**Science Communication**
Volume 30 Number 1
September 2008 48-76
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10.1177/1075547008319434
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http://online.sagepub.com

# Visibility of Team Science

## A Case Study of Media Coverage of the NSF Science and Technology Centers

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There is a growing trend toward interdisciplinary research, with team science often touted as key to the creation of new knowledge and capabilities important to solving societal problems. But the balance between the funding of team efforts versus smaller grants is an issue that continues to be debated nationally. We analyzed media coverage of 17 active U.S. National Science Foundation (NSF) Science and Technology Centers (STCs) from 2000 to 2006. Research received the greatest coverage (49.5 percent), followed by institutional news (24.4 percent). A center name appeared in 35 percent of the items, and the NSF and STC program were less visible, at 31 percent and 10 percent, respectively. Surprisingly, no significant differences were found between hard news and feature stories in mentions of centers, NSF, or STC. Thus, even with the greater length and flexibility of a feature, the STC model and nature of team science remains essentially invisible to the public through the lens of the media.

***Keywords:*** *team science; interdisciplinary; center; STC; NSF; content analysis; feature*

Many researchers are currently tackling questions that transcend disciplinary boundaries, and federal agencies are creating new models for funding interdisciplinary science. For example, in 2005, the National Science Foundation (NSF) was funding almost 200 centers of various kinds, at a cost of $350 million or around 7 percent of the agency's budget (Mervis 2005).

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**Authors' Note:** This study was conducted with support from the National Science Foundation Discovery Corps Program, Grant # CHE-0609451. Contact information: Deborah L. Illman, Department of Communication, Box 353740, University of Washington, Seattle, WA 98195-3740; e-mail: illman@u.washington.edu.

Among these are the NSF Science and Technology Centers (STCs), which integrate scientific research, engineering development, technology transfer, diversity enhancement, education, and public outreach in order to address some of the most pressing problems of our times. This program currently supports seventeen centers, working on a rich array of themes including adaptive optics, earth-surface dynamics, integrated space weather modeling, nanobiotechnology, and ubiquitous secure technology.

The balance between the funding allocated to team efforts carried out at research centers such as the STCs and to single-investigator grants is, however, an issue that has generated some controversy. For example, members of the NSF's governing board have complained that the foundation supports too many research centers (Brainard 2005). In 2004, "House appropriators attempted to remove funding for the entire 2005 class of STCs," although this move was later rescinded by the full Congress (Mervis 2005, 945).

Making sound decisions about appropriate levels of funding for interdisciplinary science requires that decision makers are adequately informed about this mode of research. Normative considerations also strongly suggest that the public has a "right to know" what is being done with its tax dollars (NIST 2002, 1) Since the mass media are among the most important sources of public information about science and technology (Cobb 2005; Nisbet and Lewenstein 2002; NSB 2002, 2004, 2006), media coverage of the STCs, and interdisciplinary science more generally, appears to be a topic of some interest.

## Background and Rationale

### What is Interdisciplinary Science?

According to Rhoten and Pfirman (2007), the term interdisciplinary science "refers to the integration or synthesis of two or more disciplines, bodies of knowledge, or modes of thinking to produce a meaning, explanation, or product that is more extensive and powerful than its constituent parts" (p. 58).

Interdisciplinarity can take place at either the individual level or at the group level. At the level of the individual, "cross fertilization," occurs when an individual scientist "knits together tools, concepts, data, methods, or results from different fields or disciplines" (Rhoten and Pfirman 2007, 58). At the group level, "team-collaboration" entails "multiple researchers with mastery in their distinct fields or disciplines, working collectively as a network or team of individuals to trade and exchange tools, concepts, ideas, data, methods, or results around a common project" (Rhoten and Pfirman 2007, 58).

Interdisciplinary teams can be created within an individual institution, such as a university, drawing members from different departments. For example, one project launched by Arizona University in 1997 involved "more than 60 ecologists, economists, geographers, anthropologists, and urban planners" (Brainard 2002, A20). In 2005, Stanford launched a $94-million initiative with 10 new interdisciplinary faculty positions to research global issues, including bioterrorism and the spread of disease (*Los Angeles Times* 2005). Teams may also involve multiple institutions, including university-university collaborations, university-industry collaborations, or university-governmental laboratory collaborations (Roy 2000).

Many team efforts are funded by agencies such as the National Science Foundation or the National Institutes of Health (NIH). Over the past three decades, the NSF has invested in interdisciplinary science and engineering through center programs of various "flavors," such as the Industry/University Cooperative Research Centers (I/UCRCs), Engineering Research Centers (ERCs), and Science & Technology Centers (STCs), among others.

Interdisciplinary approaches are nothing new: as Brainard (2002) points out, "scientists engaged in novel collaborations to make the atomic bomb, isolate the structure of DNA, and discern the movements of tectonic plates" (p. A20). However, there seems to be a growing enthusiasm for interdisciplinary research in recent years, with team science often being presented as key to the creation of new knowledge and new fields of scientific inquiry, to the generation of new products and services, and to solving some of our most pressing societal problems.

For example, William R. Brody, president of the Johns Hopkins University, has noted the need to invest in "frontier and multi-disciplinary research, the two areas that are most likely to bring about important new scientific discoveries and technological innovations" (Brody 2005). In announcing a newly funded NSF Materials Research Science and Engineering Center, Yale provost and chemistry professor Andrew D. Hamilton noted the award recognizes "the power of interdisciplinary efforts to solve really difficult problems" (*M2Presswire* 2005). And Stanford professor Colt D. Blacker is quoted in the *Los Angeles Times* (2005) saying that the majority of the "most complex and most intriguing questions that come our way require expertise from multiple disciplines." (Also see Brainard 2002; Rhoten and Pfirman 2007; Roy 2000.)

While much of the funding for interdisciplinary endeavors comes from federal agencies such as the NSF and NIH, private institutions are also providing considerable levels of financial support (Rhoten and Pfirman 2007). Some state governments are supplying money for interdisciplinary research centers, seeing them as "a way to jump start the creation of industries and jobs related to a common research theme" (Brainard 2002, A20).

Interdisciplinary thinking is also reshaping graduate and undergraduate education and student recruiting. For example, the National Cancer Institute (NCI) and the NSF recently announced a $12.8-million training program for science and engineering doctoral students to focus on nanoscience and technology with applications to cancer, aimed at building "a cadre of appropriately cross-trained investigators without whom we cannot envision development of a pipeline of new diagnostics and therapeutics," says the director of the NCI (State News Service 2005).

At the undergraduate level, Brown University is adopting a "Science Cohort" program with an interdisciplinary approach as a means to attract students (*Brown Daily Herald* 2005). On another front, University of Michigan plans over the next five years to introduce more interdisciplinary classes, "moving away from increasingly arcane, single-subject concentrations," according to the *Michigan Daily* (2005).

## Problems in Interdisciplinary Science

Interdisciplinarity is "emblazoned prominently across every national agency's proclaimed key strategies for funding modern research" (Roy 2000, xvii). However, a number of issues, including fair treatment in the proposal review process and in scientific publishing, make this mode of science challenging (Brainard 2002; Levander 2000; Metzger and Zare 1999; Rhoten and Parker 2004; Sung et al. 2003).

The risks of faculty participation in team science can be significant. For example, while agencies may seek to "provide long-term, stable financing for collaborative research that involves a high risk of failure" (Brainard 2002), researchers also need to maintain a strong publication record in order for other grants to be renewed (Mervis 2002). Rewards within the traditional academic culture can also be uncertain (Brainard 2002). Meanwhile, campuses struggle to manage entities that straddle departments and colleges and to maintain relationships with partners and affiliates (Rhoten 2003).

As a result, federal agencies are focusing not only on funding mechanisms but also on ways of overcoming barriers to interdisciplinary collaboration and of improving communication (see, for example, *U.S. Newswire* 2005). For example, an NIH symposium focusing on the grand challenges in bioengineering generated a hard-hitting prescription that emphasized the need to catalyze multidisciplinary teams, establish new collaborative programs, explicitly join engineering and biology in research and training, reinvent the academic structure, and, throughout all, communicate (National Institutes of Health, 1998). Recently, NSF and NIH were also mandated by Congress to identify barriers and opportunities at the interface of the life and physical sciences and to recommend courses of action (National Institute of Biomedical Imaging and Bioengineering 2004; Swaja et al. 2004).

## Challenges for the Media in Covering Interdisciplinary Science

While federal agencies have identified a need for better communications among researchers, the issue of communication about the work of centers through the mass media appears to have received less attention. Americans obtain much of their information about science and technology through the mass media (LaFollette 1990; National Science Board 2002; Nelkin 1995), even though the connection between media representations and public knowledge is not exactly simple (Klapper 1960; Rogers 1999; Stamm, Clark, and Torres 2001; Wynne 1993). However, as sociologist Dorothy Nelkin (1995) has pointed out, journalists do play a substantial role in shaping public knowledge and attitudes:

> By selecting their stories out of an endless stream of events and issues, [journalists] define certain subjects and not others as newsworthy. By their choices of headlines and leads, they legitimize or criticize public policies. By their selection of details, they equip readers to think about science and technology in specific ways (p. 12).

To what extent are the media equipping policymakers and the public to think about interdisciplinary efforts in science, engineering, and technology?

Our preliminary examinations of media coverage of the NSF STC outcomes suggested there may be considerable challenges. As mentioned above, some of the difficulties of carrying out interdisciplinary science arise from the fact that it does not fit into traditional academic structures. A similar situation may exist with respect to media coverage, since many of the structures and routines of journalism in general, and science reporting in particular, may not lend themselves to covering team efforts.

Another aspect of science reporting that might present a challenge for covering team science is its traditional focus on the results of science rather than on the process by which these results are produced (Bennett 1986; LaFollette 1990; Nelkin 1995). Concerns about this style of reporting have often focused on the ways in which this solidifies scientific claims and obscures scientific uncertainties (see, e.g., Stocking 1999).

Further, researchers have also noticed a strong tendency for the mass media to portray science as an individualistic, heroic endeavor (LaFolette 1990; Nelkin 1995). Even worse, from the point of view of team science, Charney (2003) observes that journalists also tend to frame science in terms of "competitive horse race in which 'winning' means being first to reach 'the answer' despite having to overcome formidable obstacles" (p. 217). In reality, much science is already done by teams, rather than by heroic loners, but the increased emphasis on interdisciplinary science seems likely to further shift the practice of science away from "autonomous, hierarchical, and competitive," and toward the "interactive, horizontal, and cooperative" (Rhoten and Pfirman 2007, 58). Clearly, this way of doing science "doesn't fit in the traditional silo," in the words of Dennis Matthews, director of the Center for Biophotonics Science and Technology—an STC headquartered at the University of California, Davis—who further observes that "everyone loves to anoint a single hero."

As an additional complication for journalists, many of the investigators involved in the STCs are members of more than one center, institute, or interdisciplinary program. This can yield a tangle of interactions and affiliations, perhaps more than can reasonably be mentioned or sorted out in the limited space of a story written in the hard news format, where the length of the story is tightly controlled (Friedman 1986).

Journalists may also cover STC-related activities as local interest or business stories, rather than as science, technology, and engineering (ST&E) stories. Research on newspaper audiences has shown that local news "tops the list of content that drives readership" (Stepp 2004). However, given space limitations, an emphasis on the role of the local member institution may come at the expense of the broader network of institutions involved in many forms of interdisciplinary science.

Another factor may be the relative proportions of "hard" or "inverted pyramid" news stories and "feature" style stories. Hard, straight, or inverted pyramid news stories are focused on current or very recent events and use the proverbial "Who, What, When, Where and Why" model. In science journalism, the hard news format frequently relies on a news peg such as the publication of findings in a prestigious journal or a presentation at scientific conferences (Clark and Illman 2006; Dunwoody 1986; Freidman 1986). Often written under tight deadlines, these stories "often highlight one author" of the recently published research paper, perhaps "with brief comments from one or two other independent scientists, including a proponent of a rival approach" (Charney 2003, 217; see also Crisp 1986; Freidman 1986; Stocking 1999). This limited-source approach does not seem to be one that lends itself to the effective coverage of team science.

In contrast, feature stories are usually longer, more complex, and more comprehensive. Features are often organized around a topic, such as the Milky Way or the function of sleep. While features may be triggered by new research findings, they are not as tightly bound by conventions of timeliness: It is often difficult to know why a feature story appeared when it did. The feature allows the journalist to explore a topic in depth and pull together work by several different researchers.

Science-feature stories are also known to be popular with readers (Stepp 2004). However, features are expensive in terms of journalists' time and effort (Blakeslee 1997; Franklin 2002). Space is also a highly valuable commodity in a newspaper, acting as another limitation on the number of science stories of any kind and especially on the number of feature stories that can be accommodated (Franklin 2002).

Given these considerations, it is perhaps not surprising that in a study of 100 newspapers, conducted by the Readership Institute (2001), papers of a variety of different sizes were remarkably consistent in terms of the balance of inverted pyramid style stories, features stories, and commentary. During the week, newspapers printed around 71 percent "straight" or "inverted pyramid" style stories and around 16 percent features. On Sundays, the proportion of inverted pyramid news dropped to around 54 percent "straight news" for large papers, and 65 percent for smaller papers, "with the balance features and commentary" (Readership Institute 2001, 6).

Thus, although they are fewer in number than the hard news stories, we wondered if features would offer more scope for covering the complexity of reporting on team science.

## Media Coverage of the NSF Science and Technology Centers: A Case Study

As a first step toward understanding media coverage of team science, the current study focuses on one model: the NSF STC program. We selected the STCs for a case study for several reasons. First, the program is often considered to be the "flagship" program for interdisciplinary research and is credited with helping "spawn a population explosion of academic research centers in the United States and around the world" (Mervis 2002). Second, while the subject matter differs among centers, the STCs form a relatively homogenous group with respect to organizational structure and the types of activities. Third, as part of their mandate from the NSF, the STCs are charged with collecting media reports about their activities providing what might be thought of as an "official record" of media coverage available for study.

The NSF STC program was initiated in 1987, with the first group of centers funded in 1989 (Mervis 2002; National Academy of Sciences 1996). Five of the current centers were established in 2000, six in 2002, two in 2005, and four in 2006 (see Table 1). A typical STC includes five to ten major institutional partners, with one "lead" institution per center (Brzakoivc 2006). Each STC involves 15 to 70 senior researchers and some 20 to 140 graduate students, drawn from a variety of disciplines (Brzakoivc 2006). Centers receive up to $20 million over five years, with the possibility of a second five-year period of funding subject to a midterm review (Mervis 2002). The program integrates scientific research, engineering development, technology transfer, diversity enhancement, education, and public outreach.

Our study analyzes center related coverage in order to address the following fundamental questions.

*RQ1:* In which media are center-related stories appearing, and which audiences are they likely to reach?

It is widely recognized that there is no single public for science and technology information; instead, a number of different constituencies can be identified. For the NSF STCs, those most likely include the following: policy makers, scientists, and engineers; high-tech businesses and industry; journalists, citizens with ties to a center's member institutions (such as university employees, alumni, and parents of students), as well as taxpayers more generally. Among the latter group, further distinctions can be drawn among the "science attentive" public, the "science interested" public, and the "residual public," that is, those who pay little attention to science and technology news (see, e.g., NIST 2002; NSB 2002).

Previous research has suggested that these groups make use of different media in learning about science and technology. For example, the science attentive public "regularly read newspapers and magazines with relevant information . . . [and] are more likely to watch science television shows, visit science Web sites and visit science museums, and buy science books" (NIST 2002, 5). While a 2001 survey found that only about 10 percent of US adults were "science attentive" (NSB 2002), this still represents over

## Table 1
## NSF STCs Currently in Operation

| Year Initiated | Center Name | Center Acronym | Lead Institution |
|---|---|---|---|
| 2000 | Center for Adaptive Optics | CfAO | University of California at Santa Cruz |
| 2000 | Center for Behavioral Neuroscience | CBN | Georgia State University |
| 2000 | Center for Environmentally Responsible Solvents and Processes | CERSP | University of North Carolina at Chapel Hill |
| 2000 | Center for Nanobiotechnology | NBTC | Cornell University |
| 2000 | Center for Sustainability of Semi-Arid Hydrology and Riparian Areas | SAHRA | University of Arizona |
| 2002 | Center of Advanced Materials for the Purification of Water with Systems | WaterCAMPWS | University of Illinois at Urbana-Champaign |
| 2002 | Center for Biophotonics Science and Technology | CBST | University of California at Davis |
| 2002 | National Center for Earth-Surface Dynamics | NCED | University of Minnesota at Twin Cities |
| 2002 | Center for Embedded Network Sensing | CENS | University of California at Los Angeles |
| 2002 | Center for Integrated Space Weather Modeling | CISM | Boston University |
| 2002 | Center on Materials & Devices for Information Technology Research | MDITR | University of Washington |
| 2005 | Center for Remote Sensing of Ice Sheets | CRESIS | University of Kansas |
| 2005 | Team for Research in Ubiquitous Secure Technology | TRUST | University of California at Berkeley |
| 2006 | Center for Coastal Margin Observation and Prediction | CMOP | Oregon Health and Science University |
| 2006 | Center for Layered Polymeric Systems | CliPS | Case Western Reserve University |
| 2006 | Center for Microbial Oceanography: Research and Education | C-MORE | University of Hawaii |
| 2006 | Center for Multi-Scale Modeling of Atmospheric Processes | CMMAP | Colorado State University |

Note: NSF = National Science Foundation; STC = Science and Technology Centers.

20 million individuals. Moreover, members of the science-attentive public tend to be more politically active than average and also to have "a high level of cross-talk with other audiences," making them potentially more influential than their numbers might suggest (NIST 2002, 6).

While a relatively strong interest in science, technology, and engineering acts as a clear predictor for ST&E-related media use, stories that emphasize any "local" angle may also attract audiences. For example, according to a recent survey by the Pew Research Center for People and the Press, "roughly nine-in-ten of those who at least sometimes read a newspaper say they spend a significant amount of time getting the news about their city, town, or region" (Pew Research Center 2006, 4). The same survey found that while 28 percent of respondents regularly watched the nightly news on CBS, ABC, or NBC and 34 percent regularly watched cable news, 54 percent watched local TV news (Pew Research Center 2006, 12). Hence, local media coverage of the activities of a STC and/or its member institutions may have the potential to reach a broader segment of the population.

These days, however, many of the traditional distinctions between media are breaking down, and media stories may appear in several different formats (NIST 2002). For example, a story may appear in the print edition of a newspaper, the online edition of a newspaper, or in both formats. Newspaper or magazine stories may also appear on TV and/or radio station Web sites, especially in situations where the media channels involved are owned by the same parent company (for an example, see Kolodzy 2003). The Internet also allows "organizations to publish materials directly to a world wide audience," which has "reduced dramatically their previous dependence on intermediaries such as television and newspaper reporters to carry important messages to the public" (NIST 2002).

*RQ2:* What aspects of the centers' mission elements receive coverage, under what circumstances, and via what types of story?

*Mission elements receiving coverage.* The STCs are charged with carrying out activities in several different areas, and these mission activities form a natural lens through which to view coverage. To what extent are these broader activities visible to audiences? For example, what proportion of coverage is about institutional factors, such as the founding of a center, compared to the proportion of stories about the research findings produced by the center?

The amount of media coverage primarily devoted to different center activities was examined in terms of institutional activities; research activities;

educational, diversity, and outreach activities; and knowledge transfer activities. Research was defined as including both basic science and new technological developments that enabled new types of research. Knowledge transfer included both business spin-offs and contributions toward solving societal problems, such as ocean and fisheries issues and cybersecurity. Education, diversity, and outreach included both formal educational events, such as science camps or summer schools, and informal educational events, such as new museum exhibits.

*News pegs.* As a rule, hard news coverage emphasizes timeliness, and coverage is therefore dependent on the existence of a suitable news peg, such as the dedication of a new STC, or the publication of new findings in a prestigious journal. Examining news pegs gives an additional indication of when centers are likely to receive coverage.

*Type of story.* Focusing on the STCs mission elements has the potential to illustrate which aspects of the centers' mission elements are visible to relevant publics. However, given the previously observed tendency toward hard news stories drawing on a limited number of sources, it also seemed useful to look at media coverage in terms of story types and to see if/how team interactions are covered in hard news and feature style stories.

*RQ3:* To what extent are the centers themselves, the National Science Foundation, and the NSF-STC model visible in the coverage?

Preliminary readings of some of the media reports suggested that in many cases research and other activities were credited to one of the center's member institutions and not to the center itself. This suggested that one basic measure of the visibility of the STCs is the extent to which the centers are mentioned by name in the media reports.

Since the appropriate level of NSF financial support for team science has been strongly debated, a question also arises of whether the role played by the NSF in funding the centers is visible in media coverage. In other words, from reading the center–related media stories, what would any interested policymaker or member of the public know about the role played by the NSF in supporting a center? More specifically, what, if anything, would a reader learn about the NSF-STC program more generally? How are team interactions portrayed? What do audiences learn about the conduct of interdisciplinary interactions in centers?

## Research Questions

To address the broad areas outlined above, the following more specific research questions were asked. RQ1 was applied to the entire set of stories obtained from the centers. The remaining research questions were applied only to stories appearing in mainstream print media, that is, newspapers and magazines aimed at general audiences (see "method" section below).

### Media Channels in Which Coverage Occurred

*RQ1:* In which media have stories related to the NSF Science & Technology Centers appeared?

### Coverage of Center Activities, Types of Stories, and News Pegs

*RQ2a:* What are the relative proportions of the different mission elements of the STCs?
*RQ2b:* What types of "news pegs" are associated with the stories about these mission elements? That is, why did a particular story appear when it did?
*RQ2c:* For the stories focusing on research and on societal problems, what are the relative proportions of hard news and feature stories?

### Visibility of the Centers and the NSF-STC Model

*RQ3a:* In what proportion of the stories is a center explicitly mentioned by name?
*RQ3b:* In what proportion of stories is the NSF and its role as a funder explicitly mentioned?
*RQ3c:* In what proportion of the stories is the center being covered explicitly identified as an STC?
*RQ3d:* Does the visibility of the centers, of the NSF, and of the STC model vary with the type of story, as defined in RQ2c above?

## Method

### Population of Media Reports Used for the Study

The study population consists of (a) media items listed in the annual reports prepared by the centers for the NSF and made available for the current study, (b) media items listed on a center's Web site, and (c) media items sent to the researchers in response to requests for media reports. There are some limitations with respect to this population. First, some centers may have kept more complete records of media coverage than others. Also, coverage from 2006 is incomplete since the compilation of items currently included in this report took place in October 2006. In several cases, the lists of media reports were obtained from center annual reports; some of these run from summer to summer. Thus, unless a center also maintains an up-to-date list of news coverage on its Web site, or supplied the more recent items in response to requests for media reports, any coverage received since the publication of the 2005-2006 annual report is not currently included.

Some centers furnished items dating from before the year in which the center was officially established. Those reports that explicitly mentioned the center (e.g., those that mentioned that a grant bid had been successful and that a center would be formed) were kept; those that had no obvious connection to the center were excluded.

The centers' annual reports and Web sites yielded a total of 947 media items of which 372 appeared in newspapers, newspaper Web sites, or in general interest magazines (see below for definitions). We were able to obtain complete and legible copies of 295 (79.3 percent) of these stories either from the centers themselves or from online databases such as LexisNexis and online newspaper and magazine archives. In some cases, a particular story—for example, a wire service story—appeared in multiple media outlets; all appearances of the material were treated as unique cases.

While the missing articles clearly represent an additional limitation to the study, this sample does include items from all of the active STCs except one of the newly established ones (class of 2006) and from a variety of mainstream print media outlets. For the purposes of this exploratory case study, these appear to be minor limitations.

## Coding Categories

### *Media Channels in Which Coverage Occurred*

It seemed more important to know that a story appeared as a *New York Times* story, for example, than to know whether it appeared in print, online, or both. Thus, any story appearing in the *New York Times* was coded as a newspaper story regardless of the format in which it appeared or whether it was produced by a *New York Times* reporter or obtained from a wire service such as the Associated Press (AP). Similarly, any story appearing on a TV Web site was classified as a TV story. This approach also had practical value: in some cases, the media listings provided by the centers were insufficiently detailed to make it clear in which format(s) an item had appeared. The ephemeral nature of the Internet also means that many of the URLs for

Web-based reports listed by the centers are no longer live: this makes it impossible to know who originally produced an item unless a center printed out a hard copy when the story first appeared.

Stories were initially coded as having appeared in a specialized audience medium or in a general audience medium. These two broad classes, specialized audience media and general audience media, were also subdivided as follows:

*Specialized audience media* (provide relatively restricted visibility)

- Publications and Web sites aimed at people working in a specialized technical area. Examples include *Analytical Chemistry*, *Astrobiology Magazine*, and *The Sedimentary Record*. Materials appearing on Web sites of scientific, engineering, and industry organizations were also included in this category.
- Publications and Web sites produced by universities and aimed at faculty, staff, students, and alumni. Examples include faculty newspapers, alumni magazines, and press releases.

Some of these “specialized” media may, of course, provide high visibility within a particular community: however, these media generally reach fewer people than “general audience” media.

*General audience media* (provide broader visibility):

- Mainstream newspapers (print and online versions)
- General audience magazines (print and online versions)
- Television and radio (including TV or radio station Web sites)
- Online-only news sources (news outlets without a readily available print or broadcast counterpart)

To obtain a more detailed picture of these general audience media, the following subcategories were also used:

Newspapers:

- Local newspapers (can reach a wide audience)
- Prestige/national newspapers, e.g., *New York Times*, *Washington Post* (important for policy makers, scientists, journalists, and the science attentive/interested publics)
- Non-US newspapers

- Wire service reports (important source for journalists and editors). Note: if a wire service story appeared in a newspaper, the item was coded as a newspaper story in this phase of the study.

Magazines:

- Popular science magazines—for example, *Popular Science*, *Discover*. *Nature* and *Science*—were also included in this category due to their prestige, wide availability, and frequent citation by journalists. (Audiences include scientists and engineers, the science-attentive/interested public, and science/technology journalists.)
- Business-economics magazines, for example, *Forbes, The Economist.* (Audience includes members of the business community.)
- General news magazines, for example, *Time, Newsweek.* (Audience: taxpayers more generally.)
- Other general audience magazines, for example, *The New Yorker.* (Audience: taxpayers more generally.)

Television and radio

- Television (TV news coverage provides broad visibility but little depth.)
- Radio (may reach a broad range of people who commute in the cars.)

Online-only news sources

As discussed above, if a media item appeared on the Internet under the auspices of an entity with a well-established physical or broadcast presence, it was coded as belonging to the parent newspaper, magazine, TV station, scientific organization, industry group, and so on. However, some media items appeared in a variety of "news aggregator" sites. These offer compilations of news stories and press releases related to a particular topic: examples include *Health News Digest*, *Science Daily*, and *Space Daily.* Our sense is that the regular audiences for many of these Web sites are members of the general public with specialized interests. However, the content of these sites is freely available to anyone with an Internet connection and may attract other members of the science-interested public as well as science and technology journalists. These sites are news focused, and they seem to more closely resemble general interest science and technology magazines than the multipurpose Web sites maintained by a number of science, engineering, and technology organizations. These Internet-only news sources were therefore treated as general audience media.

### *Coverage of Center Mission Elements, News Pegs, and Type of Story*

The media reports in the study population were first coded with respect to which of the centers' key mission elements formed the major focus of the story. That is, while a story may have mentioned other elements, each media item was identified as being *primarily* focused on the following:

- Institutional news, such as stories about a new center being established, a grant renewal, a new laboratory, etc.
- Research news, including basic science or the development of new technologies that enabled new research or new applications.
- Education, diversity, and outreach, including stories about formal activities, such as summer schools, and also informal education activities, such as museum exhibits.
- Knowledge transfer (business oriented), for example, establishment of start-up companies or the patenting of findings.
- Knowledge transfer (societal problems), primarily focused on problems such as drought or the environment.
- Other themes or for which no primary theme could be identified.

We also attempted to identify a news peg for each story: that is, to identify why the story appeared when it did. Identifications were made on the basis of material explicitly included in a story and not on additional knowledge that the coder had gained through reading other news stories about the same topic. The news peg categories were as follows:

- Establishment of/opening of a new STC.
- Other institutional event: for example, visit by dignitary, dedication of a new building, etc.
- Announcement of new research findings and activities usually through a conference or through publication in a journal
- Educational event (e.g., summer camp happens, new museum exhibit opens)
- Knowledge transfer event (e.g., patent granted, FDA approval for a new product)
- Governmental event (e.g., announcements by governors, new legislation proposed or passed)
- Other event (e.g., weather events, media-sponsored events, etc.)
- Unclear why this story appeared when it did
- Other news peg

Stories were also categorized as hard news, features, or editorial using the following definitions:

- Hard news stories: a story that emphasizes the facts of a recent or upcoming event, often associated with the inverted pyramid structure.
- Feature stories: covering a broad theme (rather than a single event), such as how the sun works and how remote sensing networks are enhancing our understanding of ecology. While features may be triggered by, and therefore refer to, the publication of new research findings, they are not as tightly bound by conventions of timeliness.
- Editorial items: this category included letter to the editor and opinion columns.

### Visibility of the Centers and the Center Model

To assess the visibility of the centers, we determined

- whether or not at least one of the centers' names was explicitly mentioned in the story.

To assess the visibility of the National Science Foundation, we determined

- whether the foundation was explicitly mentioned by name in the story (either "National Science Foundation" or "NSF" was counted as a mention), and
- whether the NSF was identified as the primary funder of the center or of some aspect of the work/project covered in the story.

To assess the visibility of the NSF-STC model, we determined whether a center was explicitly identified as follows:

- A Science & Technology Center (STC)
- An NSF-STC

Clark coded all of the stories. Intercoder reliability checks were carried out by Illman and Jim Boggs on randomly selected subsets of 10 percent of the items (95 items for type of media, 30 items for the more detailed analysis of the general audience print media.)[1] Using Holsti's formula, intercoder agreement ranged from 89 to 100 percent depending on the item.[2] Disputed items were resolved by discussion. Data were analyzed using SPSS.

## Results and Discussion

### Prevalence of STC-Related Items in Media Channels

As shown in Tables 2 and 3 below, the bulk of the media items (63 percent) reported by the STCs appeared in general audience media potentially allowing a broad audience to be exposed to center-related information. Overall, the greatest amount of coverage appeared in local newspapers. These media items therefore have the potential to reach beyond the "science attentive" public. STC-related material also appeared in general audience magazines, including popular science and technology magazines such as *Scientific American* and *Wired*, as well as in business-economics magazines such as *The Economist* and *Forbes* and newsmagazines such as *Time*. Coverage also appeared via broadcast outlets, although it was impossible to tell how many of these items were transmitted on air and how many simply appeared on a broadcast outlet's Web site.

As shown in Table 2, the centers also received coverage in various specialized media. The institutional press releases can and do form the basis of stories appearing in the general news media and have been analyzed separately (Graube, Clark, Illman). Center-related materials appearing in specialized magazines and their Web sites may also bring the work being done at the centers to the attention of members of the ST&E community more broadly.

## Center Mission Elements, News Pegs, and Types of Story

### *Mission Elements*

As shown in Table 4, center-related research activities received the greatest amount of attention: this mission element was the primary focus of almost half (49.5 percent) of the stories. Second in dominance was institutional news, the primary focus of about a quarter of the stories. Knowledge transfer and education were the least covered elements.

Many of the institutional stories were about the establishment of a new STC and touched upon several or all of the STC mission elements as subsidiary themes. Other institutional stories reported topics such as the renewal of an STC's grant, the opening of a new building, or a visit by a dignitary of some sort. Yet, others offered news about similar activities at one of the STCs' member institutions without specifically discussing the center.

## News Pegs

While the news pegs categories are broadly similar to the center mission elements, there is no one-to-one correspondence. One reason for this is that events that lie outside the STC mission elements may act as news pegs for stories that relate to center activities. For example, governmental figures

## Table 2
## Total Numbers of Different Types of Media Reports (for All Centers)

| | Total # of items, all STCs |
|---|---|
| General audience media | 598 |
| Newspapers and their Web sites | 300 |
| General interest magazines and their Web sites | 72 |
| TV/Radio stations and their Web sites | 118 |
| Online only news services | 108 |
| Specialized media | 332 |
| Specialized publication/Web site | 137 |
| University/lab media | 195 |
| Other or unknown | 17 |
| Total | 947 |

## Table 3
## A More Detailed Look at Selected General Audience Media

| | Total # of items, all STCs |
|---|---|
| Newspapers and their Web sites | 300 |
| Local newspapers | 230 |
| Prestige/national newspapers | 31 |
| Overseas newspapers | 26 |
| Wire service Web sites | 13 |
| General interest magazines and their Web sites | 72 |
| Science and Technology magazines | 43 |
| Business/finance magazines | 21 |
| News magazines | 4 |
| Other or unknown general interest magazines | 4 |
| TV and radio | 118 |
| US television | 78 |
| US radio | 24 |
| Non-US broadcasters (TV and radio) | 14 |
| Other or unknown TV/radio | 2 |

## Table 4
## Center Mission Elements Predominant in Stories

| Activity | Number | Percent |
|---|---|---|
| Research news: new technologies and basic science | 146 | 49.5 |
| Institutional news | 72 | 24.4 |
| Knowledge transfer: societal problems | 38 | 12.9 |
| Education, diversity, and outreach | 21 | 7.1 |
| Knowledge transfer: business-oriented | 15 | 5.1 |
| Other | 3 | 1.0 |
| Total | 295 | 100.0 |

may commission studies or pass legislation that has some relevance to the work being done at the centers.

Also, as discussed earlier, media items can be divided into hard news, features, and editorial formats. Hard news stories, by definition, have a clear news peg. While these items may be very short or relatively long, tightly focused or rather more complex, they are all reporting on something that just happened, or is about to happen, and the story therefore has a clear element of timeliness. In contrast, feature stories often have no clear news peg—there is no particular reason why a story should appear this week rather than next week or even next month.

The fact that no clear news peg could be identified for 61 (almost 21 percent) of the stories (Table 5) therefore points to the presence of feature stories in the study population. This topic will be taken up again in the discussion of story types below.

As shown in Table 5, the announcement of new research findings was the most common news peg found in 40.7 percent of the items examined. Institutional events were the next most-frequently encountered news peg. Education-related events acted as a clear news peg for only eighteen items (5.4 percent). These events included summer camps, visits to classrooms by center staff, and the opening of museum exhibits related to center activities. Business-related events served as news pegs for only two stories (0.7 percent); both of these reported that a center-related spin off had won a prize.

Activities of government representatives and agencies acted as a news peg for thirteen stories (4.4 percent). For example, announcements by the governor of Arizona provided a news peg for several stories that focused on the societal problem of drought in Arizona, while the granting of FDA approval for a custom eye surgery process acted as a news peg for a story about business applications of adaptive optics research.

**Table 5**
**News Pegs (i.e., Why Did This Story Appear When It Did?)**

| News Peg | Number | Percent |
|---|---|---|
| Publication of research findings | 120 | 40.7 |
| Establishment/opening of a new STC | 45 | 15.3 |
| Edu./diversity (e.g., summer camp happens) | 18 | 6.1 |
| Other inst. event: e.g., visit by dignitary, etc. | 14 | 4.7 |
| Governmental event | 13 | 4.4 |
| Knowledge transfer: business-oriented | 2 | 0.7 |
| Other event | 21 | 7.1 |
| Unclear why this story appeared when it did | 61 | 20.7 |
| Total | 295 | 100.0 |

Other events that served as news pegs included weather conditions; events generated by the media outlets themselves, such as round table discussions organized by a newspaper; annual round-ups of "hot" new technologies; rankings of the top colleges (organized along various dimensions); and annual awards made to leading scientists from different fields.

## Type of News: Hard News, Features, and Editorial

Most of the media items collected by the centers were hard news stories (76 percent); some 22.7 percent were features, and 1 percent was editorial (a letter to the editor and two guest editorial columns).

The division between hard news and features followed a similar pattern for most of the individual mission elements:

- Of the 146 stories related to the research mission of the center, 114 (78.1 percent) were hard news stories, while 32 (21.9 percent) were feature stories.
- For the 72 institutional stories, 62 (86 percent) were hard news stories, 9 items (12.5 percent) were features, and 1 was an editorial item (1.4 percent).
- For the 21 education, diversity, and outreach items, 18 (85.6 percent) were hard news, 2 (9.5 percent) were features, and 1 (4.8%) was an editorial item.
- For the 38 stories focusing on societal problems, 24 (63.2 percent) were hard news, 13 (34.2 percent) were features, and 1 (2.6 percent) was an editorial item.

## Table 6
## Visibility of Center Name, NSF, and STC Program, by Mission Element

| Mission Element | # of Stories | # with Center Name | % Center Name ($n = 295$) | # with NSF | % with NSF ($n = 295$) | # with STC | % with STC ($n = 295$) |
|---|---|---|---|---|---|---|---|
| All mission elements | 295 | 104 | 35.3 | 92 | 31.2 | 30 | 10.2 |
| Institutional news | 72 | 51 | 17.3 | 57 | 19.3 | 28 | 9.5 |
| Research news | 146 | 30 | 10.2 | 22 | 7.5 | 0 | 0.0 |
| Education,diversity, outreach | 21 | 12 | 4.7 | 9 | 3.1 | 1 | 0.3 |
| Knowledge transfer: business | 15 | 3 | 1.0 | 2 | 0.7 | 0 | 0.0 |
| Knowledge transfer: societal | 38 | 8 | 2.7 | 2 | 0.7 | 1 | 0.3 |

The pattern was, however, reversed by the business-oriented stories. Here only four of the items (26.7 percent) were in the hard news format, while 11 items (73.3 percent) followed the features format.

## Visibility of the Centers, NSF, and STC Program

Even though the stories included in this study were those identified by the centers as being related to their work, a center name appeared in only 35.3 percent of the items examined (see Table 6). As suggested by the preliminary examinations of media reports, research and researchers are more often identified in terms of a university or other member institution, leaving the centers themselves relatively invisible.

The NSF was also relatively invisible, being mentioned by name in 31.2 percent of the stories examined. The STC model was even less visible. As shown in Table 6, a center was explicitly identified as a “Science and Technology Center” in just thirty stories (10.1 percent).

## Additional Analyses by Mission Element

The sample was divided into groups on the basis of mission element, and most of the analyses presented above were repeated. Cross-tabs and chi-square tests were carried out and were significant at the $p < .05$ level for all of the cases presented below. For consistency of discussion, however, the percentage of stories mentioning names of centers, the NSF, or the STC program, and so on are presented as percentages of the full data set ($n$ = 295) rather than as percentage within specific mission element categories.

Table 6 shows that the centers were most often explicitly named in stories focusing on institutional news (71 percent). Closer examination showed that, not surprisingly, the center was named in almost all of the 45 stories reporting on the opening of a center or the renewal of center grants. Even here, however, a few stories did not give the full name of the center; instead, they simply mentioned "a new center for Topic X" or similar.

Of the research stories, 30 of 146 stories, or 21 percent, mentioned the center's name. While the centers were explicitly named in over half of the education stories, they were much less visible in stories about the other mission elements. Here, researchers were mostly identified as belonging to one of the member institutions, rather than to one of the STCs.

Mentions of the NSF and the NSF's role as a funder were also most frequent in the institutional stories, but the agency was mentioned by name in only 15 percent of research-oriented stories (22 of 146). Almost all mentions of the STC program were in the context of institutional news (28 of 72 or 39 percent). Outside of this category, only two stories containing mentions of the STC model were found. Research news stories contained no mention of the STC name.

### Visibility of Centers and the STC Model by Type of Story

Surprisingly, no significant differences in the extent to which centers were named, the NSF was mentioned, or the STC program was highlighted were found between hard news and feature stories (chi-square tests, not shown, were all nonsignificant at the $p < .05$ level). Thus, even with the greater length and flexibility of a feature story, the STC model and team mode of research interaction remains relatively invisible outside of the institutional stories generated by the establishment of a new STC.

## Conclusions

There is a growing trend toward interdisciplinary research in recent years, with team science often touted as key to the creation of the new knowledge, capabilities, products, and services that will be important to solving societal problems and maintaining our competitiveness and quality of life. In this case study, we analyzed media coverage of one kind of team effort in science and engineering as reflected in the seventeen active NSF STCs from 2000 to 2006. We obtained 295 complete and legible articles appearing in newspapers and general audience magazines and their Web sites for detailed study.

The results show not only that this trend in science and its associated issues are essentially invisible through the media, but that the synergies between research, education, technology transfer, and outreach are not picked up in reporting practices that are essentially unidimensional.

Even though the stories were those identified by the centers as being related to their work, a center name appeared in only 35 percent of the items examined, and the NSF and STC program were less visible at 31 percent and 10 percent of stories mentioning these names, respectively. Knowledge transfer, education, diversity enhancement, and outreach—despite being imported components of these centers and receiving substantial levels of taxpayer funding through the STCs—were the least visible of the center mission elements.

Research news stories contained no mention of the STC program, and only 15 percent of research-oriented stories mentioned the NSF by name. Thus, the center model and funder were relatively invisible in this most frequently encountered type of center-related story. The way in which journalists gather raw material may be a contributing factor. The news peg for many of the research stories is the publication of findings in a prestigious journal, often associated with a press release issued by one of the center's institutions. If these sources fail to mention the center and/or funding agency, the less likely the resulting news story may be to do so. Content analyses of the press releases listed by the centers analyzed in a companion study showed that three-quarters of press releases mentioned the center, but less than half mentioned the NSF STC program and one-quarter didn't mention the center at all (Graube, Clark, and Illman).

The results are surprising, given the recent attention in the journalism world to the need to consider the sources of funding for work being reported in the news. Furthermore, the findings raise an important question about the visibility of one of the nation's primary funding agencies for science and engineering. The results may have important implications for those who study public understanding of science and, in particular, public understanding of the connection between taxpayer investment in research and the generation of new knowledge and products important to our society and economy.

Most of the general media items were hard news stories (76 percent) and about 23 percent were features. These figures are broadly in line with the findings for newspapers reported by the Readership Institute (71 percent hard news, 16 percent features).

We explored whether feature stories would contain more detail about the complexity of team science. Surprisingly, no significant differences in visibility of centers, NSF, or the STC program were found between hard news and feature stories. Thus, even with the greater length and flexibility of a feature story, the STC model remains relatively invisible outside of the institutional stories triggered by the establishment of a new STC, and the nature of team science remains essentially uncharacterized.

Close examination of the research-oriented stories confirmed that, in feature stories as in hard news stories, researchers were almost always identified by university affiliation and only very rarely identified as being affiliated with an STC. Although feature stories may have cited researchers from a considerable number of different institutions, these researchers were generally introduced sequentially in order to support the various points being made in the story. While this is a standard writing technique, the resulting image is of researchers toiling away in their specialties (astronomy, chemistry, etc.) but having little, if anything, to do with one another.

We had hoped to carry out a much more detailed frame analysis of stories that emphasized the “team” nature of the STCs. Unfortunately, there were too few stories doing so for such an analysis to be feasible. Teams were rarely mentioned, and even when they were, references were cursory, giving no insight into the constitution of the team or how team members worked together.

Our comparison of hard news and feature stories in this study suggests that the space and structural constraints of the hard news format is not the reason that the team nature of center research was invisible. Rather, the reasons may have more to do with traditional beats and the ways that journalists identify and frame stories and of their understanding of what science is and how it is conducted.

Increasingly, today, researchers are banding together in larger, integrated programs of research, education, and technology transfer to tackle problems that could not be solved by any one discipline alone—problems ranging from understanding global change to unlocking the secrets of human behavior, from developing the next generation of plastic electronics and optical computing technologies to the development of sustainable energy sources, from new disinfection strategies that may help alleviate looming water shortages around the world to new ways to develop, manufacture, and deliver therapeutic drugs. They are studying more than one variable at a time. These programs aim to affect not only how research is conducted but to do so in concert with efforts to affect the recruitment and education of an increasingly diverse population of graduate and undergraduate students and to catalyze the transfer of knowledge and results to public and private sectors. These are multidimensional, highly integrated efforts that have effects that span more than one discipline, sector, department, college, institution, or industry.

The nature of these interdisciplinary programs—and what they are producing that could not have been done otherwise—is a story that remains untold because journalist's frames and routines have not kept pace with the evolving nature of team science and associated issues in research, funding, and policy. Media coverage continues to present advances in science as unidimensional. This is a limitation on access to the kinds of information that are relevant to public discourse about the growing role of interdisciplinary science in our nation's R&D enterprise today.

## Notes

1. Thanks to Dr. Jim Boggs for coding some of these stories: Dr. Boggs has a background in both electrical engineering and communications research.

2. With respect to calculating intercoder reliability, there are pros and cons to all of the available methods. The Holsti formula does not correct for chance; on the other hand, as Potter and Levine-Donnerstein have argued (persuasively, in our view), Scott's pi also has several limitations. In particular, "Scott's pi makes the assumption that values that are selected often by coders (even if they are the valid choices) constitute error and therefore should be subjected to the largest correction. It makes no allowance of the possibility that the characteristics in the content being coded are themselves unbalanced across coding values [which is the case in our study]. This bias toward balance is a serious limitation, because it ignores the concern for validity" (1999, 279).

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