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Comment

Why should we care about science books?

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Are science books important?

Why should we care about science books? After all, we live in a "new media" world where students, researchers, and the public use the World Wide Web for all their information needs. Cutting edge research appears on "preprint archives" or "open access" online journals, text"books" appear as online sites with interactive presentations and links to presentation, for creating public discussion and dialogue, and even for archiving current research. In that kind of world, what’s the purpose of looking at "old fashioned" books?

In fact, I want to argue, books are tremendously important in science. They provide structure and substance for scientific communities -- both communities within scientific practice and communities of scientific interest that extend beyond the professional scientific world, communities that encompass various publics and define their interaction with science. Science books can be understood as shared social experiences, ones that through their use create a common bond that may or may not be based on the actual content of the text. In some cases, the books may serve multiple communities, crossing boundaries in complex ways. Books serve as social memories, providing cultural touchpoints that allow communities to express their common norms and interests.

To explore these issues, I will look at books in several categories: books of daily use such as reference books, textbooks, those with clear influence on intellectual culture, and those with clear influence on broader public culture -- what the French call "*culture scientifique*," or the place of science and scientific ideas in the cultural matrix. I will look at how scientific ideas are presented, conveyed, and used to create intellectual regimes, as well as how they are used in discourses that both contribute to science's social authority and simultaneously allow the ideas to shift meanings as they get used in different contexts. I am focusing on the United States in the years after World War II, but that distinction is somewhat arbitrary; in the postwar years, science books circulated internationally and many publishers prominent in American science were outposts of European publishers.

Books "within" science

Books in the daily life of science

Many scientists will say that "if it doesn't appear in a journal, then it's not science." But in the postwar period, books clearly retained a place in the daily practice of science. Those daily practices show how books create a sense of community. Major examples include reference books like the *CRC Handbooks* (of math, chemistry, and so on) or the data-base serials that until recently were bound and treated as books (such as *Chem Abstracts* or *Science Citation Index*). Reference books represent a form of standardized knowledge, and their widespread use implies a communal judgment about which standards to use, which references to rely upon. These judgments are not merely matters of convenience, but also clear statements about trust and the establishment of networks of interaction that create the social fabric through which scientific development is woven. Other reference books contained the consensus from those networks about the findings of recent research, such as the volumes produced as *Annual Reviews* (of biochemistry, of physiology, of energy and the environment, and so on).[1]

Yet reference books also provide a marker of changes in the uses of books across the postwar period. Saying the name *CRC Handbook* out loud in a group of scientists trained before the 1990s leads to a collective sigh of recognition that demonstrates their communal power to a particular generation. More recent generations turn not to hardcover books, but to electronic databases, some of which may be identified more with the website at which they are housed than the "book" in which they appeared. The individual articles in *Annual Reviews*, for example, are available as free-standing document files; the publisher of *Annual Reviews* worries that readers will no longer identify with the underlying books and therefore will be unwilling to convince their libraries to subscribe.[2] The tables and constants for which earlier generations turned to the *CRC Handbooks* are now available on various websites and calculators. The book is no longer the repository of stored knowledge to working scientists; websites available through the Internet serve that function instead.

Yet just as working scientists have reduced their dependence on books as a source of stored knowledge, books have continued in that role among broader audiences. The lowered real costs of books and improved distribution systems created as a result of broad changes in the publishing industry have made scientific reference texts much more widely available. Doing so has created networks of people using scientific information in their daily lives that extend beyond research scientists, including members of the general public with no professional need for technical information. Recent editions of the *Merck Manual*, a compendium of medical information, for example, have sold about a million copies, with both authorized and pirated editions published worldwide.[3]

Another form of books used in the daily life of scientists are conference proceedings. They are again evidence of community, since they are literally documentation of communal efforts, of occasions when scientists came together to work through their ideas. Another type of communal book is the *festschrift*, a celebratory volume intended to document a senior researcher's career and interests and often presented to the researcher at a milestone such as retirement or a 60th or 75th birthday. Again, the nature of the *festschrift* is to highlight the personal bonds that give shape and substance to scientific communities. Production of a *festschrift* is a statement about shared values, a commitment to science as a community as well as a body of knowledge. *Festschriften* can also contain important science. The most-known example may be a paper by geophysicist Harry Hess which became one of the founding documents of plate tectonics. Because of the speculative nature of Hess's ideas (in the paper, he called them "geopoetry"), he had trouble publishing the paper in regular journals; a *festschrift* provided the necessary outlet.[4]

Despite the value of *festschriften*, conference proceedings, technical reports, and other elements of the daily life of science, many of them had a somewhat ephemeral existence in the years after World War II. They existed in a realm of publishing difficult to access reliably: the world of "grey literature," issued by organizations without the formal apparatus of publication records or library or retail distribution. During the 1960s and 1970s, these documents were often photo-offset printed from typewritten manuscripts, distributed in idiosyncratic ways by organizations or meetings without systematic publishing operations. The growth of the World Wide Web has changed the nature of grey literature: now often posted on institutional or organizational websites, these documents of the daily life of communal scientific work are now accessible through both general search engines such as Google and more specialized sites tailored to specific scientific communities. At one level, this makes the literature – and thus the communal activity – more broadly available. At another level, accessibility through the Internet is even more ephemeral than traditional grey literature, with a substantial fraction of all websites disappearing over the course of even just a few months.[5]

Textbooks

While the books of daily practice document science as a community, textbooks show even more clearly how books can create and shape a community. Used in large introductory courses in colleges and universities around the country, they sold in the tens of thousands of copies. Pauling's *General Chemistry*, Sears and Zamansky's *College Physics* (1947), Morrison and Boyd's *Organic Chemistry* (1959) -- these books and others shaped knowledge in their fields for years to come.[6] Leading introductory physics textbooks, such as Sears and Zamansky's, structured their introductions to physics around the needs of engineering students. While they added principles and abstraction to earlier texts (which had often been organized around specific experiments or demonstrations), they were fundamentally interested in teaching the Newtonian mechanics that most physics students would have to face. As the physicist and historian Charles Holbrow has shown, quantum mechanics and other issues of twentieth-century physics were almost literally an appendage, appearing in separate chapters near the ends of these texts.[7] For many work-a-day physicists, not the elite researchers but the ones keeping government laboratories and experimental facilities running, the ones doing routine calculations and operations, the engineers who make up the vast bulk of the physically-oriented scientifically-trained workforce, esoteric cutting edge science was just one part of what they learned. The world-view, the intellectual matrix into which they placed the individual facts, theories, formulas, and behaviors that to them *defined* science, that world-view was essentially a nineteenth-century world-view. For most purposes, the older world-view is productive: among the reasons that quantum mechanics succeeds as a description of the natural world is that, in the every-day case, non-quantum approaches appropriately approximate the natural world. But the use of textbooks that stressed the older approaches means that for most physicists trained in "modern physics," quantum issues are not foremost in their minds.

Textbooks, especially at the advanced level, can also be the place for creating new fields. James Watson's *Molecular Biology of the Gene* (1965) was intended both as a text and as an intellectual argument for a new field. Watson's more famous book, *The Double Helix* (1968), has been interpreted as a polemic arguing for a new, competitive, high-stakes approach to biological research.[8] Less recognized has been the role of the earlier text in creating a new discipline. Watson brought together the range of research that had previously been scattered in crystallography, biochemistry, genetics, and other fields to show that it could be taught together fruitfully -- and that, by so doing, teachers could train a new generation of scientists ready to fully inhabit this coherent area rather than merely reaching into it from their own home disciplines.[9] Similarly, E. O. Wilson's *Sociobiology* (1975) was an explicit argument for a new approach to evolutionary research.[10] Paul Samuelson's *Economics*, especially in its first two editions, established the authority of rational choice theory as the leading model in economic thought.[11]

The power of textbooks is their ability to create communities of people with similar training, similar perspectives, and similar tools. In the 1990s, as efforts gathered steam to reform the American science curriculum in public elementary and secondary schools, much attention was put on the ability of textbooks not only to convey information, but also to convey an overall sense of what science was and how it should be related to public life.[12]

Books in intellectual and public culture

There are many ways to identify books that play a role in intellectual and public culture. Some have a kind of official presence: they have won an award, a Pulitzer Prize, a National Book Award, etc. Others have become best-sellers. Yet others fall into a category I call "remembered books," the ones where someone I'm talking with remembers the book and then says “But you’re going to include *that* book aren’t you?” These are the books that have become touchstones for intellectual culture.

In the first 30 years after World War II, almost no science books won Pulitzer Prizes (the most prominent award for books in the United States). One book, James Phinney Baxter’s *Scientists Against Time* (1948), published right after the war, was a story about the atomic bomb. William Goetzmann's book, *Exploration and Empire* (1967), was about exploration of the American west. But beginning with Carl Sagan’s *Dragons of Eden* in 1978, then every year or every other year into the late 1990s, the Pulitzers begin honoring a science book. They are not all history of science books, either. They show up in both the general non-fiction and the history category of the Pulitzers. Clearly something happened in the late 1970s to make science books more central to American culture. Science became a part of the general intellectual discussion. Interestingly, that same time period is also about the time of a "science boom" in popular science magazines, television shows, and science museums.[13] The relationship of science with American culture went through a change in the late 1970s, in which science became a necessary part of any cultural discussion.

Looking at bestsellers, I see a similar pattern. Before the mid-1970s, only rarely did more than 10 new science-oriented books a year become added to the list of best-sellers maintained by the *New York Times*. But after 1978, only rarely did *fewer* than 10 science-oriented books get added to the list. More science books were being sold. That’s another marker to suggest that science had become a necessary part of ongoing cultural conversations. The Pulitzer Prize data and the bestseller data suggest that the idea that there are "two cultures" (of science and arts) that don't speak to each other may no longer hold (if it ever did).[14]

To understand this new cultural debate, we need to know more about what specific types of books were appearing on the bestseller lists. There are a least two kinds. First are the books in which "science" appears as a main character. These are the books that are about physics, or astronomy, or biology or so forth. The second set of books are those that I call "public science." These books are about, for example, sex, but they draw on the science of sex. These are the inspirational books that draw on psychological research. Many of the diet, health, fitness, and medicine books draw on scientific research or at least the appearance of scientific research. Even if some of these books don't use science well, they get some of their credibility precisely because they lay claim to the authority of science. Some people argue that science is not valued in our society. I disagree. These books become bestsellers by claiming to draw on science, which they do because science is respected in the community of ideas. The book data indicates that science actually plays a very important and respected role in general culture.

Another type of book were the "grand" books, such as Jacob Brownowski’s *Ascent of Man* or Carl Sagan's *Cosmos*. These broad sweeps of scientific ideas become bestsellers only in the 1970s. The breakthrough is most clear in 1980 with Sagan’s *Cosmos.* It was tied to an extremely popular TV show, of course, and that helped drive the sales. But the book itself was also a bestseller -- a bestseller so great that shortly after it was published, Sagan was given a $2 million contract for what would become the novel *Contact*. At the time, that was the largest advance ever given for a fiction book that was not even in manuscript form. *Cosmos* marked the moment that something different was clearly going on.

In the "science as science" category, the next big moment was Hawking's *A Brief History of Time*. Hawking’s book is the one that everybody bought but nobody read. He said in the introduction that he left out all the mathematical equations so that he wouldn't lose readers, but the book is still pretty tough to read. It sold 700,000 copies in hardcover in its first year, 400,000 copies in its second year. That’s just in hardcover. Today, new editions continue to appear. It set a new sort of expectation about what books can accomplish. Hawking’s book opened up the book publishing world – and thus the broader cultural world – to science. After it appeared, science books began to receive aisles in American book stores, agents went seeking authors to write books about engaging in science.

All of this evidence suggest that books have played a role in general American culture. Some of the evidence shows that books are even more important after the mid-1970s than they were shortly after World War II, even as alternate media such as television and eventually the Internet became more popular.

How are science books important?

Books exercise their cultural importance by contributing to public discussion in four areas.

First, books are important to the intellectual development of science itself. Even though some of the bestselling or prize-winning books are targeted to the public, they are also targeted to the scientific community or they play a role within the scientific community. That should not surprise us, given current conceptual understandings that science communication involves feedback among different forms of communication and loops that connect different types of communication.[15]

The second role that books play is to recruit people into science. By making science exciting and accessible, books help young people imagine themselves in jobs and activities that they haven't yet personally experienced.

The third role is one that cannot easily be expressed in English. The French call it *culture scientifique,* the idea of everyday culture as infused with science. If we say "a scientific culture" in English, it doesn’t carry the same meaning that it seems to carry in the French-speaking countries. The idea is that books show the integration of science and culture in our everyday life.

The final role is one of public debate, in which books are the location or the forum in which public issues can be discussed.

Intellectual development of science itself

For an example of how a prize-winning book contributes to science itself, consider E.O. Wilson’s *Sociobiology*. This book was partly intended for the science attentive public, the elite intellectual community. But it was also an argument within science itself. It was Wilson’s full, complete statement of the sociobiology program. It was intended for use within the scientific community as a statement of that program. In a very real sense, it pulled that field together, making explicit some of the connections and ideas that had previously existed only in separate papers or only in specialist communities. Wilson's book made the new field concrete.

A similar function was played by one of the textbooks listed above, James Watson’s *Molecular Biology of the Gene*. That book pulled together the field of molecular biology, which had not existed before. Whole courses were created to teach that textbook. In the same way, courses were suddenly created called "Sociobiology," based on Wilson's book, pulling together the field in a way that had not been true before. Yet, especially because of Wilson's the last chapter on humans, the book also became part of a general public discussion about the nature of who we are.

Another example is Joseph Weizenbaum's *Computer Power and Human Reason* (1976). The book is a key text within artificial intelligence. At the same time, it is also part of the general discussion about the role of computers in society, the workings of the human mind, and all those related topics.

James Gleick’s *Chaos* is interesting because it also seems to serve this intellectual role within science, even though it was written as popular science book. Gleick was just another journalist going out and writing a book that would explain some area of science. Yet the book served the function of pulling together the field of complexity and chaos in a new way. More recent books on the field cite Gleick's book as one of the things that pulled people together, that made them suddenly realize that they were all talking to each other. The public discussion shaped the intellectual discussion as well – through the medium of books.

Recruitment

Recruitment books pull people into science. These are books that people cite as "Hey, the reason I’m a scientist is because I read that book." Paul De Kruif's *Microbe Hunters* is the epitome of these books (although it was published a generation before the period I'm considering, it continued its powerful pull for many years). It is astonishing how freqeuntly that books appears in the memories (and sometimes memoirs) of senior scientists who became biologists in the 1930s, 1940s, and 1950s – they read *Microbe Hunters* and that’s what turned them on.

James Watson’s *Double Helix* is a very different kind of book, but served much of the same purpose in the 1960s, 1970s, and maybe even the 1980s. People who are today at the forefront of biotechnology or genomics read that book as graduate students and said “Yeah, That is the kind of scientist I want to be! I get to make a Nobel Prize-winning discovery, and then I get to go play tennis, and then I get to go get the girls.” That sounded like a fun kind of career.

More recently, particularly in astronomy or physics, people say that *Cosmos* (either the TV show or the book) served the same function. These are often people who were so turned on by the TV show that they went out and got the book. *Cosmos* has had the same kind of recruiting power as the De Kruif and Watson books: “Why are you an astrophysicist or an astronomer?” “Because I saw Carl Sagan’s *Cosmos*" or "I read *Cosmos*.”

Culture scientifique

The third role of books is to create a *culture scientique*. One aspect of this is that you are expected to have read some particular books if you want to call yourself "cultured." The books by Isaac Asimov and Stephen Jay Gould, or Bronowski's book, are "required reading" in cultured circles (although the list does change over time – Asimov is probably less read now than he was during his lifetime). People can't consider themselves as cultured persons if they haven’t read the essays of Lewis Thomas about medicine, or more recently Dava Sobel’s *Longitude.* Not all of these books have tremendous amounts of "science" in them – Thomas's essays are as much about philosophical approaches to illness as they are explanation of disease, and Sobel's book is more adventure story than science explanation. But one is "expected" (in some circles) to have read those books. Among the "science attentive" public, one is expected to have seen the excerpts of these sorts of books in the *New Yorker.*

Public debate

The final role is the role of public debate or public opinion. Books do not just provide information, nor do they just excite people. Some of them are in fact making arguments. Rachel Carson's *Silent Spring* is the most obvious example. That book made an argument about chemicals in society, and is widely cited as being the founding document of the environmental movement. The argument did not go uncontested. Carson's book was not attacked just by chemical companies, it was attacked by science writers. In 1963, a well known science writer named Lawrence Lessig won the American Chemical Society's Grady-Stack Award (for excellence in science journalism). As part of his award speech, he called Carson's book "highly emotional with a biased thesis." Much of his talk was an attack on *Silent Spring*. This example demonstrates the degree to which there was an argument which many people felt they needed to take up.

Similarly, Evelyn Fox Keller's *The Feeling for the Organism*, a biography of Barbara McClintock, was part of a discussion about the nature of science and whether feminine science was somehow different than masculine science. Did McClintock do science differently? Did she have some kind of female connection with her materials that males didn't have? Fox Keller was making an argument, one that's part of an ongoing argument. Lots of people have criticized some of the technical details of Fox Keller's book, but for our purposes the important point is that she was engaging in public discussion of a contemporary issue. Richard Herrnstein and Charles Murray's book on *The Bell Curve* (which argued that racial differences can explain some differences in intelligence) is similar: many people argued with the science in it, they argued about whether it properly reported research findings or interpreted data correctly. But the point is that it became a topic of discussion. *The Bell Curve* was the kind of book where there were public debates, op-ed pieces, magazine pieces, newspapers articles that cited it, policy discussions, etc. It's an example of how books can play a role in public discussion.

Conclusion

Books drive public discussion, most simply, because they are part of the media mix that permeates our culture. While we focus on the World Wide Web and other new media because of their freshness, we can't forget that there are lots of other components of science communication; books are there. More deeply, books drive public discussion because of the multiple roles they play in providing information, engaging lay expertise, and contributing to public discussion.

Books bring new perspectives into science. As we think about the functions of public communication of science and technology, we need to remember examples like *Chaos*, the book in which the journalist James Gleick pulled together an intellectual field in a way that hadn't been done before. We need to think about the stimulating of discussion – not just making a reader feel good the way a Lewis Thomas book did, but making the reader argue with a book in the way the Herrnstein and Murray book did. That is a role that books can play. That role highlights the place of books in public participation models of science communication.

Ultimately, books create the culture that we live in. They are elements both of the scientific culture and of our more general culture. By looking at them we can actually see the ways in which science and modern culture are not separate but are interwoven. Neither science nor society exists without the other one. Books provide an example of how that interaction exists in a real, material way. If we think about the multiple ways that books demonstrate the interaction of science and society, then we can begin to understand their enduring importance.

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