Popularizing Nanoscience:

The public representation of nanoscience in North American media, 1986-2000

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This presentation examines the public representation of nanoscale science and technology in North American written popular media from 1986-2000. The term nanoscience is typically used to identify pure research at the molecular level. This work endeavors to identify the unique physical properties and characteristics of matter at the scale of one-billionth of a meter (a human hair is approximately 80,000 nanometers). *Nanotechnology* is the application of these principles and structures typically in the creation of *nanoscale* devices.

At the nanoscale, accepted states and properties of matter encounter what Ratner and Ratner (2003) call the more "exotic" properties of the atomic and molecular world including wave-particle dualities and quantum effects. Because of the unique conditions of matter at the nanoscale, the field has emerged almost simultaneously in physics, chemistry, electronics, and biology. Potential nanotechnology applications have included the pursuit of molecular-sized computer memory, pharmaceutical and medical applications, pollution detection and clean-up, and textile manufacturing. As a research area, the field has been relatively quick to stabilize. Nanoscale science and technology has been targeted as a federal research and development priority. In 2003, $679 million was budgeted in federal support for the field. This is after $422 million were spent on the field in 2001 and approximately $600 million in 2002 (Ratner and Ratner, p. 2).

***There's plenty of room at the bottom*: A tiny history of nanotechnology[2]**

The term, "nanotechnology" was coined by K. Eric Drexler, an early proponent of molecular manufacturing. Drexler introduced the term and the concept while a student at MIT. Drexler's concept was informed by a 1959 speech titled *There's plenty of room at the bottom* given by Nobel Prize-winning physicist Richard Feynman.

Feynman speculated that in the future, scientists would be able to arrange atoms into any substance desired. Drexler took this concept and applied it to a variety of different fields claiming that molecular-sized machines could repair damaged cells, create endless amounts of fuel, structure microscopic computers, and even provide the technology for cyronics, the hope of bringing dead cells back to life (Trausch, 1988). This vision was the conceptual foundation of Drexler's 1986 book *Engines of creation: The coming era of nanotechnology*. *Engines* was a popularized account of Drexler's vision and was embraced by many fringe science fiction and fantasy groups. Drexler's more complex *Nanosystems: Molecular machinery, manufacturing, and computation* presented the scientific case for molecular manufacturing. The book was not well received in scientific communities. Critics argued that the concept of molecular manufacturing was a fundamental misunderstanding of chemistry. Others noted that nothing in the book had been demonstrated or replicated (Regis, 2004).

While Drexler's vision of nanotechnology started at the molecular level, others working in the field started with larger chunks of matter which they then broke down to nanosized particles. This approach was enabled by new technologies such as the scanning tunneling microscope, introduced by Gerd Binning and Heinrich Rohrer at IBM's Zurich Research Laboratory in 1980 and the atomic force microscope invented in 1985 by Binning. These technologies enabled scientists to obtain three dimensional images at the nanoscale from metal surfaces. Such images are useful for determining the size, arrangement, and connections among the molecules and aggregates on the surface of the metal. In 1985, Richard Smalley and Robert Curl at Rice University and Sir Harry Kroto, from the University of Sussex, discovered a new form of carbon which they called a "buckyball" as its structure mirrored the domes created by inventor Richard Buckminster Fuller.

Smalley was a strong critic of Drexler's vision of nanotechnology and of the concept of molecular manufacturing. In 2001, in an article in *Scientific American* Smalley contested the basic premise of molecular manufacturing claiming that Drexler's ideas were not possible. Smalley wrote, “Selfreplicating, mechanical nanobots are simply not possible in our world. To put every atom in its place--the vision articulated by some nanotechnologists-would require magic fingers. Such a nanobot will never become more than a futurist's daydream (Smalley, p. 77). Although Eric Drexler's vision did much to popularize the field, by the year 2000 Smalley's carbon Buckyballs had become the image and principle marketing tool of the nano-industry.

Throughout the late 1980's and 1990's discoveries and new measuring technologies encouraged further interest and progress in top-down approaches to nanoscale research. In 1988, AT&T Bell Labs chemists Paul Alivisatos, Moungi Bawendi, and Michael Steigerwald showed that molecules behave differently at the atomic level. This work empirically tested claims which had been theorized by quantum mechanics. Other projects, including the formation of the IBM logo out of xenon atoms (by IBM scientist Don Eigler in 1990), and the creation of a 10 micrometers sized guitar (at Cornell in 1997) demonstrated the potential for exact manipulation of atoms at the molecular scale. The industrial applications of nanotech were improved following the discovery of carbon "nanotubes," which were Buckyballs linked and shaped into hollow carbon tubes. Nanotubes showed researchers that molecules could be shaped in different ways at the nanoscale.

Predictions about nanotechnology have been broad ranging and fantastic. Articles in the public media have claimed that nanotechnology will lead to cryogenics and the repair of damaged (or dead) cells (Drexler, 1986, p. 135), a cure for cancer, self-repairing highways, bullet-proof clothing as thin as a rain jacket (Berger, 2003), and affordable, abundant, energy (Economist, 2003). Although not a prominent part of the literature, cautions about nanotechnology have been raised as early as Hapgood's 1986 article in *Omni Magazine* (Hapgood, 1986) which was one of the first popular accounts of nanotech research. Those cautious about building molecular sized machines have coined the term "grey goo" to refer to intelligent swarms of Nano robots the size of a virus that devour everything in their path (Radford, 2003). This nano-terror was the plot of Michael Crichton's novel *Prey* released in November 2002. Other writers have claimed that nanosized particles, because of their size and ability to seep into skin and vital organs, may be toxic to humans (Feder, 2003). In April 2003, The Manitoba-based ETC group became the first advocacy group calling for a moratorium on the manufacture of synthetic nano-particles created in the absence of health, safety, and environmental impacts (ETC group web site. http://www.etcgroup.org/).

Despite these wide ranging claims, the initial applications of nanotechnology have been rare and selective. In some cases, existing technologies have been problematically re-situated as nanotechnology.[3] Nanotechnology has been applied in electronic computer memory technology and in polymer coatings. Because of their high conductivity and strength, carbon nanotubes are useful for making computer chips and memory storage devices. However, these applications are not novel and have been in place for several decades. For example, much of the work in nanoscale electronic memory storage intersects with what is called MEMS (or MOEMS) Technology, or micro (optical)-electrical-mechanical systems, which apply molecular layers onto silicon to integrate mechanical elements, sensors, and other electronics. In polymers, molecular sized particles have been blended and layered on surfaces since the 1960s. More recent uses of nanotechnology have occurred in automobile manufacturing to create stronger materials, textile manufacturing to increase stain resistance, and in various beauty products such as skin cream and suntan lotions (Hearn, 2003).

Pilot Study: Results from Prior Research

From 2002-2004 we conducted a preliminary study of written media reporting of nanotechnology (Faber, in press). The goal of this first preliminary, historical study was to examine the concepts through which nanoscale science and technology was first represented in the public media. The study method generally followed the process outlined by Huckin (2004) for blending quantitative data gathering and qualitative results (Huckin, 2004, pp. 16-19). Articles were selected from the ABI/Proquest on-line database. Using trial and error, we determined that the first reference to “nanotechnology” or “nanoscience” in the database occurs in 1986 with the word “nanotechnology” (Hapgood, 1986). For this reason, we used January 1, 1986 as the start date. December 31, 1999 was used as the end date in order to collect articles that appeared in the early emergence of the field. The keywords "nanotechnology" and “nanoscience” were used as the search string and "article text" as the search criteria. Publication type was entered as "all."

The search generated 885 articles ranging from several lines to several pages in length. Given that the research goal to was examine popular written representations of nanoscience and technology I read through the data set but manually selected articles published in newspapers, general interest magazines (e.g.,Time, Newsweek) and popularized scientific publications (e.g., Popular Science). This created a second data set of 203 articles. These articles were printed and filed by month and year. Table 1 presents the number of articles in the data set per year.

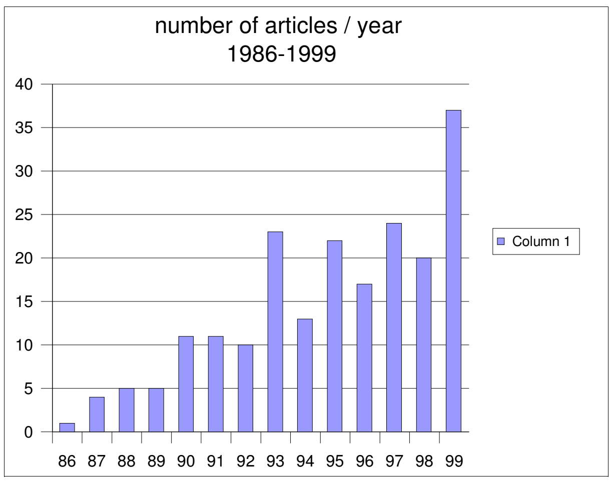

Table 1. Number of Articles in Pilot Data Set 1986-1999

This study characterized thirty nine (39) different representations of nanotechnology and nanoscience in 262 occurrences of the term. On average, each representation occurred 6.89 times. Those representations that occurred more than the average (6) were identified as “high occurring representations.” Table 2 lists these representations.

Representations of Nanoscale Science & Technology High Count
(n>6 from data set of 262 occurrences)

Molecular Manufacturing (n=48)	Future Computers (n=23)	Medical Applications (n=19)
Science Fiction (n=15)	Biology/Cybernetics (n=11)	Future Electronics (n=11)
Eric Drexler Biographical (n=10)	Inventions: New & Possible (n=9)	Ed Regis Biographical (n=9)
Micro-Machines/Self assembly (n=9)	Cryogenics (n=8)	Foreign Competition (n=8)

Table 2. High occurring representations (Source: Faber, in press)

These representations situated nanoscale science and technology as an extension of existing science and scientific application (biology, computer science, medicine). Nanoscale work added different approaches and methods within each existing field. However, the category “molecular manufacturing" was an exception to the above characterization as it was not overtly linked to an existing science or application and in many cases was situated in opposition to existing disciplinary practices. Biographies about pioneers in the field (Eric Drexler, Ed Regis) were also high-mention categories. These more social representations appeared to play important roles in promoting and sustaining interest in the emerging area. As noted above, Eric Drexler was an early promoter of the concept of molecular manufacturing and molecular self-assembly and his biographical representations implicitly supported the representation “molecular manufacturing.”

This first study concluded that the early emergence of nanoscience and technology in the popular media occurred as a “competitive and transitional social-rhetorical process in which the new emerged within existing and established understandings of science but was mediated by biographical and other human-interest narratives about the research and its applied technologies” (Faber, in press). This reporting was almost uniformly positive. There were few accounts (critical or positive) of the societal, environmental, and health and safety implications of nanoscale research and technologies.

Early accounts emphasized technical applications of nanoscale research but did not differentiate between actual science and pseudo-science (what Hass and Kleine (2003) have called “Junk Science”). Cybernetics, cryogenics, and molecular self-assembly received similar treatment as medical devices (coatings on medicines) and in-use applications for computer memory. Later representations solidified the science into marketable categories closely aligned with business and investment opportunities. By 1999, those areas not aligned with existing and recognizable practices (e.g., molecular manufacturing) were beginning to be displaced by existing and established fields and interests.

Current Study

Our current research takes a more detailed examination of these early public accounts of nanoscale science and technology. Using "narrative" as the gross unit of our analysis, our objective is to determine how the narrative depicts nanoscale research and technology within six specific topic codes. Taken from Zimmerman et al. (2001), the topics codes include: Social Context, Method, Theory/Agent, Data/Statistics, Related Research, and Relevance. These are elaborated in Table 3.[3] Following the results of the pilot study, we retained the term "representation" to categorize the interpretations of nanoscale work reported in written media.[4]

Topic Code Categories

Topic code	***Description***
Social Context	Prestige/bias: who conducted, funded research, where conducted, published
Method	How research was conducted, research design and procedures
Theory/agent	Why effects occurred, properties of causal agents, underlying mechanisms
Data/statistics	What was observed in the reported study or statistical tests
Related research	Replication of or connections with other results
Relevance	Importance or applicability of findings

Table 3. Topic code categories (adapted from Zimmerman et. al. 2001, p. 40)

Method

Data Set

The pilot study only used the terms "nanoscience" and "nanotechnology." In order to build a more comprehensive database, we expanded the search terms to include the phrases: *scanning tunneling microscopy; atomic force microscopy; nanolithography; self assembly;* and *nanostructure*. These terms were identified by James Murday, (2000), Executive Secretary, National Science and Technology Council's Subcommittee on Nanoscale Science, Engineering, and Technology in his literature citation count review of nanoscience topics in specialized technical literature (p. 5).

The follow-up study used more selective criteria to establish the data set. Newspaper and news magazine selection was made more consistent with data sets established by similar projects in the literature (see Friedman, et al. 1996, p. 8 for widest coverage). In addition, newspapers from geographical areas cited as "top 10 nanotechnology development areas" were added to the data set (Stuart, 2003). A list of media used is included in Appendix A. The new dataset is comprised of 58 articles.

Findings

Below, preliminary findings from four of the six categories will be discussed: Social Context, Method, Theory/Agent, and Related Research. Research into categories Data and Relevance is ongoing.

Social Context

The articles positioned nanoscale science and technology within an elite social context. Nanoscience and technology was overwhelmingly affiliated with well-known universities and corporate research labs. Only 7 articles in the data set associated nanoscale work with cultural phenomenon (movies, fiction) whereas 79 separate universities and research centers were named across the data set. Four academic fields were associated with nanoscale science and technology: physics, biology, chemistry, and computer science. Nanoscale work was not associated with social groups or institutions (nonprofits, development agencies, hospitals). If societal issues were considered, links to these issues (poverty, food supply, disease treatment) were initiated within narratives about elite institutions (research universities, for-profit corporations). As was found in the pilot study, biographical information played an important part in establishing the social context for these articles with Eric Drexler and Richard Smalley receiving the highest number of mentions.

National/Regional Coverage. As part of the Social Context categorization, articles were grouped by national/regional media and the geographical scope of the information reported in the article (national/regional).

For example, the category National/National represents articles written by a national media (e.g., *Washington Post*) that discussed nationally occurring events (e.g., research in more than one geographical area) The category Regional/Regional represents articles written by regional media (e.g., *Boston Globe*) that discuss regional events (research at a Boston-area university). The N/A category records articles that did not have a regional attribution (book reviews, movie reviews, cultural studies pieces). Table 4 displays this categorization.

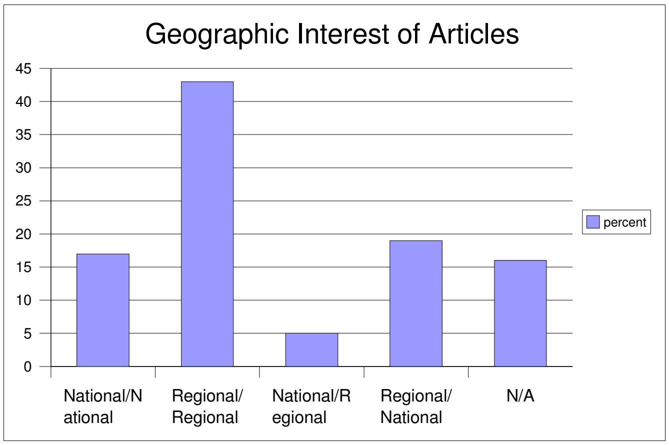

Table 4. Geographical Interest of Articles

This distribution showed that the majority of coverage was undertaken by regional media and focused on the regional social context. This suggests that regional media have used nanoscience research and technology as a promotional device for their regional interests and economic development. For example, Clarke (1992), a writer for the *San Francisco Chronicle*, profiles Silicon Valley as a new center for nanotechnology research and product development (published in *Seattle Post-Intelligencer*). Gillmor (1998), writing in the *San Jose Mercury News* published a feature article on nanotech research at IBM in San Jose, Stanford University, and other local San Jose companies. Similarly Schubert (1999), writing about a University of Washington (*Seattle Post-Intelligencer*) Internet initiative, claimed that the new Internet hub would enable the school to profile the latest in nanoscience research. Finally, the connection between nanotechnology and economic development was made overt by Baca (1999) in an *Albuquerque Journal* article. Here, Baca wrote about government initiatives which have led to growth in high tech companies. Baca specifically notes the growth in nanotechnology firms in New Mexico.

Research and Technological Methods Cited by Articles

The category "research method" reported how the research was conducted, the research design and procedures that led to specific findings. In addition, we added to this category descriptions of how specific technologies functioned or how specialized equipment was developed and operated. Data from this category was categorized in four ways: no method, description of process, speculative/interpretive, and not applicable (e.g., articles that reported about new nanotechnology buildings on college campuses). Table 5 shows these categorizations.

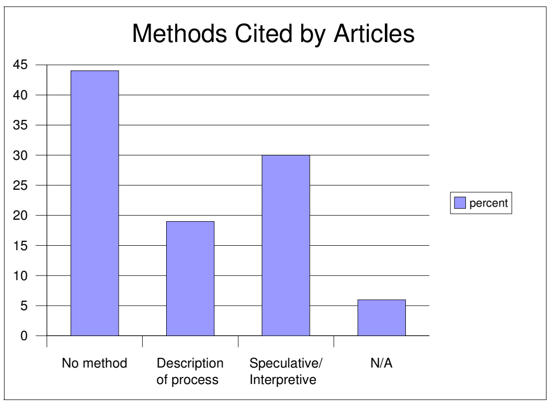

Table 5. Research methods cited by articles

Very few articles (19%) provided a description of the methods that led to the research findings or the procedures that enabled the technology. The majority of articles relied on speculative and interpretive claims based on the opinion of the writer (30%) or provided no evidence of a method for reaching conclusions. (44%).

Claims about the social implications of nanotechnology were exclusively based on interpretive methods including speculative claims that derived from book reviews and science fiction. For example, David Einstein (1999), writing in the *San Francisco Chronicle* claimed, "if you want insights into the technology of the next century or two, the place to go is science fiction" (B1). Einstein writes specifically about nanotechnology, defining it as "microscopic machines made of biological material." He claims that "science fiction has had a field day with nanotech" and uses these sources to claim medical and industrial applications for the field.

Similarly, David Lazarus (1999) (*San Francisco Chronicle*) provides a positive review of *The long boom: A vision for the coming age of prosperity* (the book's authors are from UC Berkeley and Atherton, CA which is near Silicon Valley). Though Lazarus notes that the book is optimistic and "much-hyped" his review uncritically accepts and promotes the book's speculative claims about future technologies and its definition of nanotechnology as "atom-sized robots." In 1990 Fiction writer Michael Crichton published a column in *Newsweek* predicting advances in medical technology that "will revolutionize medicine with futuristic devices, ranging from biosensors that dispense drugs from under the skin to nanomachines, hardly larger than red blood cells, that course through our bloodstream scrubbing the insides of our arteries" (p. 58). Crichton provided no method for how these claims were developed nor did he provide a method for how the nanomachines would be developed or function.

Theory/Agent

Three primary frames were constructed to interpret the naturalized (assumed) theories informing the reporting of nanoscale work. First, 15% of the articles assumed that nanoscale work was legitimate or necessary because the work created efficiencies, developed faster technology, enabled time savings, and created smaller parts. I labeled these claims "Theories of Efficiency."

Second, 47% of the articles assumed that nanotechnology was part of a positivist evolution of science. These articles assumed that nanoscale work was legitimate because it would eventually realize potential in different areas. These claims were categorized by their use of modality (will, could, should, might) which has been associated with hedging (Faber, 2003). I labeled these claims "Positivist evolutionary."

Third, 37% of the articles made extreme assumptions about the inevitability of nanoscale work. For example, these articles assumed that nanoscale devices were already in existence, that molecular manufacturing was inevitable, or that nanoscale medical applications were already being used. These claims were categorized by the use of the present or the past tense (e.g., “Nanotechnology is gaining mainstream respectability. . . . Science clearly has accepted the notion” Hall, 1999). I labeled these claims “Inevitability.” Figure 5 shows these naturalized assumptions that informed nanotechnology reporting.

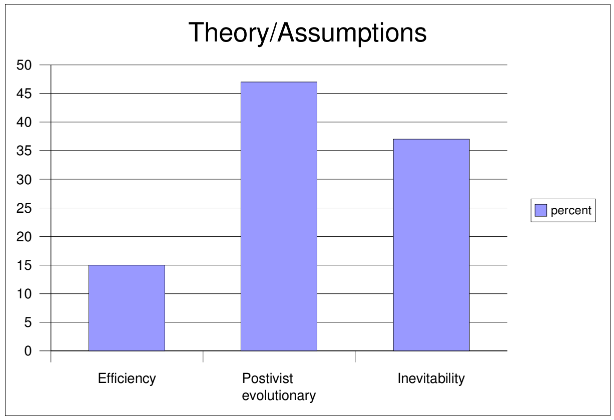

Table 6. Theory / Naturalized assumptions informing nanotechnology reporting

This category is complicated by the operation of more than one theoretical framework within each article. While the researchers are working from their own assumptions, the reporter approaches the topic from a potentially different set of naturalized assumptions. For this study, we examined the assumptions presented by the article itself. The results suggest assumptions within the reporting of nanoscience work and not necessarily those held by the scientists and technologists conducting the research.

Related Research

Zimmerman et al. write that the category “related research” describes “Information about whether the findings have been replicated or fit other results” (p. 40). Data for this category was compiled from references in the articles to recognizable research topics or disciplinary fields.

These results were similar to those found in the pilot study. Twenty three separate categories of related research were found. The categories cited most often were “manufacturing” (18%), medicine (18%), and computing (18%). These categories correlated directly with the most often mentioned representations of nanoscale science and technology in the pilot study. Other categories that received high mention in both studies were: electrical components, biotechnology, and philosophical/cultural perspectives (cited as "science fiction" in pilot study). Research accounts were positive and supportive of research and technological development in the area. Negative accounts, societal impacts, or cautionary accounts were few and typically embedded within larger narratives.

Conclusion and Speculation: The Symbolic Capital of Nanotechnology

In these articles, nanotechnology is unproblematically perceived as a symbol of technological progress and advancement and the social context built by these perceptions is one of elite activity and privilege that holds key economic benefits for those fortunate enough to be included. Pierre Bourdieu (1977) argued that symbolic capital is "perhaps *the most valuable form of accumulation* in a society" (p. 179, emphasis in original) because as a form of prestige and renown it is "the more or less perfect interconvertibility of economic capital" (p. 177). In other words, symbolic capital entails the collection of wealth and power but in ways that appear neither overt nor self-interested. The symbolic economy has a way of disguising the interplay of economic advantage, functioning instead through activities of gift-giving, personal conduct, linguistic performance, and exchange, what Bourdieu calls the "good-faith economy" (p. 173). Bourdieu puts it this way,

> Once one realizes that symbolic capital is always *credit*, in the widest sense of the word, i.e., a sort of advance which the group alone can grant those who give it the best material and symbolic *guarantees*, it can be seen that the exhibition of symbolic capital (which is always very expensive in economic terms) is one of the mechanisms which (no doubt universally) make capital go to capital (p. 181, emphasis in original).

For much of its early emergence, nanoscale science and technology functioned within an intensely political-and capital-intensive symbolic economy. Even as early as 1986, proponents of nanotechnology had begun to trade elite social status, reputation, and social interest (e.g. medical research) in order to build new centers of economic and social capital. Symbolic capital was evident in the way articles associated nanoscience with particular individuals who were similarly associated with elite institutions (Drexler, Smalley, Regis). The biographical information presented in early-stage reporting personalized the field and provided the technology with a recognizable and empathetic face. At the same time, this grounding in symbolic capital (institutional and biographical sources) was important since few articles presented research methods or provided methodological information to support the reported claims. The lack of empirical grounding is noteworthy because the articles promoted assumptions about natural progress, efficiency, and inevitability of nanotechnology that were not demonstrated by the research but based largely on speculation. Yet, reporting did not critically evaluate or assess these key assumptions.

This symbolic capital was in play at the same time as university departments in Chemistry and Physics faced declining enrollments and closure (e.g., Kings College London; a recent report by the Royal Society of Chemistry predicted that optimistically 20 current departments of Chemistry in the UK will survive and at worst only six -- Durham, Cambridge, Imperial, UCL, Bristol and Oxford would remain in 2014 (Curtis, 2004)). Thus, the emergence and rise of nanotechnology during these years can be seen, using Bourdieu's terms, as the movement of capital to capital. With the decline of molecular manufacturing as a viable representation of nanoscale work, nanoscience now appears largely as a resurrected hybrid discipline of chemistry and physics and chemistry and electronics. This is a hypothesis we will take into the 2000-2006 data set. From an historical perspective, our current research on the emergence of nanoscale science and technology from 1986-2000 has suggested some of ways that this capital may have moved and transformed itself from one site to another.

End Notes

1. I would like to recognize the research assistance provided by Clarkson undergraduate students Peter Bird, Margaret Petroccione, Adrienne Povero, and Romana Semouchtchak. This presentation is based upon work supported by the National Science Foundation under Grant No. 0423400. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation.
2. Some of the material presented in this historical section is adapted from Faber (2004).
3. In April 2004, the investment firm Asensio & Company, complained to New York attorney general Eliot Spitzer that a nanotechnology index fund established by Merrill Lynch included companies that had little to do with actual nanoscale work. Merrill Lynch defined nanotechnology as any product or production process that is measured at 100 nanometers or smaller. This definition included processes that did not exploit the unique characteristics of materials at the nanoscale and products developed before actual research in nanotechnology. Cases like these have led Drexler to recently complain that the term nanotechnology is used so broadly "it is almost meaningless" (Feder, 2004).
4. As Zimmerman et al., note, the topic code taxonomy "provides a basis for more detailed analysis of media articles" including coding specific methods reported, types of research designs, and the interconnections between and among various research projects (p. 40).
5. A representation of the narrative is a substantive summary accounting of the narrative. It is constructed by combining the various frames taken from the text into a single summary account. A representation does not need to be consistent and may be contradictory. Wertsch (1997) describes representation as a "mediational means" which stands-in for the originary object. In this way, the representation is an account that summarizes and interprets the cogent meanings of the narrative. Chouliaraki and Fairclough describe representation as "explanatory critique" which has four characteristics: (1) demonstrates a problem, (2) outlines the obstacles in the way for solving that problem, (3) examines the function the unmet need plays in sustaining or changing existing social arrangements, and (4) proposes ways of removing obstacles (1999, p. 33]. As the penultimate degree of abstraction from the originary text, the representation fits the text to its larger social and scientific context. Yet, at this point, the analysis remains descriptive. Thus, the representation presents what Halliday (1987; 1993) has called a "dynamic perspective" of the text. This perspective characterizes happenings, processes, and becomings (1998). In other words, it is a descriptive style not designed to prescribe judgment but to relate 'the world as it appears.'

Appendix A

News media referenced in this study

1. *The Washington Post* and *Los Angeles Times* as members of the national prestige press.
2. The *Houston Post*, *Miami Herald*, *Philadelphia Inquirer*, and *Boston Globe*, as representatives of large newspapers from balanced geographical regions of the United States.
3. The *Allentown (PA) Morning Call* and *Charlotte (N.C.) Observer*, as examples of medium-sized newspapers.
4. The *Albany (NY) Times-Union*, The *Albuquerque Journal*, *The Arizona Republic*, *Baltimore Sun*, *Chicago Tribune*, *Detroit Free Press*, *San Francisco Chronicle*, and *San Jose Mercury News* to cover geographical regions that have been indicated as the top 10 major nanotechnology development areas.
5. *NY Times* for its coverage of science and technology issues.
6. The *Wall Street Journal* for its role as a leading financial newspaper.
7. *Seattle Post-Intelligencer* for geographic distribution and coverage in a technology-intensive region.

In addition to these US-based papers, we added three Canadian newspapers: *The Globe and Mail*, as a member of the national (Canadian) prestige press, *Edmonton Journal*, representing geographical region, *Halifax Chronicle*, representing geographical region. These three papers were also included among the seven papers used in Einsiedel's (1992, p.92) content analysis of science coverage in major Canadian newspapers.

News magazine selection was based on Zimmerman et al. (2001) Media included:

Time, *Newsweek*, and *Maclean's* (Canada). To this list we included *US News and World Report*, *Popular Science*, *Reader's Digest*, and *Discover*.

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