increasing number of channels devoted to S&T and health (e.g., Discovery Health, the National Geographic Channel, and the History Channel)[7] and niche market channels [e.g., the Research Channel, the University Channel, and NASA TV (Folkenflik 2003)].

Nova[8] and other science programs have become highly dependent on visual images. Advances in photographic technology and computer graphics, such as microscopic visuals and computer-generated imagery (CGI), have made it possible to create shows on subjects like genomics, cosmology, and string theory. In addition, CGI can create realistic images of worlds that no longer exist (e.g., the shows "Walking with Dinosaurs" and "Walking with Beasts").

Most programs and documentaries on PBS and cable and satellite channels are highly regarded. According to the 2001 NSF survey, 8 percent of Americans watch *Nova* regularly

[6]According to the executive producer of *Nova*, "science lends itself so well to a mystery story. It always starts with a question… Another element of a science story is usually a star or a cast of characters—some researcher or a group" (Apsell 2002).

[7]In one survey, 37 percent of respondents said they regularly watched documentaries on cable channels. More men than women said they watched these shows (Pew Research Center for the People and the Press 2000a).

[8]Hollywood has occasionally taken its cues from *Nova*. For example, the idea for the 1999 movie *Twister,* which drew notice for its special effects, actually came from the *Nova* episode "Tornado" (Apsell 2002).

Table 7-1
Leading sources of information on scientific developments in Europe, by country: 2001
(Percent)

Country	Television	Press	Radio	School or university	Scientific journals	Internet
All	60	37	27	22	20	17
Belgium	64	37	30	25	21	18
Denmark	61	39	23	28	17	16
Germany	68	44	26	14	15	14
Greece	62	30	33	29	13	10
Spain	53	26	34	25	17	14
France	65	35	34	17	21	10
Ireland	61	39	40	21	14	20
Italy	49	28	16	34	33	24
Luxembourg	42	30	24	19	14	14
Netherlands	59	49	36	27	21	23
Austria	65	41	41	14	16	16
Portugal	59	23	28	19	8	14
Finland	59	50	21	27	22	18
Sweden	66	46	25	23	21	14
Great Britain	60	42	26	23	19	23

NOTE: Respondents were asked to rank six sources of scientific news, with 1 being most important and 6 being least important. First and second choices were then added together.

SOURCE: European Commission, Eurobarometer 55.2 survey and standard report, *Europeans, Science and Technology,* December 2001.

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or most of the time; another 29 percent watch it occasionally.[9] However, other types of programming, such as evening and morning newscasts and newsmagazines like *60 Minutes*, *20/20*, and *Dateline*, reach far more people. Therefore, most television viewers are exposed to information about S&T in news shows that occasionally cover these subjects.[10]

Although television newsmagazines can be a leading source of news about science for the public, the regular audience for these shows has been declining in the past few years (37, 31, and 24 percent in 1998, 2000, and 2002, respectively, among all adults). Most of this audience erosion occurred among women (Pew Research Center for the People and the Press 2002a).[11]

Local newscasts contain a relatively large number of segments about health and medicine. In addition, more time is spent on the weather than any other story in a local newscast. According to the National Institute of Standards and Technology (NIST 2002), "TV weathercasters are often the most visible representatives of science in U.S. households." They have educated the public about jet streams, fronts, barometric pressure, and environmental issues such as global climate change and have even involved schools in collecting the data displayed.

Television entertainment programs occasionally dispense information about science to the public.[12] Because such shows attract relatively large audiences, many people may be educated or become aware of science and science-related issues by watching them. However, television can also distort or mischaracterize science and thus contribute to scientific illiteracy (Nisbet et al. 2002). People whose job it is to communicate science information to the public are concerned that the drive for higher ratings is leading television networks to devote more air time to "monsters of the deep, alien abductions, angels, [and] ghosts, all of which pass for science in…the television industry today" (Apsell 2002).[13] Such shows even appear on educational networks, including

[9]According to one survey, PBS viewership has remained stable (Pew Research Center for the People and the Press 2000a).

[10]For example, in February 2003, *60 Minutes* had a segment on the India Institute of Technology, which trains large numbers of engineers who have become the driving force of innovation in the United States. The long-running series *Sunday Morning* almost always contains at least one segment aimed at fostering public appreciation for S&T; for example, in April 2003, the show included a segment called "Celebrating Einstein's Genius."

[11]An assistant managing editor of National Public Radio recently explained that although the network morning shows do have segments on science, physics is not part of the portfolio "because it's the women who are home getting the kids ready and who have the TV on in the kitchen" (Girshman 2002).

[12]For example, scientists and kids conducting science experiments appear regularly as featured guests on late night talk shows. A lead character on the long-running comedy *Friends* is a paleontologist who is passionate about his work. The dramatic series *The West Wing* has tackled science-related subjects as diverse as the importance of governmental support of basic research, the meaning of the peer review process, and the difference between a physicist and a psychic.

[13]A recent example of this type of program is "Confirmation: The Hard Evidence of Aliens Among Us?," which, according to the chairman of a university physics department, made it more difficult for viewers to distinguish "charlatans from honest researchers" (Krauss 1999). Other examples include psychics and mediums who either have their own shows or make frequent appearances on talk shows; newscast segments, coinciding with release of the movie *Signs*, devoted to the "mystery" of crop circles (which were exposed as a hoax in 1992); and the special "Conspiracy Theory: Did We Land on the Moon?, " which drew large numbers of viewers (Oberg 2003). Some scientists view such programs as harmful because "a misinformed public…is as worrisome as an uninformed public" (Chism 2002).

Discovery, The Learning Channel, and The History Channel (Chism 2002).

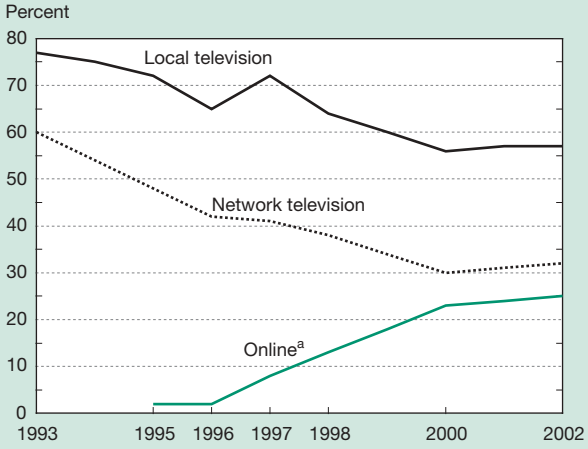
The Internet

Although the Internet has not overtaken television and newspapers as a primary source of news (including S&T news), the results of NSF and other surveys indicate that Internet access is affecting where Americans get news and is an even bigger factor in their acquisition of information about specific scientific issues.

Trends in the Internet as a News Source. According to the Pew Research Center for the People and the Press, the Internet displaced network television in some U.S. households during the late 1990s (figure 7-3). Part of the time Americans used to spend watching television network newscasts is being used instead to browse news-oriented websites. According to the Pew surveys, the percentage of Americans going online for news at least 3 days per week grew from 2 to 23 percent between 1996 and 2000. Even though the number of people connected to the Internet continued to increase between 2000 and 2002, the number relying on the Internet as a news source did not. This finding holds true even among college graduates, who tend to be far more Internet savvy than those with less education.

Characteristics of Internet News Users. The demographic profile of Internet news users has remained virtually unchanged: they tend to be younger, male, more affluent, and better educated. For example, in 2002, Pew survey respondents going online for news at least once a week included 43 percent of those younger than 50 (nearly double the percentage of those 50 and older), 41 percent of men (compared with 29 percent of women), and 57 percent of college graduates (compared with 26 percent of high school graduates).

Figure 7-3
Use of broadcast versus online news: 1993–2001



[a]Online news is obtained at least 3 days a week.

SOURCE: Pew Research Center for the People and the Press, Biennial Media Consumption Survey, 2002.

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Categories of News Sought Online. Categories of news sought online have changed somewhat over the years (Pew Research Center for the People and the Press 2002a). The most popular category in 2002 was weather, followed by science and health (table 7-2). Technology, which topped the list in 1996, ranked fourth in 2002, just below international news. (Interest in international news grew 10 percentage points between 2000 and 2002, possibly because of the events of September 11, 2001.)

Internet users and nonusers have different news interests. In 2002, Internet users were more likely than nonusers to be interested in news about S&T, business and finance, international affairs, culture and arts, and sports, and they were less likely than nonusers to be interested in news about religion and crime. The S&T category had the greatest difference: 21 percent of Internet users said they followed news about S&T very closely, compared with 11 percent of nonusers[14] (table 7-3).

Science Information on the Internet. Although the Internet is not the leading source of news, it is now the preferred source when people are seeking information about specific scientific issues. In the 2001 NSF survey, when asked where they would go to learn more about a scientific issue such as global warming or biotechnology, 44 percent of respondents chose the Internet as their preferred source. About half as many (24 percent) chose books or other printed material, an indication that encyclopedias and other reference books are now taking a back seat to the Internet as research tools for the general public. No other source scored above 10 percent. (See figure 7-1, appendix table 7-3, and sidebar, "Science and the Internet.")

Table 7-2
Use of Internet as source of news: 1996–2002
(Percent)

Type of news	1996	1998	2000	2002
Weather	47	48	66	70
Science and health	58	64	63	60
International	45	41	45	55
Technology	64	60	59	54
Political	46	40	39	50
Business	53	58	53	48
Entertainment	50	45	44	44
Sports	46	39	42	47
Local	27	28	37	42

SOURCE: Pew Research Center for the People and the Press, Biennial Media Consumption Survey, 2002.

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[14]Experienced Internet users reported spending 5.5 percent of their online time looking up medical information and 7.5 percent of their time on the news (Cole 2002).

Table 7-3
News followed by American public, by Internet user status: 2002
(Percent)

Type of news	All respondents	Use Internet	Do not use Internet
Community	31	31	31
Crime	30	29	33
Health	26	25	27
Sports	25	26	23
Local government	22	22	22
International affairs	21	23	17
Washington news	21	22	20
Religion	19	16	24
Science/technology	17	21	11
Business/finance	15	17	11
Entertainment	14	14	12
Consumer news	12	13	11
Culture and arts	9	11	7

SOURCE: Pew Research Center for the People and the Press, Biennial Media Consumption Survey, 2002.

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Newspapers and Newsmagazines

The decline in newspaper readership during the past decade has been well documented. In addition, newspapers have reduced the number of reporters specializing in science and the amount of space devoted to stories about science (Girshman 2002).[15]

Surveys conducted by the Pew Research Center show that the percentage of Americans responding positively to the question "do you happen to read any daily newspaper or newspapers regularly, or not" declined from around 70 percent or more in the early and mid-1990s to 63 percent in the early 2000s. Responses to another question, "did you get a chance to read a daily newspaper yesterday," showed a similar pattern: those answering "yes" fell from approximately 50 percent in the mid-1990s to 41 percent in 2002. Data from NSF surveys indicate that newspaper readership has declined at all education levels.

The percentage of people who report regularly reading a weekly newsmagazine such as *Time*, *U.S. News and World Report*, or *Newsweek* fell from a high of 24 percent during the mid-1990s to 13 percent in 2002; the amount of time spent reading these magazines also declined (Pew Research Center for the People and the Press 2002a).

The leading science magazines in the United States (according to sales figures) are *Popular Science*, *Discover*, *Scientific American, Wired, Natural History, Science News, Astronomy,* and *Science*. A total of 4.4 million copies of these publications are sold each month, with *Popular Science* accounting for 1.5 million, *Discover* about 1 million, and *Scientific American* approximately 700,000. The vast majority of both subscribers and readers of science magazines are men, and they tend to be well educated and have high incomes. For example, 85 percent of the readers of *Scientific American* have college degrees, and 60 percent have graduate or professional degrees. Readers of *Wired* have the highest average household income: $132,000. The average age of science magazine readers is in the 40s: 49 for *Scientific American* and *Discover*, 43 for *Popular Science*, and 41 for *Wired* (Wertheim 2003).

[15] Although most major newspapers have reduced science coverage, the *New York Times* may be an exception.

Science and the Internet

Various surveys offer insights into the public's use of the Internet as a source of general or scientific/health-related information:

- **Why use the Internet?** According to a survey conducted in 2002, 28 percent of very experienced Internet users (6 or more years) said that the primary reason they started using the Internet was the "ability to get information quickly." This was the highest percentage of any of the choices respondents were given; "for work" came in second at 24 percent, followed by "for school" at 14 percent. In addition, 61 percent of respondents said that the Internet is a very or extremely important source of information; 60 percent gave the same response for books, as did 58 percent for newspapers and 50 percent for television (Cole 2002).
- **Is Internet information accurate?** In a survey conducted in 2002, 50 percent of respondents said that most of the information on the World Wide Web is reliable and accurate, and 40 percent said that about half of the information is accurate. The comparable percentages for 2001 were 56 percent and 36 percent, respectively (Cole 2002).
- **Is Internet information trustworthy?** In another survey, when respondents were asked about their trust in various sources of information on medical and health research, the Internet came in last (at 56 percent), behind nurses (95 percent), pharmacists (94 percent), "your physician" (93 percent), medical schools and teaching hospitals (92 percent), "your dentist" (90 percent), voluntary health agencies (87 percent), media sources (63 percent), pharmaceutical companies (62 percent), and health maintenance or health insurance organizations (56 percent) (Research!America 2003).
- **How frequent are Internet visits?** In 2002, 18 percent of those surveyed said they had visited a website for science information once or twice during the past 30 days; 8 percent said three to five times and another 8 percent said more than five times (Davis, Smith, Marsden 2003).

Books

People still read. In a recent survey, most respondents (75 percent) said that their use of the Internet has not affected the amount of time they spend reading books, newspapers, and magazines. About 20 percent said they spend less time reading because of the Internet, and 6 percent said they actually spend more time reading because of the Internet. Books rival the Internet as a very or extremely important source of information: almost identical numbers of respondents, three of five, made this claim. In addition, books were second only to television as a very or extremely important source of entertainment (Cole 2002).

Despite the expanding array of alternative sources of information, books continue to influence public debate and "are part of the media mix that permeates our culture" (Lewenstein 2002). Probably the most famous example of a science book influencing public debate was Rachel Carson's *Silent Spring,* which is widely credited with having started the environmental movement.

In addition to textbooks, handbooks, manuals, and conference proceedings that are written and produced for students and working scientists, there are science-related books meant for the general public, and some of these make bestseller lists and win prizes. By reaching a wider audience, they stimulate public and intellectual debate and contribute to popular culture. Other widely used books such as birdwatching guides and nature books spark interest in science among nonscientists. Self-improvement books about subjects such as diet, physical and mental health, and sex draw on medical, psychological, and other types of scientific research.

An indicator of increasing interest in scientific subjects among the book-reading public is the growing frequency with which science-related books make bestseller lists. Beginning in the late 1970s, such books began to appear more often on those lists and also started to win prizes on a regular basis. The release of Carl Sagan's *Dragons of Eden* marked a major milestone in the publication of books about science. It made the *New York Times* bestseller list in 1977 and won the Pulitzer Prize in the "general nonfiction" category in 1978. Thereafter, the number of science-related books added to the *Times* bestseller list in a typical year increased from fewer than 10 to more than 10, and books about science began receiving Pulitzer Prizes every year or every other year (figure 7-4 and table 7-4).

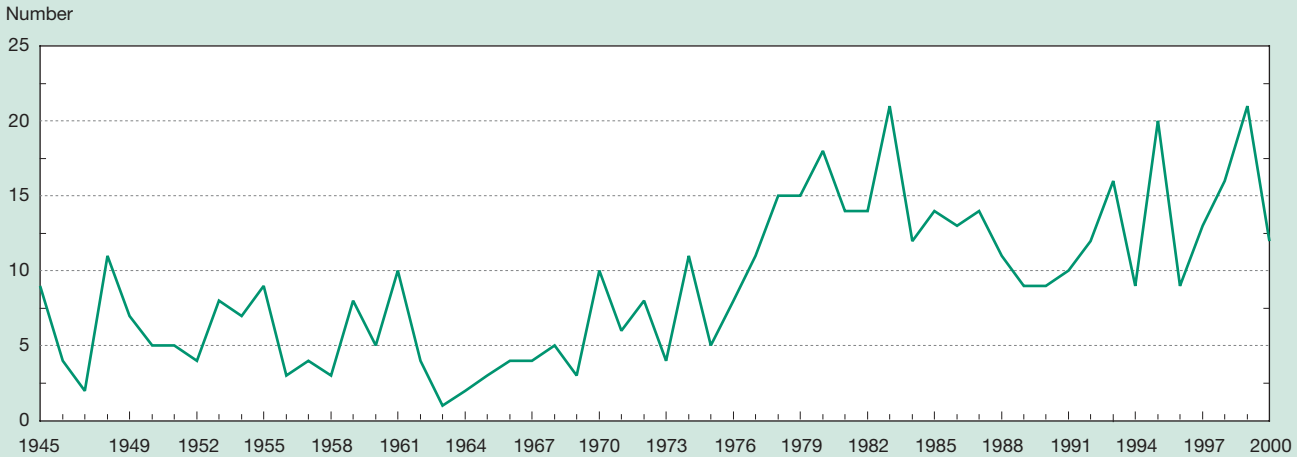
A few years after *Dragons of Eden* was published, another milestone was reached. Once again, Sagan was responsible. In 1980, his *Cosmos* became the first science-related book on the *Publishers Weekly* bestseller list to sell more than a half million copies. It was followed in 1988 by Stephen Hawking's *A Brief History of Time*, which has sold more than 9 million copies worldwide.

According to a science historian who has tracked the increasing popularity of books about science, an author's style and personality have a lot to do with whether a book reaches a wide, mainstream audience and becomes a bestseller (Lewenstein 2002). Sagan is a case in point. The success of his *Cosmos* was partially attributable to the popularity of the television series he hosted. The $2 million advance he subsequently received for his science fiction novel *Contact* was then the largest advance ever paid for a work of fiction.

Museums

Surveys show that S&T museums are more popular in the United States than in Europe. In 2001, 30 percent of NSF survey respondents said they had visited such a museum in the last 12 months, compared with only 11 percent of Europeans surveyed (European Commission 2001). When Europeans who had not visited an S&T museum were asked their reasons, a third said they were not interested in going

Figure 7-4
Science titles added to *New York Times* bestseller list: 1945–2000



SOURCE: B. Lewenstein, How science books drive public discussion, paper presented at conference, Communicating the Future: Best Practices for Communication of Science and Technology to the Public (Gaithersburg, MD, March 8, 2002).

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Table 7-4
Science-oriented Pulitzer Prize books after World War II

Award year	Title	Author	Category
1947	*Scientists Against Time*	Baxter	History
1967	*Exploration and Empire*	Goetzmann	History
1978	*Dragons of Eden*	Sagan	General nonfiction
1979	*On Human Nature*	Wilson	General nonfiction
1980	*Godel, Escher, Bach*	Hofstadter	General nonfiction
1982	*Soul of a New Machine*	Kidder	General nonfiction
1984	*Social Transformation of American Medicine*	Starr	General nonfiction
1986	*…The Heavens and the Earth*	McDougall	History
1988	*Launching of Modern American Science*	Bruce	History
1991	*Ants*	Holldobler & Wilson	General nonfiction
1995	*Beak of the Finch*	Weiner	General nonfiction
1998	*Summer for the Gods*	Larson	History
1998	*Guns, Germs, and Steel*	Diamond	General nonfiction
1999	*Annals of the Former World*	McPhee	General nonfiction

SOURCE: B. Lewenstein, How science books drive public discussion, paper presented at conference, Communicating the Future: Best Practices for Communication of Science and Technology to the Public (Gaithersburg, MD, March 8, 2002).

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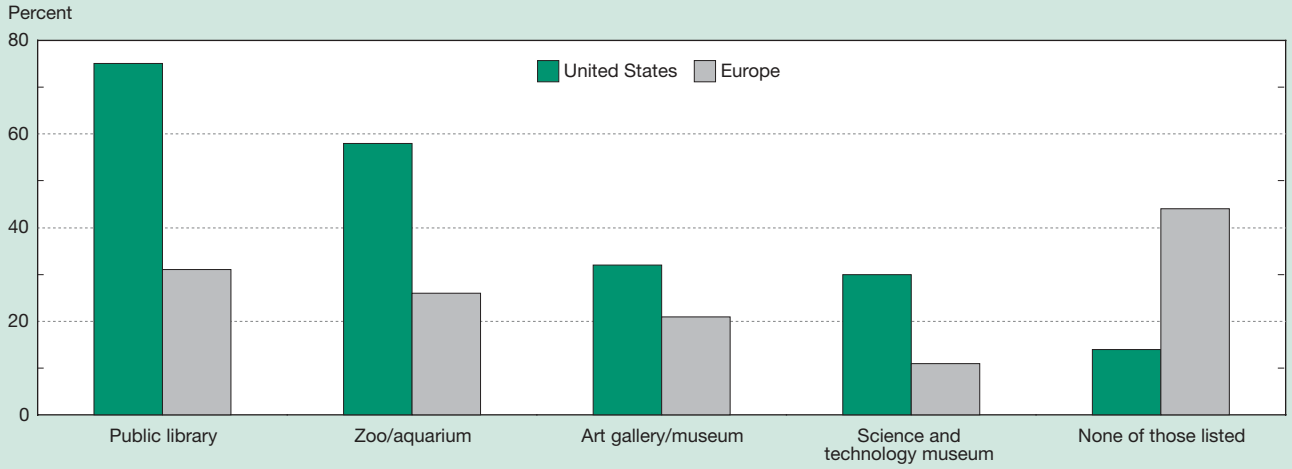
Figure 7-5
Type of establishment visited during past 12 months: 2001



SOURCES: National Science Foundation, Division of Science Resources Statistics, Survey of Public Attitudes Toward and Understanding of Science and Technology, 2001; and European Commission, Eurobarometer 55.2 survey and standard report, *Europeans, Science and Technology,* December 2001.

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and nearly as many said they did not have the time (only 3 percent said the entrance fee was too high).[16]

S&T museums are not the only public attractions that are less popular in Europe than in the United States. Europeans are also much less likely than Americans to visit zoos (26 versus 58 percent) and libraries (31 versus 75 percent) and are even less likely to visit art museums (21 versus 32 percent). Only 14 percent of surveyed Americans said they had not visited any of the four types of attractions during 2001, compared with nearly half (44 percent) of Europeans (figure 7-5).

Public Interest in S&T

Surveys conducted by NSF and other organizations consistently show that Americans are interested in issues related to S&T. Very few people admit to not being interested in these subjects. In 2001, about 45 percent of NSF survey respondents said they were very interested in new scientific discoveries and the use of new inventions and technologies. About the same number said they were moderately interested

[16]Surveys conducted in the United Kingdom show that young people there are not interested in attending science-based attractions such as museums or in watching television programs about science. "Essentially, science is not a major thing in their world" (Burnet 2002).

in these subjects. Only about 10 percent were not interested at all.[17]

In Europe, 45 percent of survey respondents said they were "rather interested" in S&T, which is similar to the percentage of Americans who expressed an interest.[18] However, in sharp contrast to the 10 percent of American respondents who admitted disinterest in S&T, more than half (52 percent) of European respondents said they were not interested. U.S. and European findings coincided in two areas: more men than women expressed an interest in S&T, and respondents were more interested in medicine and the environment than in S&T in general.[19]

Despite the American public's professed interest in S&T issues, there is reason to believe that their interest may not be as strong as the data indicate. Surveys conducted by the Pew Research Center for the People and the Press show that community affairs, crime, health, and sports were the four types of news followed most closely by the American public in 2002; S&T ranked ninth, down two slots from its 2000 ranking. In addition, the level of interest in S&T (as measured by the percentage of survey respondents following related news very closely) declined between 1996 and 2002, along with an even greater decline for health-related stories (although these stories continued to rank high compared with other topics). In fact, by the same measure, interest in most subjects declined during the period; international affairs was an exception to this trend. (See table 7-5 and sidebar, "Few Science-Related News Stories Attract Public Interest.")

Still, interest in news about S&T is only part of the story. Other indicators discussed earlier in this chapter, including the popularity of S&T museums and the growing number of science-related books on bestseller lists, suggest that many people are interested in science even though they may not follow science news.

Table 7-5
News followed very closely by American public: 1996–2002
(Percent)

Type of news	1996	1998	2000	2002
Community	35	34	26	31
Crime	41	36	30	30
Health	34	34	29	26
Sports	26	27	27	25
Local government	24	23	20	22
Washington news	16	19	17	21
International affairs	16	16	14	21
Religion	17	18	21	19
Science and technology	20	22	18	17
Business and finance	13	17	14	15
Entertainment	15	16	15	14
Consumer news	14	15	12	12
Culture and arts	9	12	10	9

SOURCE: Pew Research Center for the People and the Press, Biennial Media Consumption Survey, 2002.

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The Public's Sense of Being Well Informed About S&T Issues

In general, most Americans do not think they are well informed about S&T issues. In the 2001 NSF survey, fewer than 15 percent of respondents described themselves as being very well informed about new scientific discoveries and the use of new inventions and technologies; approximately 30 percent considered themselves to be poorly informed.[20] Americans felt better informed about local school issues, economic issues and business conditions, new medical discoveries, and environmental pollution. On some types of issues, people felt less informed in 2001 than they used to. This downward trend is particularly noticeable for the five S&T-related issues included in the survey: new medical discoveries, new scientific discoveries, the use of new inventions and technology, space exploration, and environmental pollution (appendix table 7-4).

The European public also feels uninformed about S&T. In 2001, most Europeans (61 percent) said they felt poorly informed; one-third felt well informed. Europeans were more likely to feel well informed about sports, culture, and politics than about S&T issues and about as likely to feel uninformed about economics and finance as about S&T (European Commission 2001).

[17]Other surveys had similar findings (VCU Center for Public Policy 2003). When asked about their interest in scientific discoveries, only 10 percent of respondents said they were "not much interested," and only 3 percent said they were "not at all" interested; 44 percent said they had "a lot" of interest, and 43 percent reported "some" interest.

[18]In Europe, the greatest interest in S&T tended to be in countries with relatively large numbers of college graduates, including Sweden (64 percent interest in S&T), Denmark (61 percent), the Netherlands (59 percent), and France (54 percent). Conversely, relatively low interest was found in countries with fewer college graduates, such as Ireland (32 percent interest) and Portugal (38 percent). Exceptions to this general relationship between higher education and interest in S&T were Greece, where interest was high (61 percent), and Germany, where interest was low (30 percent).

[19]The American public is very likely to read or listen to news about public health issues. For example, in a Research!America survey, 71 percent of respondents said they were very likely to read or listen to news about medical breakthroughs in treatments for diseases, 67 percent said the same about public health crises, and 60 percent said they were likely to pay attention to news about research that keeps people free from disease (Research!America 2002).

In Europe, survey respondents with a high level of formal education were more likely than others to say they were interested in the environment. In contrast, there was no association between education and level of interest in medicine. The Internet ranked third among the S&T developments of greatest interest to Europeans (European Commission 2001).

[20]In another survey conducted in 2001, only 11 percent of respondents described themselves as "very informed" about scientific discoveries, 60 percent thought they were "somewhat informed," 24 percent answered "not very informed," and 4 percent said that they were not at all informed about scientific discoveries (VCU Center for Public Policy 2002).

Few Science-Related News Stories Attract Public Interest

For nearly 2 decades, the Pew Research Center for the People and the Press has been tracking news stories that attract public interest. Of the approximately 1,000 most closely followed news stories of 1986–2002, not many had anything to do with science and/or technology. And, of the few that did, most were about weather and other types of natural disasters (such as earthquakes) and health-related subjects—not about scientific breakthroughs and technological advances. It should be noted, however, that an engineering/technology story actually does top the list. In July 1986, 80 percent of those surveyed said they were closely following news about the explosion of the space shuttle Challenger—not a natural disaster, but a manmade one. Table 7-6 lists the most closely followed S&T-related stories of 2000–2002 (Pew Research Center for the People and the Press 2003).

In 2000, the leading science-related news story was the announcement that scientists had completed mapping the human genome. For a science story, this one attracted a relatively high level of interest: 16 percent of respondents said they were following the story very closely. Nevertheless, that percentage was about half that (31 percent) needed to make the top 10 list for 2000. The leading story for the year was increasing gas prices: 61 percent of respondents followed that story very closely (Pew Research Center for the People and the Press 2000b).

The events of September 11, 2001, had a dramatic effect on news consumption. The Pew Research Center's surveys show that the average percentage of respondents following a typical news story more than doubled, from 23 percent during the 1990s to 48 percent in 2001. And, the center's top 10 list for 2001 looks very different from lists compiled in previous years. Eight of the top 10 news stories of 2001 were terrorism related; the percentage of respondents who followed these stories ranged from 78 percent down to 51 percent. Two science-related stories—the anthrax scare and a weather-related story—just missed the top 10, ranking 12th and 13th (at 48 and 47 percent), respectively (Pew Research Center for the People and the Press 2001). (At 61 percent, the rising price of gas was the top non-terrorism-related story of 2001.)

In 2002, interest in terrorism declined, although terrorism-related stories continued to dominate the top 10 list. At 65 percent, the top story in 2002 was the sniper shootings in the Washington, D.C., area. Two science-related stories—hurricanes on the Gulf Coast and cases of West Nile virus—ranked 12th and 15th (at 38 and 34 percent), respectively, in 2002 (Pew Research Center for the People and the Press. 2002c).

Table 7-6
Science/technology-related news stories attracting most public interest: 2000–02
(Percent)

News stories	Public interest	Date question asked
Reports of anthrax in United States	47	Nov-01
Firestone tire recall	42	Oct-00
Winter weather in Northeast and Midwest	42	Jan-01
Reports of anthrax in United States	41	Nov-01
Hurricanes in Louisiana and Gulf of Mexico	38	Oct-02
Cases of West Nile virus	34	Sep-02
Bush decision on stem cell research	31	Aug-01
Federal ruling on Microsoft	28	Jun-00
Food and Drug Administration's decision on RU-486	26	Oct-00
Outbreak of foot-mouth disease in Europe	22	Mar-01
Midwest floods	20	Apr-01
Droughts in United States	19	Apr-02
Reports on AIDS in Africa	19	Jul-00
Worldwide AIDS epidemic	19	Aug-01
Hackers attacking websites	18	Feb-00
Mad cow disease in Europe	18	Aug-01
AOL-Time Warner merger	17	Jan-00
Government's plan for Microsoft	16	May-00
Mapping human genetic code	16	Jul-00
Earthquake in India	15	Feb-01
Missile defense system	15	May-01
Oil spill off coast of Spain	15	Dec-02
Reports of cloned baby by religious cult	14	Jan-03
Court ruling in Microsoft case	13	Apr-00
Floods in Mozambique	10	Mar-00
United Nations special session on AIDS	6	Jul-01

NOTE: Percents reflect respondents who said they followed the story "very closely." Because Pew Research Center surveys are conducted every 2 weeks, the "reports of anthrax" item appears twice in November 2001.

SOURCE: Pew Research Center for the People and the Press, News Interest Index, Public Attentiveness to News Stories: 1986–2002 (Washington, DC, 2003).

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Public Knowledge About S&T

Surveys conducted in the United States and Europe reveal that many citizens do not have a firm grasp of basic scientific facts and concepts, nor do they have an understanding of the scientific process. In addition, belief in pseudoscience (an indicator of scientific illiteracy) seems to be widespread among Americans and Europeans. Studies also suggest that not many Americans are technologically literate.

Importance of Scientific Literacy

Scientific literacy in the United States (and in other countries) is fairly low. (Scientific literacy is defined here as knowing basic facts and concepts about science and having an understanding of how science works.) The majority of the general public knows a little but not a lot about science. For example, most Americans know that the Earth travels around the Sun and that light travels faster than sound. However, few know the definition of a molecule. In addition, most Americans are unfamiliar with the scientific process.[21]

It is important to have some knowledge of basic scientific facts, concepts, and vocabulary. Those who possess such knowledge are better able to follow science news reports and participate in public discourse on science-related issues. An appreciation of the scientific process may be even more important. Understanding how ideas are investigated and analyzed is a sure sign of scientific literacy. It is valuable not only in keeping up with important science-related issues, but also in evaluating and assessing the validity of any type of information and participating meaningfully in the political process (Maienschein 1999).

As noted earlier in this chapter, the science community has expressed concern that the public's lack of knowledge about science may have far-reaching consequences. Experts in science communication have identified challenges and successes in efforts to address this lack of knowledge. (See sidebar, "Communicating Science to the Public.")

The benefits of scientific literacy have become increasingly apparent in the wake of a landmark 1993 Supreme Court decision that addressed how particular types of evidence should be handled in legal proceedings (Kosko 2002). A recent survey revealed that many judges did not possess the knowledge necessary to determine whether evidence presented as scientific was, in fact, scientific. Seeking assistance in recognizing which scientific claims should be kept out of the courtroom, a group of judges recently approached a scientist who has spent part of his career helping the public distinguish valid from unfounded scientific claims. The judges asked the scientist to provide them with "indicators that a scientific claim lies well outside the bounds of rational scientific discourse." (See sidebar, "Science and the Law.")

[21]Researchers have concluded that fewer than one-fifth of Americans meet a minimal standard of civic scientific literacy (Miller, Pardo, and Niwa 1997).

Understanding Scientific Terms and Concepts

Neither Americans nor Europeans got high marks in a 2001 quiz designed to test their knowledge of science. Both groups were asked 13 questions. On average, Americans answered 8.2 questions correctly, compared with 7.8 for Europeans.[22] Americans scored higher than Europeans on seven of the questions (figure 7-6).

Response to one of the questions, "human beings, as we know them today, developed from earlier species of animals," may reflect religious beliefs rather than actual knowledge about science. In the United States, 53 percent of respondents answered "true" to that statement in 2001, the highest level ever recorded by the NSF survey. (Before 2001, no more than 45 percent of respondents answered "true.") The 2001 result represented a major change from past surveys and brought the United States more in line with other industrialized countries about the question of evolution.

During most of the 20th century, probably the most contentious issue related to the teaching of science has been whether and how evolution is to be taught in U.S. public school classrooms.[23] The controversy has continued in the new millennium, erupting in Ohio, Georgia, Texas, and elsewhere. Contention about this issue also surfaced in England in 2001. (See sidebar, "More Than a Century After Darwin, Evolution Still Under Attack in Science Classrooms.")

Neither the U.S. survey nor the Eurobarometer has shown much change in the public's level of knowledge about science, with one exception: the number of people who know that antibiotics do not kill viruses has been increasing. In 2001, for the first time, a majority (51 percent) of U.S. respondents answered this question correctly, up from 40 percent in 1995. In Europe, 40 percent of respondents answered the question correctly in 2001, compared with only 27 percent in 1992.[24]

The promising trend in knowledge about antibiotics and viruses suggests that a public health campaign to educate the public about the increasing resistance of bacteria to antibiotics has been working. This problem has been the subject of widespread media coverage,[25] and whenever the main culprit—the overprescribing of antibiotics—is mentioned, so is the fact that antibiotics are ineffective in killing viruses. In addition, parents of young children, especially those prone to ear infections, have been warned by their pediatricians

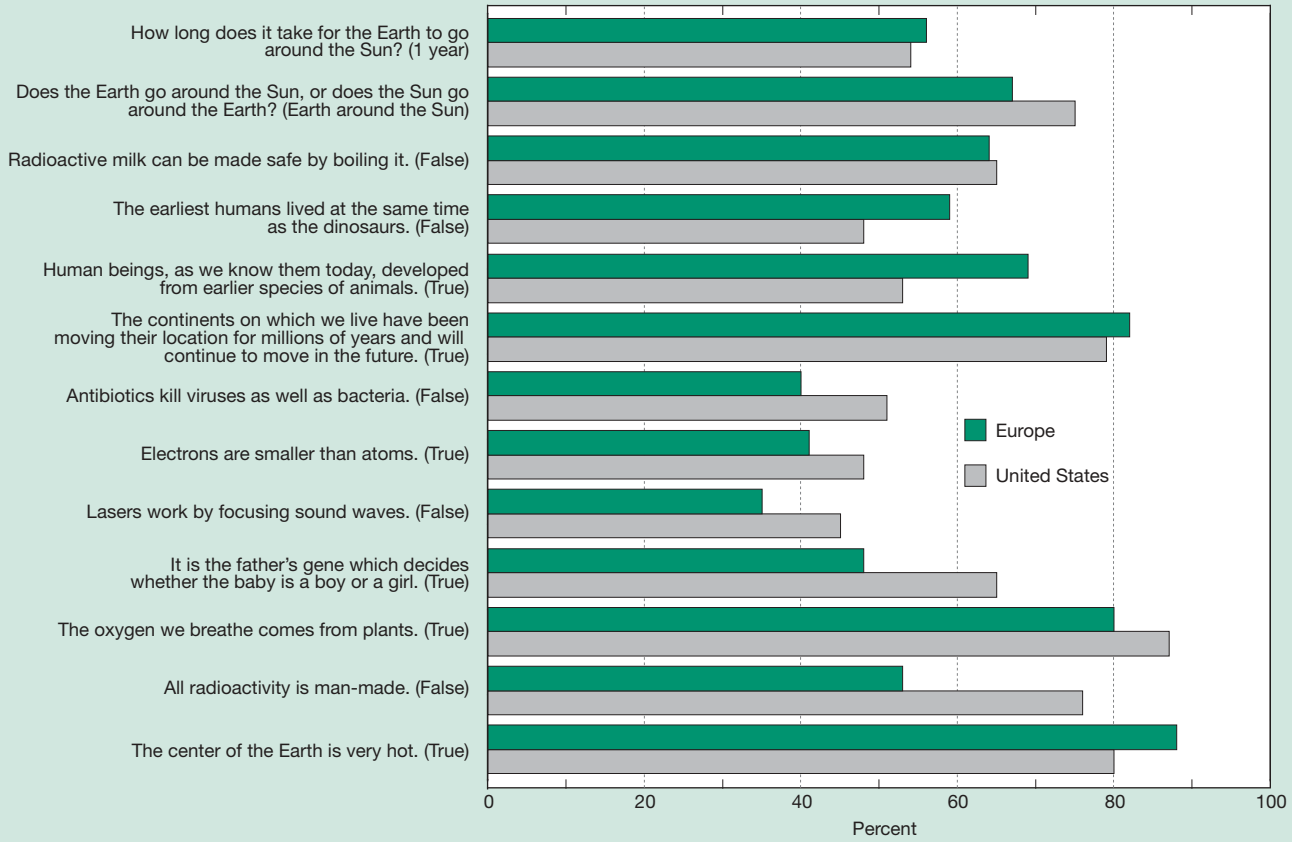
[22]In Europe, residents of Sweden, the Netherlands, Finland, and Denmark scored the highest, residents of Portugal, Ireland, Greece, and Spain the lowest.

[23]The National Science Board issued a statement on the subject in August 1999 (National Science Board 1999).

[24]Results from another survey indicate that most (93 percent) of the public has seen, heard, or read reports about the overuse of antibiotics causing a serious health problem. Although 79 percent of survey respondents were aware that colds and the flu are caused by viruses, not bacteria, and 61 percent knew that antibiotics are not effective in treating viruses, about half (49 percent) believed that antibiotics are at least somewhat effective in treating colds and the flu (Taylor and Leitman 2002).

[25]Recent examples include the outbreaks of severe acute respiratory syndrome (SARS) and monkey pox during 2003.

Figure 7-6
Public understanding of scientific terms and concepts: 2001



SOURCES: National Science Foundation, Division of Science Resources Statistics, Survey of Public Attitudes Toward and Understanding of Science and Technology, 2001; and European Commission, Eurobarometer 55.2 survey and standard report, *Europeans, Science and Technology*, December 2001.

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about this problem.[26] However, the message still has not reached a large segment of the population, in both the United States and Europe.

Americans apparently are also becoming more familiar with the terminology of genetics. In a 2001 NSF survey, 45 percent of respondents were able to define DNA. The percentage of correct responses to this survey question increased in the late 1990s, a trend that probably reflected the heavy media coverage of DNA use in forensics and medical research. More recently, a 2003 Harris poll found that 60 percent of adults in the United States selected the correct answer when asked "what is DNA?" (the genetic code for living cells), and two-thirds chose the right answer when asked "what does DNA stand for?" (deoxyribonucleic acid) (KSERO Corporation 2003).

Surveys also indicate that the American public lacks an appreciation of basic statistical concepts and terminology. If statistics were confined to academic journals and textbooks, this finding would be of limited interest. But daily newspapers and even television newscasts rely on tables and charts to illustrate all kinds of trends. (See sidebar, "Understanding Statistics.")

Understanding the Scientific Process

NSF surveys have asked respondents to explain in their own words what it means to study something scientifically. Based on their answers, it is possible to conclude that most Americans (two-thirds in 2001) do not have a firm grasp of what is meant by the scientific process.[27] This lack of understanding may explain why a substantial portion of the population believes in various forms of pseudoscience. (See discussion of "Belief in Pseudoscience" in this chapter.)

In 2001, both the NSF survey and the Eurobarometer asked respondents questions designed to test their knowledge of how an experiment is conducted and their understanding

[26]A recent study found that the number of prescriptions for antibiotics for children in the United States declined significantly between 1996 and 2000 (Finkelstein et al. 2003) and that parents who demand antibiotics for their children's ear infections can be swayed by doctors to change their minds (Siegel 2003).

[27]Correct explanations of scientific study include responses describing it as theory testing, experimentation, or rigorous, systematic comparison.

Communicating Science to the Public

Experts in science communication agree that there is no general audience for information about science and technology (S&T). Messages must be tailored to the needs and knowledge levels of specific audiences, especially policymakers, the press, researchers, and the "science-attentive" public (i.e., people who are interested in and knowledgeable about science, which is 10 percent of the population, according to the 2001 National Science Foundation survey).*

Science communicators cite two recent trends that have had a major impact on their profession:

- **The Internet has revolutionized communication.** Science communicators no longer have to depend on television and print reporters. The impact of the Internet on information dissemination has been so monumental that it is often likened to that of television, which, a generation earlier, also revolutionized communication with the public by bringing visual images into people's living rooms (Cole 2002).
- **News reporting has become increasingly fragmented.** Network news broadcasts and big-city daily newspapers no longer dominate news coverage the way they used to. Science communicators must focus on providing the types of news and information required by a relatively small group of specialized reporters. This requires focusing more on the type of news and information needed by such reporters and less on what the press can do to serve the needs of the science community (Borchelt 2002).

In March 2003, communicators gathered at a conference sponsored by the U.S. Department of Energy and the National Institute of Standards and Technology (NIST). Their main purpose was to identify best practices for communicating information about S&T to the public. A related report (NIST 2002) identifies successful communication programs (based on audience size, number of Web hits, and length of support) and attributes their success to several practices:

- Illustrating both the process and the product of science
- Involving scientists in a substantial way†
- Considering the political climate and/or involving decisionmakers‡
- Using multimedia, illustrations, and interactivity to bring science to life
- Relating science to the everyday environment
- Avoiding parochialism§
- Viewing the topic from the audience's point of view, not the institution's
- Using face-to-face methods
- Reaching out beyond the science-attentive public
- Providing information to the commercial media in easily usable form

According to the NIST report, public education campaigns are being carried out by many of the corporations, hospitals, and government agencies that fund and conduct research. The report also notes that many outreach and education programs sponsored by government laboratories and academic institutions are premised on the assumption that the public has a right to know how its tax dollars are being used.

*Science-attentive members of the public are most likely to be male, young, and affluent. They are also likely to vote, be politically active, be savvy about technology, and understand scientific information with minimal explanation (Borchelt 2002).

†Communicators may encounter resistance when they attempt to involve scientists. A recent survey of scientists (Sigma Xi Membership Poll, conducted with Research!America in 2001) found that 42 percent engaged in no public outreach. Asked why, 76 percent said they did not have time, 28 percent did not want to, and 17 percent did not care. Only 12 percent of the surveyed scientists said they were engaged in political outreach, and 20 percent were in contact with the media.

‡A well-designed communication campaign can minimize public and political opposition to new technologies. Such a campaign spelled success for The Orange County (California) Water District's plan to use treated wastewater as a source of drinking water, a technology that failed to gain acceptance in other California communities (Ferch 2002).

§Universities tend to limit their Web-based science reporting to their own research activities. But at the University of Wisconsin–Madison, The Why Files website draws on stories from all sources for its popular "science behind the news" coverage (Devitt 2002).

of probability—two important aspects of scientific literacy.[28] Only 43 percent of Americans and 37 percent of Europeans answered the experiment question correctly. Both groups did better with probability: 57 percent of Americans and 69 percent of Europeans answered that question correctly.

[28]The question pertaining to experimental evaluation was: "Now, please think of this situation. Two scientists want to know if a certain drug is effective in treating high blood pressure. The first scientist wants to give the drug to 1,000 people with high blood pressure and see how many experience lower blood pressure levels. The second scientist wants to give the drug to 500 people with high blood pressure, and not give the drug to another 500 people with high blood pressure, and see how many in both groups experience lower blood pressure levels. Which is the better way to test this drug? Why is it better to test the drug this way?"

The text of the probability question was: "Now think about this situation. A doctor tells a couple that their 'genetic makeup' means that they've got one in four chances of having a child with an inherited illness. Does this mean that if their first three children are healthy, the fourth will have the illness? Does this mean that if their first child has the illness, the next three will not? Does this mean that each of the couple's children will have the same risk of suffering from the illness? Does this mean that if they have only three children, none will have the illness?"

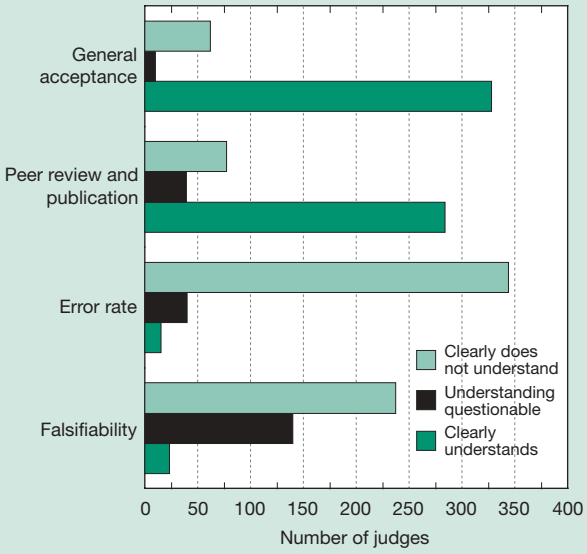
Because the Eurobarometer report was translated from French to English, the question wordings may not have been identical to those in the NSF survey. However, approximate comparisons are possible.

Science and the Law

In 1993, the U.S. Supreme Court issued a landmark decision in the case of *Daubert* v. *Merrell Dow Pharmaceuticals*. *Daubert* articulated standards judges should use (falsifiability, error rate, peer review, and general acceptance) to determine the admissibility of expert testimony in court. It affirmed that judges had a responsibility to be gatekeepers, keeping evidence that did not meet these standards out of the courtroom.* For example, applying the Daubert guidelines, judges have excluded handwriting analysis as evidence in a number of cases (Adams 2003).

One of the issues raised by the *Daubert* decision was whether judges could fulfill their new gatekeeping function. Did they know enough about science and the scientific method to be able to apply the *Daubert* guidelines? A few years ago, a team of researchers attempted to find out (Dobbin et al. 2002). To assess how well judges understood the four standards prescribed in *Daubert,* the researchers surveyed 400 state trial court judges in all 50 states. A majority of the judges clearly understood peer review and general acceptance, but only a fraction clearly understood falsifiability and error rate (figure 7-7). The survey results suggest that "many judges may not be fully prepared to deal with the amount, diversity and complexity of the science presented in their courtrooms" and that "many judges did not recognize their lack of understanding" (Gatowski et al. 2001).

Figure 7-7
Understanding of *Daubert* guidelines for admitting scientific evidence: 2001



SOURCE: S. Gatowski et al. 2001. Asking the gatekeepers: A national survey of judges on judging expert evidence in a post-*Daubert* world. *Journal of Law and Human Behavior* 25(5): 433–58.

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Acknowledging that most members of the judiciary do not have a scientific background, the Supreme Court recommended that judges obtain outside expertise to guide them in their gatekeeper responsibilities. The Court suggested that judges ask organizations such as the National Academy of Sciences and the American Association for the Advancement of Science for assistance in identifying experts to review scientific testimony before it is presented to juries. The latter now has such a project, Court Appointed Scientific Experts (CASE). In addition, the Federal Judicial Center publishes and distributes to federal judges a *Reference Manual on Scientific Evidence* that contains chapters on how science works, statistics, survey research, several aspects of medical science, and engineering (Federal Judicial Center 2000).

Furthermore, a group of judges recently asked renowned physics professor Robert L. Park for guidance on how to recognize questionable scientific claims. The author of a landmark book on the subject, Park came up with "seven warning signs" that a scientific claim is probably bogus (Park 2002):

1. The discoverer pitches the claim directly to the media (thus bypassing the peer review process by denying other scientists the opportunity to determine the validity of the claim).
2. The discoverer claims that a powerful establishment is trying to suppress his or her work. (The mainstream science community may be deemed part of a larger conspiracy that includes industry and government.)
3. The scientific effect involved is always at the very limit of detection.
4. The evidence for a discovery is anecdotal.
5. The discoverer says a belief is credible because it has endured for centuries.
6. The discoverer has worked in isolation.
7. The discoverer must propose new laws of nature to explain an observation.

*In March 1999, in the case of *Kumho Tire Co., Ltd. et al.* v. *Carmichael et al.,* the Supreme Court ruled that the *Daubert* gatekeeping obligation applies not only to scientific testimony but to all expert testimony, including that of engineers (National Academy of Engineering 1999).

More Than a Century After Darwin, Evolution Still Under Attack in Science Classrooms

In 1999, the Kansas State Board of Education decided to delete evolution from the state's science standards. The action received widespread press coverage and sparked an outcry in the science community. Most of the public also disagreed with the decision, which was reversed after board members who had voted for the change were defeated in the next election.

Thus began another round of attacks on the teaching of evolution in public school classrooms. Similar eruptions have been occurring since the landmark 1925 Scopes "monkey" trial. Although Tennessee teacher John Scopes was convicted, science ended up being the true victor, according to the history books and thanks to the play *Inherit the Wind.* The next milestone occurred in 1987 when the Supreme Court struck down a Louisiana law that prohibited the teaching of evolution unless equal time was given to creationism.

Recently, controversy over the teaching of evolution has emerged in Kansas and nearly 20 other states. In general, the recent attacks on evolution have come from two directions: a push to introduce "intelligent design" in science classrooms as a viable alternative to evolution* and efforts to add evolution disclaimers to science textbooks.

In June 2001, the U.S. Senate adopted a "sense of the Senate" amendment to the Elementary and Secondary Education Act authorization bill (which later became known as the "No Child Left Behind Act"). Although the text of the amendment appeared to promote the development of students' critical thinking skills, it also contained the following sentence: "Where topics are taught that may generate controversy (such as biological evolution), the curriculum should help students to understand the full range of scientific views that exist." Concerned that the amendment was a thinly veiled attempt to inject the theory of intelligent design into science curriculums (because of the singling out of evolution as a controversial theory), nearly 100 science organizations mobilized in opposition to the amendment.† The amendment never made it into the final bill, but some of the language was included in the conference committee report. Although such text does not have the force of law, proponents of the intelligent design theory began to claim congressional endorsement in their efforts to persuade school boards in several states and localities to include the theory in science instruction (Palevitz 2002).

In 2002, Ohio's state school board became embroiled in a year-long controversy about the inclusion of evolution in the state's science education standards (Clines 2002). Although the board ultimately approved standards that strongly advocated the teaching of evolution, the door was left open for teachers to permit classroom discussions that treat intelligent design as an alternative to evolution (Sidoti 2002).

School boards in other states have also been involved in evolution-related controversies. In Georgia, the Cobb County school board decided to affix stickers to science textbooks stating that "evolution is a theory, not a fact, regarding the origin of living things." This was not the first such action. In 1996, Alabama began requiring evolution disclaimer stickers on biology textbooks. Similar statewide efforts were turned back in Louisiana (Maggi 2002) and Oklahoma (Cable News Network 2001). Although Alabama now has the only statewide policy, local governments in other states are using disclaimer stickers. Cobb County and other locales are facing legal challenges to the evolution disclaimers.‡

Controversy over the teaching of evolution has also affected institutions of higher education:

- A biology professor at a Texas university came under fire for religious discrimination when he posted a demand on his website that students who wanted a letter of recommendation from him for postgraduate studies had to "truthfully and forthrightly affirm a scientific answer" to the question of how the human species originated (Madigan 2003).
- In 2002, a new college in Virginia started primarily for home-schooled students was denied accreditation by the American Academy for Liberal Education because the college requires professors to sign a statement of faith that they will teach from a creationist perspective (Olsen 2002).

This kind of controversy is almost unheard of in other industrialized nations. However, that may be changing. For example, there was a recent uproar in England when teachers at a college were accused of giving preference to a creationism interpretation of biology.

*The theory of intelligent design holds that life is too complex to have happened by chance and that, therefore, some sort of intelligent designer must be responsible. Critics claim that this theory is simply a more sophisticated form of creationism (which the courts have said may not be taught in public schools). They argue that intelligent design theory has nothing to do with science because its assertions are not falsifiable: they cannot be tested or observed and cannot undergo experimentation (Morris 2002). In contrast, "[evolution] has been directly observed in operation not only in the laboratory but also in the field. Where there is still room for argument and discussion is in the precise contributions of different mechanisms to evolutionary change. In this vibrant debate, intelligent design offers no meaningful contribution" (Greenspan 2002). According to Eugenie C. Scott, president of the National Center for Science Education, "There aren't any alternative scientific theories to evolution" (Watanabe 2002). In October 2002, the American Association for the Advancement of Science Board of Directors passed a resolution on intelligent design that "calls upon its members to assist those engaged in overseeing science education policy to understand the nature of science, the content of contemporary evolutionary theory and the inappropriateness of 'intelligent design theory' as a subject matter for science education" (Pinholster 2002).

†In 2001, the president of one of these organizations, Eugenie C. Scott of the National Center for Science Education, received the National Science Board Public Service Award for increasing public understanding of science and engineering.

‡Bruce Alberts, president of the National Academy of Sciences, asked 30 scientists and physicians in Georgia to lobby Cobb County board members to remove disclaimers (MacDonald 2002).

Understanding Statistics

Reports on scientific and medical studies, even those written for lay readers, often include supporting statistics and related terminology. In addition, many news articles discuss the results of public opinion polls and present survey findings in tables or graphs. Even though familiarity with basic statistical concepts can make the news more meaningful, many Americans lack that familiarity. Surveys conducted in 1987 by the Roper Organization and in 2002 by Child Trends, Inc., and the Annie E. Casey Foundation asked two questions designed to assess the public's knowledge of statistics. Both questions concerned "margin of error" information in reports on public opinion polls.

When asked whether they found the margin of error useful or were unsure what it meant, 40 percent of respondents in 2002 said it was useful (up from 25 percent in 1987) and 39 percent were unsure of its meaning (down from 48 percent in 1987); few said they understood it but did not find it useful (17 percent in 2002 and 14 percent in 1987).

Respondents were also asked to choose among four definitions of "what a 4% margin of error means." The percentage choosing the correct definition, "if every adult answered the questions, the results would very probably be within 4 points of those reported," nearly doubled between 1987 and 2002, from 16 to 30 percent. It should be noted, however, that the majority of respondents in both years answered incorrectly (more chose "including all possible sources of error, the results should be no more than 4 points off the mark" than the correct definition), an indication that most Americans do not have a strong grasp of this particular area of statistics.

Technological Literacy

Most Americans are probably not technologically literate. They have little conception of how science, technology, and engineering are related to one another, and they do not clearly understand what engineers do and how engineers and scientists work together to create technology. Those are the major findings of a recent report issued by the National Academy of Engineering (NAE) and the National Research Council (NRC) (Committee on Technological Literacy 2002). In addition, the International Technology Education Association (ITEA) concluded from its 2001 survey that "adults are very interested in but relatively poorly informed about technology" (Rose and Dugger 2002).[29]

[29]Almost everyone surveyed agreed that technological literacy is an important goal. About three-fourths of the respondents said it is very important "for people at all levels to develop some ability to understand and use technology"; the remaining fourth said that it was somewhat important. Responses were similar for both sexes and all age groups.

In the NAE/NRC report, technological literacy was defined as "one's ability to use, manage, assess, and understand technology." The concept includes an understanding of the nature of technology, the design process, and the history of technology; a capacity to ask questions and make informed decisions about technology; and some level of hands-on capability related to the use of technology. (See sidebar, "Characteristics of a Technologically Literate Citizen.")

Characteristics of a Technologically Literate Citizen

The National Academy of Engineering and the National Research Council have identified the following indicators of technological literacy (Committee on Technological Literacy 2002):

Knowledge

- Recognizes the pervasiveness of technology in everyday life
- Understands basic engineering concepts and terms, such as systems, constraints, and tradeoffs
- Is familiar with the nature and limitations of the engineering design process
- Knows some of the ways in which technology shapes human history and people shape technology
- Knows that all technologies entail risk, some that can be anticipated and some that cannot
- Appreciates that the development and use of technology involve tradeoffs and a balance of costs and benefits
- Understands that technology reflects the values and culture of society

Ways of Thinking and Acting

- Asks pertinent questions, of self and others, regarding the benefits and risks of technologies
- Seeks information about new technologies
- Participates, when appropriate, in decisions about the development and use of technology

Capabilities

- Has a range of hands-on skills, such as using a computer for word processing, surfing the Internet, and operating a variety of home and office appliances
- Can identify and fix simple mechanical or technological problems at home or work
- Can apply basic mathematical concepts related to probability, scale, and estimation to make informed judgments about technological risks and benefits

According to the NAE/NRC report:

> Technology has become so user friendly it is largely "invisible." Americans use technology with a minimal comprehension of how or why it works or the implications of its use or even where it comes from. American adults and children have a poor understanding of the essential characteristics of technology, how it influences society, and how people can and do affect its development.

The report also notes that, "like literacy in reading, mathematics, science, or history, the goal of technological literacy is to provide people with the tools to participate intelligently and thoughtfully in the world around them." The following points are also made:

- Technological literacy is particularly important for decisionmakers in business, government, and the media. However, as the report notes, "there is no evidence to suggest that legislators or their staff are any more technologically literate than the general public."
- Technological literacy is extremely important to the health of the U.S. economy. Technological innovation is a major factor in the vitality of the economy, and an increasing number of jobs require workers to be technologically literate.

Although discussions of technological literacy imply agreement about the definition of technology, many people define technology far too narrowly. Their definition is usually restricted to computers and the Internet.[30]

In the ITEA survey, respondents were asked to name the first word that comes to mind when they hear the word "technology." Approximately two-thirds said "computers." Moreover, when given a choice of two definitions for "technology," 63 percent chose "computers and the Internet," whereas 36 percent chose "changing the natural world to satisfy our needs." Younger people were more likely than older people to choose the broader definition.

A majority of survey respondents (59 percent) associated the word *design* (in relation to technology) with "blueprints and drawings from which you construct something" rather than "a creative process for solving problems." College graduates were more likely than others to choose the latter definition.

The ITEA survey results suggest that most Americans feel confident in their knowledge of technology. More than three-fourths of those interviewed said they could understand and use technology either to a great extent (28 percent) or to some extent (47 percent). Younger respondents and college graduates were more likely than others to feel confident about technology.

Respondents were also asked whether they thought they could explain how certain technologies work. Most (90 percent) said they could explain how a flashlight works, 70 percent could explain how a home heating system works, 65 percent could explain how a telephone call gets from point A to point B, and 53 percent could explain how energy is transferred into power.

For each example except the flashlight, women were less confident than men in their ability to explain the technology. Respondents who said they had a "great" understanding of technology and those who held technology- or computer-related jobs were more likely than others to say they could explain the technology in the four examples.

Despite their apparent confidence about explaining how various technologies work, respondents had difficulty answering specific questions. About half (51 percent) did not know that using a portable phone while in the bathtub does not create a risk of electrocution, and only a fourth (26 percent) knew that FM radios operate free of static. However, 82 percent knew that a car operates through a series of explosions, and 62 percent knew that a microwave oven does not heat food from the outside to the inside.

Belief in Pseudoscience

Although S&T are held in high esteem throughout the modern world, pseudoscientific beliefs continue to thrive, coexisting alongside society's professed respect for science and the scientific process. The science community and those whose job it is to communicate information about science to the public have been particularly concerned about the public's susceptibility to pseudoscientific or unproven claims that could adversely affect their health, safety, and pocketbooks (NIST 2002).

Pseudoscience has been defined as "claims presented so that they appear [to be] scientific even though they lack supporting evidence and plausibility" (Shermer 1997, p. 33).[31] In contrast, science is "a set of methods designed to describe and interpret observed and inferred phenomena, past or present, and aimed at building a testable body of knowledge open to rejection or confirmation" (Shermer 1997, p. 17).

Belief in pseudoscience is relatively widespread.[32] For example, at least a quarter of the U.S. population believes in astrology, i.e., that the position of the stars and planets can affect people's lives. Although the majority (56 percent) of

[30] Technology actually encompasses not only the tangible artifacts of the human-designed world (e.g., bridges, automobiles, computers, satellites, medical imaging devices, drugs, genetically engineered plants) but also the larger systems of which the artifacts are a part (e.g., transportation, communications, health care, food production), as well as the people and infrastructure needed to design, manufacture, operate, and repair the artifacts.

[31] According to one group studying such phenomena, pseudoscience topics include yogi flying, therapeutic touch, astrology, fire walking, voodoo magical thinking, alternative medicine, channeling, Carlos hoax, psychic hotlines and detectives, near-death experiences, unidentified flying objects and alien abductions, the Bermuda Triangle, homeopathy, faith healing, and reincarnation (Committee for the Scientific Investigation of Claims of the Paranormal).

[32] A February 2002 CBS News poll found that 57 percent of Americans believe "that there are such things as ESP [extrasensory perception] or telepathy, or other experiences that can't be explained by normal means" (CBS News 2002). A Harris poll conducted in February 2003 revealed that 84 percent of those surveyed believed in miracles, 51 percent in ghosts, 31 percent in astrology, and 27 percent in reincarnation. Women and those with less formal education were more likely than others to believe in these paranormal phenomena (Taylor 2003).

those queried in the 2001 NSF survey said that astrology is "not at all scientific," 9 percent said it is "very scientific" and 31 percent thought it is "sort of scientific" (figure 7-8 and appendix table 7-5).

Belief in astrology is more prevalent in Europe, where 53 percent of those surveyed thought it is "rather scientific" and only a minority (39 percent) said it is not at all scientific (European Commission 2001). Europeans were more likely to say that astrology is scientific than to say the same about economics: only 42 percent of those surveyed thought that economics was scientific. Disciplines most likely to be considered scientific by Europeans were medicine (93 percent), physics (90 percent), biology (88 percent), astronomy (78 percent), mathematics (72 percent), and psychology (65 percent). History (33 percent) was at the bottom of the list. (Comparable U.S. data on the various disciplines do not exist.)

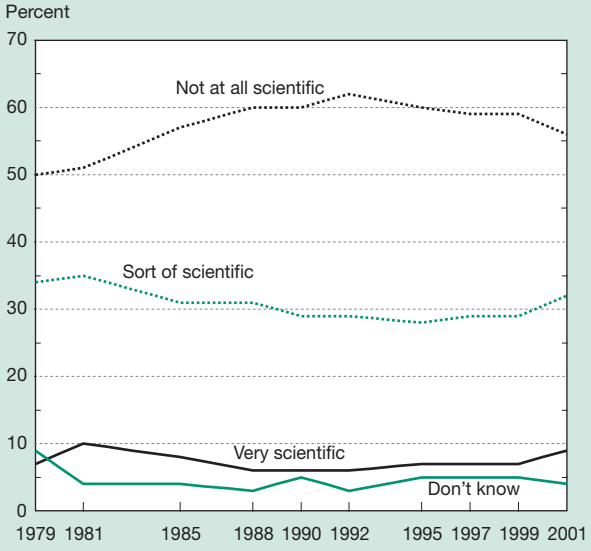
In the United States, skepticism about astrology is strongly related to level of education: 74 percent of college graduates said that astrology is "not at all scientific," compared with 45 percent of those with less than a high school education and 52 percent of those who had completed high school but not college. In Europe, however, respondents with college degrees were just as likely as others to claim that astrology is scientific.

Europeans were more likely than Americans to agree that "some numbers are particularly lucky for some people." The percentages were 46 percent and 32 percent, respectively.

Surveys conducted by NSF and other organizations suggest that at least half of the U.S. public believes in the existence of extrasensory perception (ESP), and a sizable minority believes in unidentified flying objects and that aliens have landed on Earth. In the 2001 NSF survey, 60 percent of respondents agreed that "some people possess psychic powers or ESP," and 30 percent agreed that "some of the unidentified flying objects that have been reported are really space vehicles from other civilizations."

Surveys even show increasing belief in pseudoscience (Newport and Strausberg 2001). Of the 13 paranormal phenomena included in a periodically administered Gallup survey, belief in 8 increased significantly between 1990 and 2001, and belief in only 1 (devil possession) declined. Belief in four of the phenomena (haunted houses, ghosts, communication with the dead, and witches) had double-digit percentage point increases between 1990 and 2001[33] (figure 7-9).

Figure 7-8
Public assessment of astrology: 1979–2001



SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Public Attitudes Toward and Understanding of Science and Technology, various years. See appendix table 7-5.

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Public Attitudes About Science-Related Issues

Public attitudes about science are generally more positive in the United States than in Europe, although both Americans and Europeans strongly support government funding for basic research. Recently, the public has grappled with controversial developments in biotechnology, especially human cloning and stem cell research. (The vast majority of Americans oppose the former, but attitudes about the latter are mixed.) Regardless of their attitudes about these and other science-related issues, the American public's confidence in the science community has remained high for several decades.

S&T in General

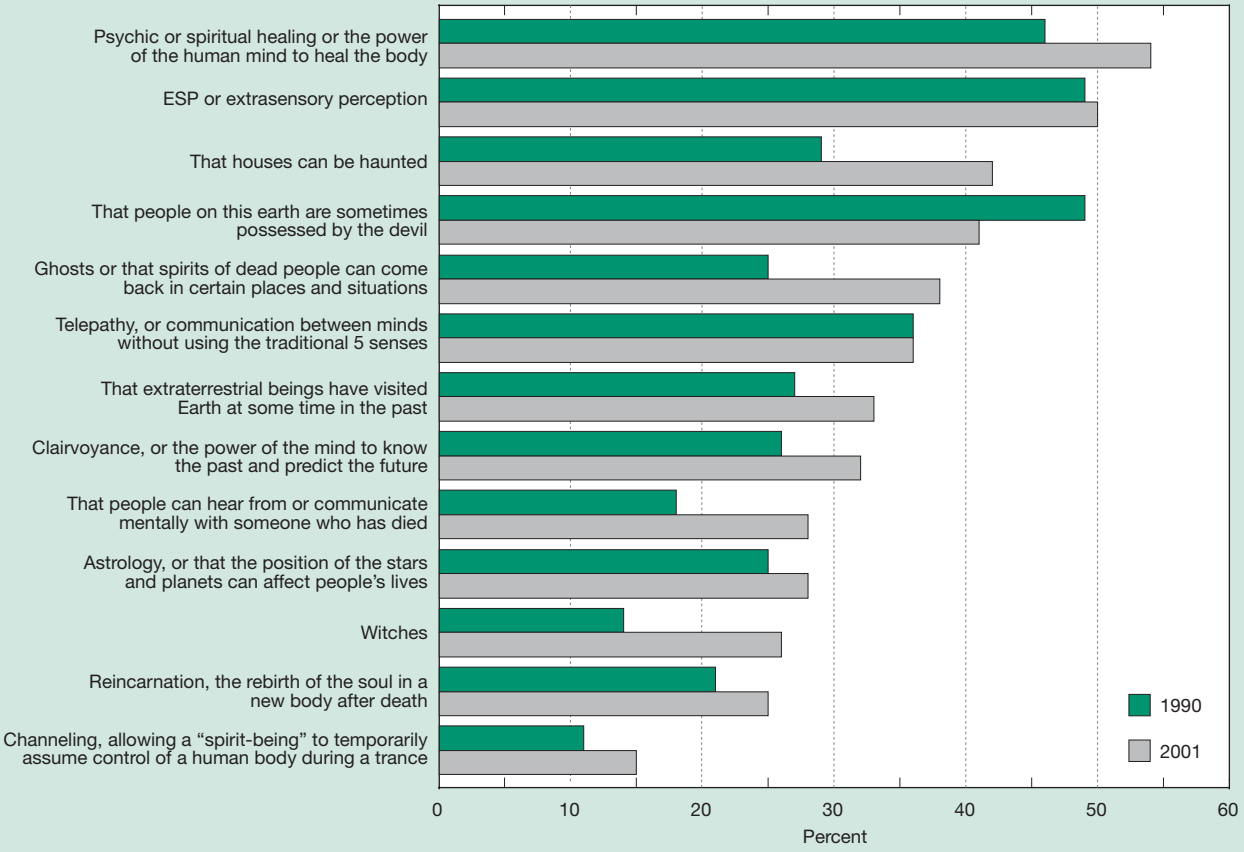
In general, Americans have highly favorable attitudes regarding S&T. In the Virginia Commonwealth University (VCU) 2002 Life Sciences Survey, 86 percent of respondents agreed that developments in science have helped make society better, and 90 percent agreed that "scientific research is essential for improving the quality of human lives" (VCU Center for Public Policy 2002).[34]

Americans seem to have more positive attitudes about the benefits of S&T than are found in Europe, as reflected in levels of agreement with various statements in the 2001 NSF and Eurobarometer surveys:

[33]Various researchers have demonstrated that a continuing parade of paranormal depictions in movies and psychic mediums on television distort some viewers' perception of reality and thus fuel such beliefs (Sparks, Nelson, and Campbell 1997; and Nisbet et al. 2002).

[34]When respondents were asked to name the development in science over the last 30 years that "has made the most positive contribution to society," 27 percent said medical and health (including vaccines, research, devices, and medicines), 24 percent said computers and/or the Internet, 5 percent said mass communication (including cell phones, satellites, TV, and radio), and 2 percent said biotechnology (including cloning, embryo research, DNA, and genetic research). When asked to name the development that has had the most negative effect on society, fewer respondents could provide an example (50 percent, compared with the 70 percent who named a positive development), and no single response stood out. The items that received the most votes as negative contributions were mass communication (8 percent), computers and the Internet (6 percent), weapons (5 percent), and nuclear weapons (4 percent) (VCU Center for Public Policy 2002).

Figure 7-9
Belief in paranormal phenomena: 1990 and 2001



SOURCE: F. Newport and M. Strausberg, Poll analyses: Americans' belief in psychic and paranormal phenomena is up over last decade, Gallup Organization (Princeton, NJ, 2001).

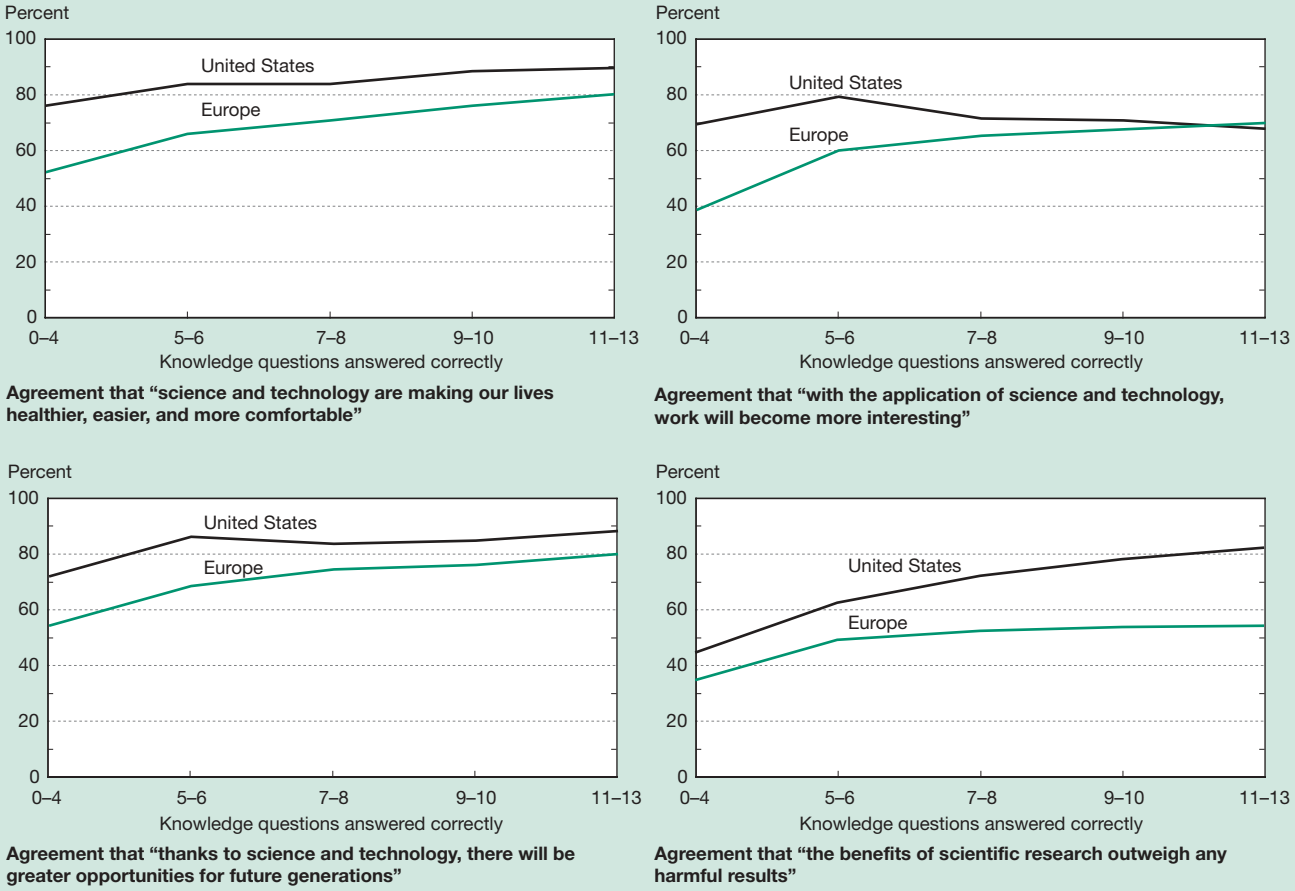
Science & Engineering Indicators – 2004

- **"Science and technology are making our lives healthier, easier, and more comfortable."** In the United States, 86 percent of respondents agreed, compared with 71 percent of Europeans. In addition, one of five Europeans disagreed, nearly twice the proportion of Americans who disagreed.
- **"With the application of science and technology, work will become more interesting."** In the United States, 86 percent agreed, compared with 71 percent in Europe.
- **"Thanks to science and technology, there will be greater opportunities for future generations."** In the United States, 85 percent agreed, compared with 72 percent in Europe.
- **"The benefits of scientific research outweigh any harmful results."** In the United States, 72 percent agreed, compared with 50 percent in Europe. In addition, only one-tenth of Americans disagreed, compared with one-fourth of Europeans. Although the percentage of Americans agreeing with this statement has held steady at more than 70 percent since 1988, agreement has declined in Europe, falling 11 percentage points between 1992 and 2001.

Findings from the surveys also suggest certain relationships between knowledge of S&T and belief in its benefits. It seems that in Europe, the more people know about science (i.e., the more knowledge questions they answer correctly), the more likely they are to believe in its benefits (as reflected in their agreement with the four statements discussed above). If such a relationship exists in the United States, it generally is much weaker. Regardless of education level, Americans generally are more likely than Europeans to view S&T as beneficial. (For the most part, this difference is most apparent at the low end of the knowledge scale and lessens as knowledge scores increase.) The one exception to these general conclusions is the statement about the benefits of research outweighing harmful results. Here, the relationship between knowledge and agreement is stronger in the United States than in Europe, and the American–European differences in level of agreement are greater at the upper end of the knowledge scale than the lower end (figure 7-10).

Despite Americans' highly favorable views about the benefits of S&T, a sizeable segment of the population has some reservations. In the 2003 VCU Life Sciences Survey, 63 percent of respondents agreed that "scientific research these days doesn't pay enough attention to the moral values

Figure 7-10
Public belief in benefits of science and technology, by level of related knowledge: 2001



SOURCES: National Science Foundation, Division of Science Resources Statistics, Survey of Public Attitudes Toward and Understanding of Science and Technology, 2001; and European Commission, Eurobarometer 55.2 survey and standard report, *Europeans, Science and Technology*, December 2001.

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of society" (28 percent agreed strongly, 35 percent somewhat), and more than half agreed that "scientific research has created as many problems for society as it has solutions" (19 percent agreed strongly, 36 percent somewhat). In the 2001 Life Sciences Survey, those who said that "religious beliefs provide…guidance in [their] day-to-day living" were considerably more likely than others to support both statements (VCU Center for Public Policy 2001). In Europe, 31 percent of those surveyed agreed that "Europeans should be less concerned with ethical questions relating to modern science and technology"; 46 percent disagreed.

Findings from the NSF and Eurobarometer surveys also reveal some reservations about S&T in both the United States and Europe:

- **"We depend too much on science and not enough on faith."** In the United States, 51 percent of respondents agreed with this statement, compared with 45 percent in Europe.
- **"Science makes our way of life change too fast."** In the United States, 38 percent agreed, compared with 61 percent in Europe.

In the United States, the more knowledgeable respondents were about science, the less likely they were to agree with these statements (figure 7-11).

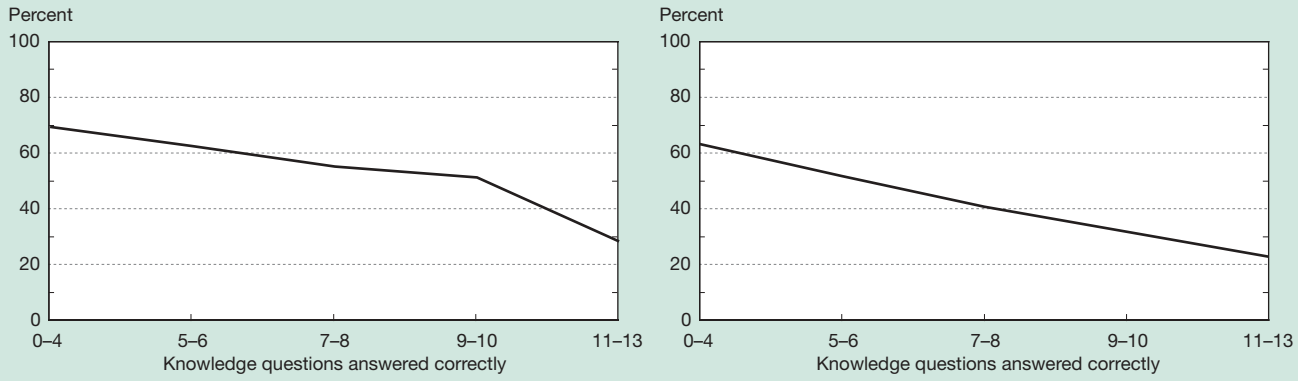
Federal Funding of Scientific Research

All indicators point to widespread public support for government funding of basic research in the United States. This has been the case since at least the mid-1980s.

In 2001, 81 percent of NSF survey respondents agreed with the following statement: "Even if it brings no immediate benefits, scientific research that advances the frontiers of knowledge is necessary and should be supported by the Federal Government."[35] The stability of this measure of public support for basic research is noteworthy. The level of agree-

[35]Another survey found support for government funding of scientific research among 81 percent of respondents in 2001 (identical to the NSF survey result) and 75 percent in 2002 (Research!America 2002, 2003).

Figure 7-11
Public concerns about science and technology, by level of related knowledge: 2001



SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Public Attitudes Toward and Understanding of Science and Technology, 2001.

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ment with this statement has consistently been around 80 percent since 1985. In addition, a consistently small percentage of respondents have held the opposite view. In 2001, 16 percent disagreed with the statement (appendix table 7-6).

Europeans also favor government investment in basic research. Seventy-five percent of those surveyed agreed with the above statement and only 10 percent disagreed. In addition, 83 percent of Europeans agreed that "basic scientific research is essential for the development of new technologies."

Although there is strong evidence that the American public supports the government's investment in basic research, few Americans can name the two agencies that provide most of the Federal funds for this type of research. In a recent survey, only 6 percent identified the National Institutes of Health as the "government agency that funds most of the medical research paid for by taxpayers in this country," and only 2 percent named NSF as "the government agency that funds most of the basic research and educational programming in the sciences, mathematics and engineering in this country." In the same survey, 67 percent could name the Food and Drug Administration as the "government agency that conducts the review and approval of new drugs and devices before they can be put on the market in this country," and 24 percent were able to name the Centers for Disease Control and Prevention as the "government agency whose primary mission is disease prevention and health promotion in this country" (Research!America 2002).

When Americans are surveyed about national priorities, scientific research is seldom one of their choices. Nevertheless, it is included as one of the priority choices in an ongoing Research!America survey. In the latest survey, 47 percent of respondents said that "more money for science research and engineering" was "very important"; that percentage was higher for all of the respondents' other four priority choices: education programs (84 percent), medical and health research (70 percent), Social Security and Medicare (73 percent), and tax cuts (50 percent) (Research!America 2003).[36] In the previous survey, most respondents said they would favor an elected official who supports increased funding for research (Research!America 2002).

In 2002, only 14 percent of NSF survey respondents thought the government was spending too much on scientific research; 36 percent thought the government was not spending enough, a percentage that has held relatively constant for more than a decade. To put the response on scientific research in perspective, it helps to look at the percentage who thought the government was not spending enough in other program areas: improving health care (75 percent) and education (74 percent), reducing pollution (60 percent), improving national defense (31 percent), and exploring space (12 percent) (appendix table 7-7).

The loss of the Columbia space shuttle in early 2003 apparently had little, if any, impact on public support for the U.S. space program. Public attitudes about manned space flight were strikingly similar to those recorded in 1986 after the loss of the space shuttle Challenger (see sidebar "Public Opinion in the Wake of the Columbia Space Shuttle Tragedy).

Support for increased government spending on research is more common in Europe than in the United States. When asked about the statement "public research budgets ought to be higher in Europe," 60 percent of Eurobarometer respondents agreed.

[36]In the latest survey, about 60 percent of respondents supported doubling total national spending on government-sponsored medical research over the next 5 years; 30 percent did not support such an increase (Research!America 2003). Support for doubling spending decreased about 10 percent from the previous year's survey.

Public Opinion in the Wake of the Columbia Space Shuttle Tragedy

Loss of the Columbia space shuttle on February 1, 2003, did not have an immediate impact on public attitudes about the U.S. space program. In a Gallup survey conducted shortly after the tragedy, 82 percent of respondents expressed support for continuing the manned space shuttle program; only 15 percent favored ending the program (Moore 2003 and Newport 2003). These findings are almost identical to those recorded after the loss of the Challenger space shuttle in January 1986.

In addition, a majority of Americans continue to support funding for the National Aeronautics and Space Administration (NASA) and the U.S. space program. Nearly half (49 percent) of those surveyed after the Columbia tragedy thought funding should be maintained at its current level, and one-fourth favored an increase in funding. In the same poll, 17 percent thought funding should be reduced, and another 7 percent said the program should be ended altogether. These findings are not markedly different from those obtained in December 1999, when 16 percent of survey respondents favored increased funding for NASA, 49 percent wanted funding to stay at its current level, 24 percent favored a cutback, and 10 percent thought the U.S. space program should be terminated. The findings are also similar to those obtained after the loss of the Challenger. Americans also continue to favor manned over unmanned missions. After the loss of the Columbia, 52 percent of survey respondents said they favored manned missions, whereas 37 percent favored unmanned missions. Public opinion on manned versus unmanned exploration has changed little since 1990.

In the 2003 poll, 45 percent of respondents rated NASA's job performance as excellent, and 37 percent rated it as good; only 2 percent gave NASA a poor rating. In surveys conducted before 2003, no more than 26 percent of respondents ever rated NASA's performance as excellent (that high point occurred in 1998). The exceptionally high percentage of excellent ratings in 2003 may reflect the addition of the phrase "looking beyond the tragedy" to the survey question.

In other survey questions posed after the loss of the Columbia, nearly 60 percent of respondents said they were "deeply upset" by the event (similar to response after the Challenger accident), and about 70 percent said they had expected that "something like this would happen again sooner or later." When respondents were asked about their confidence in NASA's ability to prevent similar accidents in the future, 38 percent expressed a "great deal" of confidence, and 44 percent had a "fair amount" of confidence; again, this response is similar to that after the Challenger accident.

S&T Role in National Security

Americans are aware of the role of S&T in national security. According to one survey, 26 percent of the population is extremely or very concerned with the threat of biological or chemical terrorism such as anthrax or smallpox, 29 percent are somewhat concerned, and 45 percent are only slightly or not at all concerned. About 90 percent think that scientific research is either extremely or very important in preparing for and responding to threats of bioterrorism, and more than 80 percent strongly or somewhat support increased funding for such research (Research!America 2002).

Another survey, conducted by the Gallup Organization for the Bayer Corporation (2003), found that almost all adult Americans (96 percent) view S&T as playing a critical role in national security both domestically and internationally. When asked about the role of S&T in meeting future terrorist threats, 80 percent said that role is very important, and 17 percent said it is somewhat important.

Americans also are aware of the S&T role in specific aspects of national security, including military, intelligence, and law enforcement preparedness. More than 75 percent of survey respondents said that S&T plays a very important role in military and intelligence preparedness (about 20 percent said "somewhat important"), and 57 percent viewed the S&T role in law enforcement preparedness as very important. Most respondents said that the United States is either very or somewhat reliant on S&T for military preparedness (95 percent), intelligence preparedness (93 percent), and law enforcement preparedness (86 percent); the "very reliant" percentages were 63 percent, 57 percent, and 32 percent, respectively.

Americans also recognize the importance of a knowledgeable public in dealing with national security threats. Nine in 10 agreed that it is important for average Americans to be scientifically literate in order to understand and deal with nuclear terrorism, bioterrorism, and cyberterrorism.

Three-fourths of Americans also expect that the emphasis on national security after the events of September 11, 2001, will create new job opportunities in S&T for today's students. Survey respondents also agreed that it is either very important (62 percent) or somewhat important (33 percent) for those entering the new homeland security jobs to be scientifically literate, and 72 percent agreed that scientific literacy is more important for students now than it was before September 11. However, more than half of respondents (52 percent) were very concerned, and 38 percent were somewhat concerned, that today's students may lack "the math and science skills necessary to produce the science excellence required for homeland security and economic leadership in the 21st century."

Biotechnology and Medical Research

The introduction of new technologies based on genetic engineering is one of the few science-related public policy issues to raise controversy in recent years. From a nationwide recall of taco shells containing genetically modified corn not approved for human consumption to scientists promising to clone humans in the not-too-distant future, Americans have been trying to determine whether the potential benefits of biotechnology outweigh the risks. For example, the benefits of genetically modified food (increased productivity, longer shelf life, and reduced reliance on chemical pesticides) have been offset by concerns about health and environmental risks and consumers' right to choose what they eat. These controversies have also surfaced elsewhere in the world, often more dramatically than in the United States. (See sidebar, "European Public Opinion About Mad Cow Disease.")

European Public Opinion About Mad Cow Disease

Europeans believe that scientists are less to blame than others for the mad cow disease problem. About half (51 percent) of those surveyed agreed that scientists "bear a great deal of responsibility" (European Commission 2001). In contrast, 74 percent held the agri-food industry responsible, 69 percent blamed politicians, and 59 percent thought farmers were at fault. About half (45 percent) said they did not have enough information to say who is responsible. The higher their level of knowledge about science, the more likely Europeans were to blame the industry, politicians, and farmers and the less likely they were to blame scientists.

Asked what should be done to avoid such problems in the future, 89 percent thought that "scientists ought to keep us better informed about the possible hazards of certain scientific or technological advances," 86 percent said that scientists should "communicate their scientific knowledge better," 82 percent thought that the industry should be better regulated, and 72 percent thought that politicians should "rely more on the opinion of scientists."

International Attitudes About Biotechnology

Although antibiotechnology sentiments are more common in Europe than in the United States, optimism about biotechnology actually increased in Europe during recent years, as it did in the United States. These are the latest findings from a series of studies tracking U.S. and European public attitudes about biotechnology and its applications.[37]

In 2002, 69 percent of surveyed Americans thought that biotechnology would "improve our way of life in the next 20 years." This is a considerable gain over the 51 percent who expressed that view in 2000. In addition, the proportion who thought that biotechnology would "make things worse" in the next 20 years fell from 29 percent in 2000 to 11 percent in 2002. The pattern was similar in Europe, where the proportion of survey respondents who were optimistic about biotechnology increased from 38 percent in 1999 to 44 percent in 2002, while the proportion who were pessimistic dropped from 31 percent to 17 percent. In Europe, the gain in optimism after 1999 was enough to offset the downward trend of the preceding 8-year period, so that optimism is now back to its level of 10 years ago.

How do public attitudes about biotechnology compare with attitudes about other technologies? In 2002, 89 percent of Americans said that solar energy would "improve our way of life in the next 20 years," 88 percent held that view about computers, 82 percent about telecommunications, and 73 percent about the Internet. Expectations were less positive for space exploration (67 percent), cell phones (59 percent), nanotechnology (52 percent), and nuclear power (48 percent). In Europe, the pattern was similar, although the proportion of positive responses never exceeded 80 percent for any technology. Telecommunications, computers, and solar energy all scored in the 70s in Europe; mobile phones and the Internet scored about 10 percentage points lower; and several technologies scored in the 50s, including space exploration, nanotechnology, and nuclear energy (at 27 percent, the lowest).

What does the public think about the usefulness, risk, and moral acceptability of agricultural and medical applications of biotechnology? Data from surveys in Europe (1996, 1999, and 2002) and the United States (1997, 2000, and 2002) show the following:

- European attitudes about biotechnology in 1996 were about the same as U.S. attitudes in 1997. However, by 1999, there was a dramatic drop in European support for agricultural applications of biotechnology, including genetic engineering of foods (to make them higher in protein, increase their shelf-life, or improve their taste) and crops (to make them more resistant to insect pests). In contrast, U.S. public support for these applications remained virtually unchanged between 1997 and 2000.
- Between 1996 and 1999, there were moderate to large declines in public support for genetically modified foods and crops in nearly all European countries. The exceptions were Austria (foods and crops), Sweden (foods), and Spain (crops).
- By 2002, overall support for agricultural applications of biotechnology had changed little in either Europe or the United States. In the majority of European countries, support for genetically modified foods increased somewhat (by levels as high as 16 to 17 percent in Austria, Sweden, and the United Kingdom), while support remained stable

[37] The U.S. survey was overseen in 1997 by Jon D. Miller, Chicago Academy of Sciences; in 2000 by Susanna Priest, Texas A&M University; and in 2002 by Toby Ten Eyck, Michigan State University. The European survey was conducted in 1996, 1999, and 2002 for the European Commission by George Gaskell, Martin Bauer, and Nick Alum.

in Germany and Finland and declined further in France, Italy, and the Netherlands.

- In both Europe and the United States, attitudes about medical applications of biotechnology (such as genetic testing to detect inherited diseases) have been significantly more positive than attitudes about agricultural applications. However, although the European and U.S. public continued to express high levels of support for medical applications in 2002, a significant minority of respondents in Europe had concerns about medical uses of genetic information: "Access to genetic information by government agencies and by commercial insurance is widely seen as unacceptable" (Gaskell, Allum, and Stares 2003). Other surveys are finding similar concerns in the United States (VCU Center for Public Policy 2001).
- In Europe, public support for medical applications of biotechnology is strongest in Spain and weakest in Austria.
- Public support for cloning human cells and tissues is stronger, and the subject far less controversial, in Europe than in the United States.

Public Support for Genetic Engineering

In no NSF survey year has a majority of Americans agreed that the benefits of genetic engineering outweigh the harmful results.[38] However, in the latest survey, approximately 9 of 10 respondents said they supported genetic testing to detect inherited diseases.[39] In addition, 6 of 10 supported the production of genetically modified food. Fewer than half supported cloning animals. NSF survey data show a slight, gradual decline in the American public's support for genetic engineering between 1985 and 2001. The shift can be seen most clearly among college-educated respondents and those classified as attentive to S&T issues.

Human Cloning and Stem Cell Research

The most recent survey data show that:

- The vast majority of Americans oppose the cloning of human beings.
- There is no consensus on medical research involving human embryonic stem cells. Although public opinion has fluctuated since 2001, it seems to be fairly evenly divided.

Human Cloning. All recent surveys that measure public opinion on human cloning have yielded similar findings: about four out of five Americans say they are opposed, and most of those say they are strongly opposed. In one survey, 65 percent of respondents said they were strongly opposed to human cloning, and only 13 percent said they favored it (VCU Center for Public Policy 2003).

Opposition to human cloning seems to be based on moral objections, not safety concerns. In a 2003 survey, 90 percent of respondents said they believed that cloning of humans is morally wrong; only 8 percent said it was morally acceptable. Public opinion on this subject has held steadfast since 2001 (Gallup 2003).

In 2002, 7 out of 10 respondents agreed that it is morally wrong "for businesses to use human cloning technology in developing new products"; only 19 percent thought this was morally acceptable (VCU Center for Public Policy 2002). In 2003, 8 percent of respondents described themselves as having a "very clear" understanding of the difference between human reproductive cloning and human therapeutic cloning; 26 percent were "somewhat clear," 32 percent were "not very clear," and 33 percent were "not at all clear." (Therapeutic cloning refers to the use of cloning technology in medical research to develop new treatments for diseases.)

Opposition to cloning crosses all demographic boundaries. In the 2002 VCU survey, clear majorities of both college graduates and respondents who expressed a high level of interest in science said they were strongly opposed to human cloning and considered it morally wrong for businesses to use cloning technology in product development. Strong opposition to cloning was also found among respondents who said they clearly understood the difference between therapeutic and reproductive cloning.

Opposition to therapeutic cloning is not quite as strong as opposition to human cloning in general: 32 percent of respondents in the 2003 VCU survey were strongly opposed to this use of cloning, 16 percent were somewhat opposed, 21 percent strongly favored it, and 29 percent somewhat favored it. Among respondents who said they clearly understood the difference between therapeutic and reproductive cloning, 46 percent opposed therapeutic cloning and 53 percent favored it; their views were similar to those of respondents who said they did not understand the distinctions. College graduates were somewhat less opposed than others to therapeutic cloning.

Stem Cell Research. Public opinion on stem cell research is not as clear cut as that on cloning. Recent survey findings on the subject are mixed.[40]

The public's interest in stem cell research apparently declined in 2002. When asked how much they had "seen, read, or heard" about medical research involving human embryonic stem cells, 13 percent of survey respondents said "a lot" (compared with 25 percent in 2001) and 20 percent said "nothing at all" (compared with 10 percent in 2001). In both years, about two-thirds of respondents answered "a little" or

[38] In another survey conducted in 2001, however, 57 percent of Americans agreed that, overall, the benefits of conducting genetic research outweighed the risk, 27 percent said the opposite, and 13 percent said they didn't know. Most (83 percent) were very or somewhat confident that "new genetic research will lead to major advances in the treatment of diseases during the next 15 years" (VCU Center for Public Policy 2001).

[39] In another survey conducted in 2001, 77 percent of Americans agreed that "genetic testing [should be made] easily available to all who want it." Many, however, thought that genetic testing would lead to discrimination: 84 percent believed that health insurance companies would probably deny coverage on the basis of testing results, and 69 percent thought employers would probably turn down job applicants (VCU Center for Public Policy 2001).

[40] A recent study indicated that the public's lack of knowledge and indecisiveness and the way in which questions are worded are all factors in producing the mixed results in survey research on the subject of human embryonic stem cell research (Nisbet forthcoming).

"not much." College graduates were more likely than others to report exposure to information about stem cell research (Pew Research Center for the People and the Press 2002b).

In one survey, support for medical research that uses stem cells from human embryos declined from 48 percent in 2001 to 35 percent in 2002 and then increased to 47 percent in 2003. Opposition increased from 43 percent to 51 percent and then fell to 44 percent during the same period (VCU Center for Public Policy 2003). In another survey conducted in 2002, 43 percent of respondents said they supported Federal funding for stem cell research, down from 55 percent who gave that response in a Gallup poll conducted in 2001(Pew Research Center for the People and the Press 2002b). Support for Federal funding was somewhat higher (50 percent) and opposition lower (35 percent) among respondents who said they had heard at least a little about the issue.

A 2002 survey asked respondents what was more important: conducting research toward medical cures or not destroying human embryos (Pew Research Center for the People and the Press 2002b). Nearly half (47 percent) chose the former and 39 percent chose the latter.

In a more recent (2003) survey, 54 percent of respondents said that medical research using stem cells obtained from human embryos is morally acceptable, and 38 percent said it is morally wrong. These numbers were virtually unchanged from the previous year's survey (Gallup 2003). Public opinion on the morality of stem cell research tracks closely with views about abortion (VCU Center for Public Policy 2003).

Religious beliefs play a major role in shaping public opinion on various forms of medical research. For example, those who say that religion is important to them are more likely than others to oppose stem cell research and are less likely to think that the benefits of genetic research outweigh the risks. In 2001, 7 out of 10 survey respondents who said that religion was not important to them favored stem cell research, compared with 38 percent of those who said that religion provides a great deal of guidance for them (VCU Center for Public Policy 2001).

A 2002 survey also asked respondents what influenced their opinion on government funding of stem cell research (Pew Research Center for the People and the Press 2002b). Those who supported funding were most likely to cite media coverage[41] as the most important influence (42 percent), followed by their education (28 percent); religion was not a major factor. In contrast, opponents of funding were more likely to cite their religious beliefs (37 percent) than any other influence.

In the same 2002 survey, political conservatives and respondents with relatively little formal education were more likely than others to oppose stem cell research. Nearly two-thirds of college graduates agreed that the government should fund stem cell research; only one-fourth disagreed. Among respondents who had not completed high school, only one-third (35 percent) favored government funding for stem cell research, whereas nearly half (46 percent) were opposed (Pew Research Center for the People and the Press 2002b).

Scientists and medical researchers are Americans' most trusted source of information on stem cell research. More survey respondents said they had "a lot" of trust in this group than said they trusted specialists in medical ethics (28 percent), family and friends (15 percent), religious leaders (15 percent), President Bush (11 percent), the news media (5 percent), and members of Congress (4 percent) (VCU Center for Public Policy 2001).

Optimism About Curing Disease

Americans are more confident about the capacity of science and medicine to solve problems associated with disease than they are about society's capacity to address many other problems. Americans are more optimistic about reducing cancer mortality rates (in 2001, 71 percent of survey respondents expected the rate to decline by more than half) than they are about a variety of other challenges facing society, including improving voter turnout, reducing traffic accident fatalities, and cutting the crime rate. The only challenge that elicited greater confidence from respondents was teaching children to read by the time they reach the third grade: 75 percent thought that was possible (VCU Center for Public Policy 2001).

Environmental Issues

Concern about the quality of the environment declined after 2001, according to the Gallup Organization's Earth Day survey, conducted in March of each year. In 2003, 34 percent of those surveyed said they "worried a great deal" about the quality of the environment, down from 42 percent in 2001 (but about the same as 2002) (Saad 2003a).

Environment Compared With Other Concerns

Of the 11 problems asked about in the Earth Day survey, the quality of the environment ranked 9th in terms of "worry." More people said they worried a great deal about the availability and affordability of health care (55 percent), the possibility of future terrorist attacks in the United States (49 percent), crime and violence (45 percent), the economy (44 percent), drug use (42 percent), illegal immigration (37 percent), hunger and homelessness (37 percent), and unemployment (36 percent). Between 2001 and 2003, worry about the economy, illegal immigration, and unemployment increased, while worry about the other problems either declined or stayed the same (Saad 2003a).

Although the environment does not register with the public as a serious current problem, it is considered one of the most important problems the country will face in 25 years. But even by the long-term measure, concern about the environment has declined. Until 2002, the environment was the most frequently mentioned problem in response to the 25-year outlook question, more important than Medicare and Social Security, lack of energy sources, and the economy. However, in both 2002 and 2003, the economy topped the

[41] Media coverage of stem cell research increased sharply between 2000 and 2001 and then fell steeply between 2001 and 2002 (Nisbet forthcoming).

list of long-term problems. In 2003, 14 percent of those surveyed named the economy (compared with 3 percent in 2001) and 9 percent named the environment (compared with 14 percent in 2001) (Saad 2003a).

Global Warming

In 2002, only 17 percent of Americans said they understood the issue of global warming "very well," about half (52 percent) understood it "fairly well," and the rest (about a third) answered either "not very well" or "not at all." There is a three-way split in public opinion on global warming as a problem, with approximately equal numbers of respondents saying it is a very serious problem, a moderate problem, and a slight problem (or not a problem at all) (Saad 2002).

Whatever their view about the seriousness of global warming, more than half (51 percent) of Americans think its effects have already begun, and others expect to see effects within a few years (6 percent) or within their lifetime (12 percent). Only 10 percent said the potential effects of global warming will never happen. In addition, most Americans (61 percent) believe that human activities are more responsible for increases in the Earth's temperature over the last century than natural causes, and most (62 percent) believe that news reports about the seriousness of global warming are either accurate or underestimate the problem. A third of those surveyed said that the media exaggerate the problem (Saad 2003b).

Although Americans seem to be aware of the issue and believe press reports, they are less concerned about global warming than other environmental hazards. On a list of 10 types of environmental issues, "damage to Earth's ozone layer" and the "'greenhouse effect' or global warming" ranked sixth and ninth, respectively, in 2002 (table 7-7). In addition, after increasing from 24 percent in 1997 to 40 percent in 2000, the number of people who worry a great deal about global warming declined to 29 percent in 2002. In fact, 9 of the 10 items on the list had similar declines between 2000 and 2002, with "maintenance of the nation's supply of fresh water for household needs" the only exception (Saad 2002).

Government Environmental Policy

Although half of Americans think the Federal Government needs to do more to protect the environment, satisfaction with the government's efforts has increased since the 1990s (Dunlap 2003). In 2003, 51 percent of survey respondents said the government was doing "too little" to protect the environment, down from 58 percent in 2000 and 68 percent in 1992. More than a third (37 percent) of respondents in 2003 said the government was doing "about the right amount," up from 30 percent in 2000 and 26 percent in 1992 (McComb 2003).

When survey respondents were asked to choose between two statements about tradeoffs between environmental protection and economic growth, "protection of the environment should be given priority, even at the risk of curbing economic growth" or "economic growth should be given priority, even if the environment suffers to some extent," more chose the former than the latter (47 versus 42 percent) in 2003. However, the percentage choosing the first statement has been declining steadily since 2000, reaching its all-time low (since the question was first asked nearly 20 years ago) in 2003; agreement with the second statement reached its all-time high in 2003 (figure 7-12) (Saad 2003a).

In 2003, most respondents (55 percent) opposed opening up the Alaskan Arctic Wildlife Refuge for oil exploration; 41 percent were in favor of it. About half (51 percent) opposed expanding the use of nuclear energy; 43 percent were in favor. These percentages have held fairly steady since 2001. In addition, between 70 and 80 percent of those surveyed in 2003 favored more stringent standards for auto emissions and business/industrial pollution, mandatory

Table 7-7
Environmental concerns of American public: 1997–2002
(Percent)

Issue	1997	1999	2000	2001	2002
Pollution of drinking water	NA	68	72	64	57
Pollution of rivers, lakes, and reservoirs	NA	61	66	58	53
Contamination of soil and water by toxic waste	NA	63	64	58	53
Maintenance of nation's supply of fresh water for household needs	NA	NA	42	35	50
Air pollution	42	52	59	48	45
Damage to Earth's ozone layer	33	44	49	47	38
Loss of tropical rain forests	NA	49	51	44	38
Extinction of plant and animal species	NA	NA	45	43	35
Greenhouse effect or global warming	24	34	40	33	29
Acid rain	NA	29	34	28	25

NA not available

NOTE: Percents reflect respondents who said they worry "a great deal" about the issue.

SOURCE: L. Saad, Poll analyses: Americans sharply divided on seriousness of global warming, Gallup Organization (Princeton, NJ, 2002).

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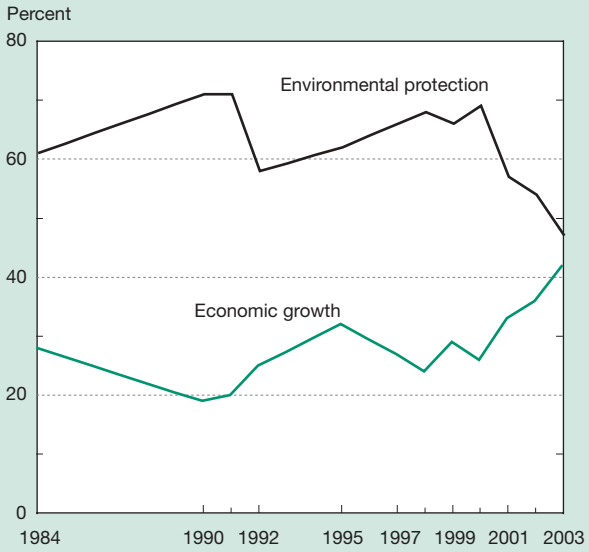
Figure 7-12
Public priorities for environmental protection vs. economic growth: 1984–2003



NOTE: Respondents were asked: "With which one of these statements about the environment and the economy do you most agree—protection of the environment should be given priority, even at the risk of curbing economic growth (or) economic growth should be given priority, even if the environment suffers to some extent?"

SOURCE: The Gallup Organization, Poll topics and trends: environment, 2003.

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controls on greenhouse gases, and stricter enforcement of environmental regulations (Dunlap 2003).

Technological Advances

Americans welcome new consumer products that are based on the latest technologies. Nowhere is that more obvious than in the burgeoning market for an array of devices that enhance and expand audio and visual communication capabilities.[42] At least two-thirds of the population now has a personal computer, and a similar percentage has a cell phone. In 2002, almost half (44 percent) said they owned a DVD player, up from 16 percent 2 years earlier. The number owning a Palm Pilot or a similar device more than doubled between 2000 and 2002, from 5 to 11 percent (Pew Research Center for the People and the Press 2002a). The number of households with cable or broadband access to the Internet has also been climbing rapidly (Cole 2002).

Most people believe that technology plays an important role in their lives. In a 2001 survey by ITEA, 59 percent disagreed with the statement "technology is a small factor in your everyday life." Most people (62 percent) also thought that technology has had a greater effect on society than either the environment (20 percent) or the individual (17 percent). However, an overwhelming majority (94 percent) agreed that "the results of the use of technology can be good or bad" (Rose and Dugger 2002).

In the same survey, 75 percent of respondents wanted to know something about how technology works, compared with 24 percent who admitted not caring how it works as long as it works. Among respondents ages 18 to 29, 84 percent were interested in knowing how technology works.

In Europe, an overwhelming majority (95 percent) of those surveyed agreed that "technology is a major factor in the innovations developed within a country." In addition, 84 percent of Europeans agreed that "science and technology play an important role in industrial development," 64 percent agreed that "our economy can only become more competitive if we use the most advanced technologies," and 56 percent agreed that "the Internet is essential for the development of new economic activities." However, about half of those surveyed in Europe agreed that "scientific research does not make industrial products cheaper" and that "many high-tech products are only gadgets."

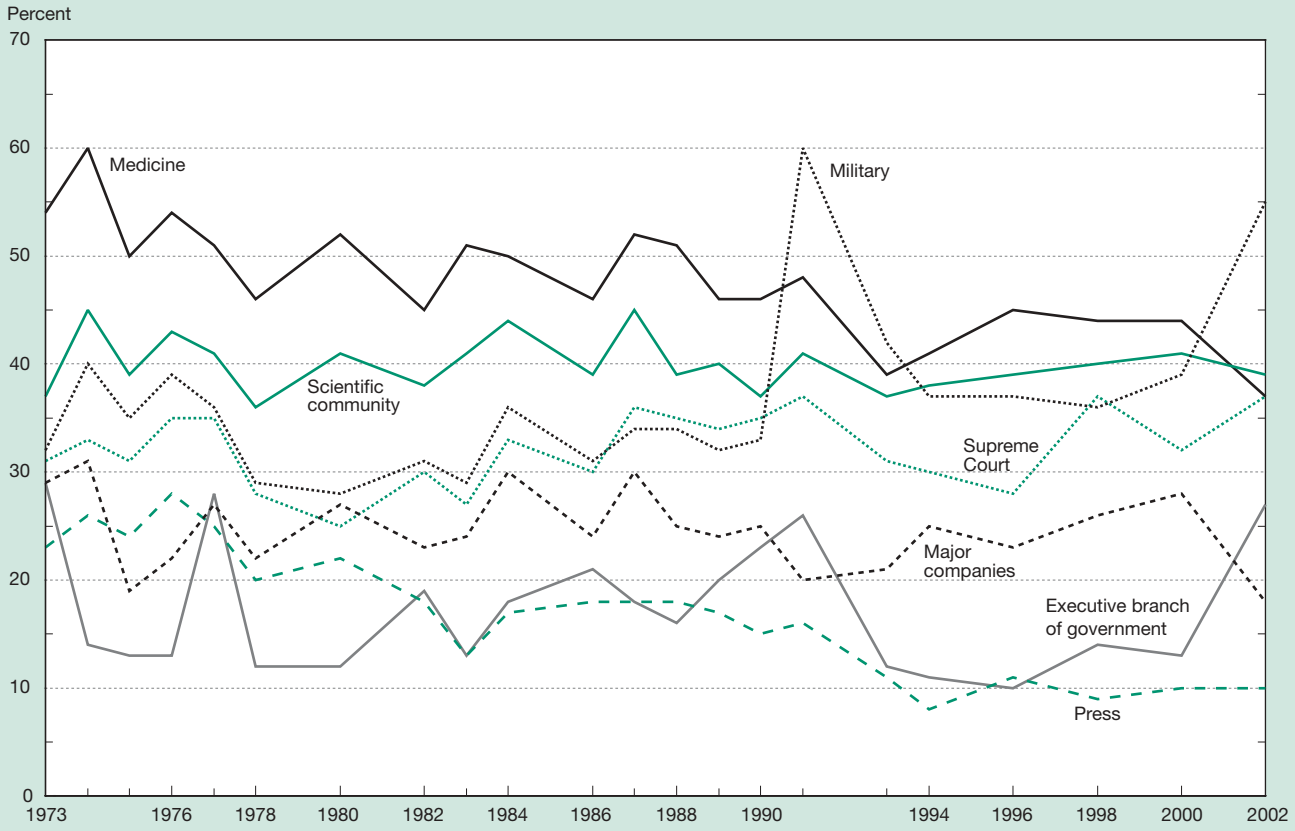
Higher Education

Every other year, the American Council on Education commissions a survey to gauge the public's perceptions of higher education. As in previous years, the 2003 survey revealed that most Americans recognize the benefits of higher education (Selingo 2003). Findings from the 2003 survey include the following:

- **Importance of a college degree.** About half (51 percent) of respondents agreed that a 4-year college degree is essential for success; 42 percent disagreed. Nearly half (46 percent) agreed that a graduate or professional degree will soon be more important than a 4-year degree; another 18 percent strongly agreed.
- **Value as a resource.** An overwhelming majority (91 percent) of those surveyed agreed that colleges and universities are one of America's most valuable resources; 35 percent strongly agreed.
- **Government spending.** When asked about state and Federal Government investment in higher education, 67 percent of respondents said that governments should spend more, 10 percent said that governments spend too much, and 10 percent said that current spending is about right.
- **Public vs. private schools.** When asked to compare the quality of education at public and private universities, 41 percent of respondents thought education was better at private schools, 13 percent said the opposite, and 38 percent said the quality was about the same.
- **Workforce preparedness.** Although 56 percent of those surveyed agreed that college graduates today are well prepared for the workforce, only 4 percent strongly agreed; 34 percent disagreed, and an additional 5 percent strongly disagreed.

[42] A survey conducted in 2002 asked both Internet users and nonusers if communication technology has made the world a better or worse place. Sixty-six percent of Internet users and 54 percent of nonusers said it has made the world better; 6 percent of users and 17 percent of nonusers said it has made the world worse.

Figure 7-13
Public expressing confidence in leadership of selected institutions: 1973–2002



SOURCE: J. A. Davis, T. W. Smith, and P. V. Marsden, *General Social Survey 1972–2002 Cumulative Codebook* (University of Chicago, National Opinion Research Center). See appendix table 7-8.

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- **Research role.** More than half (56 percent) of respondents said that it is very important for colleges to conduct research that leads to discoveries about the world; 28 percent said it was important, and 14 percent said it was somewhat important.
- **Business development role.** Most respondents thought that colleges play at least a somewhat important role in fostering a healthy economy (i.e., conducting research that will make American businesses more competitive, helping to attract new businesses to local regions, and helping local businesses and industries be more successful); between 36 percent and 42 percent thought these roles were very important.

Confidence in Leadership of the Science Community

Public confidence in the leadership of various professional communities has been tracked for nearly 3 decades. Participants in the General Social Survey (GSS) are asked whether they have a "great deal of confidence, only some confidence, or hardly any confidence at all" in the leadership of various professional communities (Davis, Smith, and Marsden 2003). In 2002, 39 percent said they had a great deal of confidence in the leadership of the scientific community. This was the first time in the history of the survey that greater confidence was expressed in science than in medicine (figure 7-13 and appendix table 7-8).

Under normal circumstances, the science community would have claimed the top spot in the GSS in 2002. However, 55 percent of respondents said they had a great deal of confidence in the leadership of the military, up from 39 percent in 2000.[43] The events of September 11, 2001, and the subsequent war in Afghanistan may have contributed to the increase in public confidence in the military. A similar trend was seen in the early 1990s, when confidence in the military rose from 33 percent in 1990 to 60 percent in 1991 (at the time of the Gulf War); confidence in the military then dropped to 42 percent in 1993.

[43]The U.S. military also topped the public confidence list in a poll conducted for the *Chronicle of Higher Education,* with 65 percent of those surveyed saying they had a great deal of confidence in the military. In that survey, 4-year colleges ranked second (51 percent), followed by the local police force (48 percent) and 4-year public-supported colleges and universities (46 percent). Other institutions mentioned in the survey included doctors (40 percent) and the presidency (33 percent).

Table 7-8
Prestige of various occupations: 1997–2002
(Percent)

Occupation	1997	1998	2000	2001	2002
Scientist	51	55	56	53	51
Doctor	52	61	61	61	50
Military officer	29	34	42	40	47
Teacher	49	53	53	54	47
Police officer	36	41	38	37	40
Priest/minister/clergyman	45	46	45	43	36
Engineer	32	34	32	36	34
Architect	NA	26	26	28	27
Member of Congress	23	25	33	24	27
Athlete	21	20	21	22	21
Entertainer	18	19	21	20	19
Journalist	15	15	16	18	19
Business executive	16	18	15	12	18
Lawyer	19	23	21	18	15
Banker	15	18	15	16	15
Union leader	14	16	16	17	14
Accountant	18	17	14	15	13

NA not available

NOTE: Percents are based on "very great prestige" responses to the following question: "I am going to read off a number of different occupations. For each, would you tell me if you feel it is an occupation of very great prestige, considerable prestige, some prestige, or hardly any prestige at all?"

SOURCE: The Harris Poll, survey conducted by Harris Interactive, August 15–19, 2002.

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Other noteworthy changes in public confidence between 2000 and 2002 include:

- Declines of at least 7 percentage points in scores for the medical community (from 44 to 37 percent), banks and financial institutions (29 to 22 percent), major companies (28 to 18 percent), and organized religion (28 to 19 percent).
- An increase of 14 percentage points for the executive branch of the Federal Government, from 13 to 27 percent, which was the highest level in a quarter of a century. As with the military, the increase in the public's confidence in the executive branch may reflect the events of September 11, 2001.[44]
- An increase of 5 percentage points for the U.S. Supreme Court (32 to 37 percent).

The science community has ranked second or third in the GSS public confidence survey in every year since 1973. Although the vote of confidence for the science community has fluctuated somewhat over the years, it has remained around 40 percent. In contrast, although the medical profession has ranked first in most years, its vote of confidence, once as high as 60 percent (in 1974), has been gradually declining.

The public's confidence in the leadership of the press and television (10 percent for both) was the lowest of all institutions. These ratings have changed little in the past 10 years.

Science Occupations

Perceptions of science occupations can be assessed by examining the prestige that the public associates with them. Respondents to an August 2002 Harris poll ranked "scientist" first among 17 occupations in terms of prestige, the first time the top spot did not go to "doctor" (table 7-8).[45] The engineering profession ranked seventh, the same as in 2001 but up one spot from 2000 (Taylor 2002a).

Although the public accorded less prestige to engineers than to scientists, doctors, military officers, teachers, police officers, and the clergy, engineers did command more respect than 10 other occupations."[46]

The public's perception of science occupations can be measured in other ways. When asked how they would feel if their son or daughter wanted to become a scientist, 80 percent of respondents to the 2001 NSF survey said they would be happy with that decision (18 percent said they would not care and 2 percent said they would be unhappy). Responses were the same for both sons and daughters.

[44]Within weeks of September 11, the number of people who said they trusted the government to do what is right most of the time hit its highest levels in 30 years, rising to 55 percent in one *New York Times*/CBS News poll (Stille 2002). (As recently as 1998, the figure was as low as 26 percent.)

[45]The question asked was: "I am going to read off a number of different occupations. For each, would you tell me if you feel it is an occupation of very great prestige, considerable prestige, some prestige, or hardly any prestige at all?" The rankings are based on the "very great prestige" responses.

[46]However, in a 2000 Gallup survey that asked the public about standards of honesty and ethics in 32 professions, engineers ranked 9th (Carlson 2000). In a November 2002 Harris poll (Taylor 2002b), scientists ranked fifth out of 21 occupations (after teachers, doctors, professors, and police officers, and just ahead of the President and judges) in response to the question "Would you generally trust each of the following types of people to tell the truth, or not?"

The 2001 Eurobarometer survey found that the three professions held in highest esteem by the European public all had a scientific or technical dimension: doctors (71 percent), scientists (45 percent), and engineers (30 percent). Rankings were similar in 1992 (except that engineers ranked fourth, after judges). Scientists were most likely to be rated highly in Sweden (55 percent), Greece (53 percent), and Denmark (50 percent). In addition, when asked who they would trust to explain the reasons for a local disaster, Europeans were more likely to name scientists than any other group.

An overwhelming majority of surveyed Europeans (96 percent) thought it was important for their country to encourage more young people to enter careers in S&T. Asked why more young people were not choosing scientific studies and careers, more than half of survey respondents agreed that lack of appeal, lack of interest, and difficulty were factors; about a third cited the poor image of science in society.

Seventy-one percent of surveyed Europeans thought more should be done to encourage girls and young women to pursue scientific studies and careers, and 67 percent agreed that "there ought to be more women in European scientific research." Sixty-three percent thought that the European Union should be more open to foreign scientists, and 58 percent agreed that the best scientists leave Europe for the United States.

Conclusion

Most Americans recognize and appreciate the benefits of S&T. The public is also highly supportive of the government's role in funding basic research. By most measures, American attitudes about S&T are considerably more positive than attitudes in Europe.

In both the United States and Europe, however, residents do not know much about S&T. The percentage of correct responses to a battery of questions designed to assess the level of knowledge and understanding of scientific terms and concepts has not changed appreciably in the past few years. In addition, approximately 70 percent of Americans do not understand the scientific process, technological literacy is weak, and belief in pseudoscience is relatively widespread and may be growing.

Although Americans generally have very positive attitudes about S&T and high regard for the science community, some harbor reservations about S&T, and 70 percent believe that scientific research does not pay enough attention to moral values. Although Americans are overwhelmingly opposed to human cloning, they are more evenly divided about stem cell research.

Americans continue to get most of their information about the latest developments in S&T from watching television. However, the Internet has made inroads and is now the leading source of information on specific scientific issues.

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