

Current Comments

Science: 101 Years of Publication of High Impact Science Journalism

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I have followed with keen interest the explosion in science journalism over the past few years. So I've written essays examining several of the new science magazines,¹⁻⁴ as well as some older ones.⁵⁻⁷ In this essay, I'd like to discuss the journalistic role of *Science*—which celebrated its 100th anniversary last year.

Most scientists recognize *Science* as a leading vehicle for reporting original research in a wide range of specialties. Our citation studies show that *Science* consistently publishes significant and highly cited papers. According to the 1980 *Science Citation Index*®'s (*SCI*®) *Journal Citation Reports*® (*JCR*™), *Science*'s impact factor is 5.7, which ranks it fifty-ninth among the nearly 5,800 *JCR* journals. The impact factor is a measure of how frequently the average article in a journal is cited. By comparison, *Nature*'s impact factor is a slightly higher 6.4. The highest impact factor in the *JCR*, 28.5, belongs to *Advances in Immunology*. But both *Science* and *Nature* are among the top two percent of *SCI* journals. Moreover, the 1980 immediacy index for *Science* is 1.53. This ranks twentieth in the *JCR* file and indicates that a good percentage of *Science*'s papers are well cited soon after publication.

The number of super-cited papers that have been published in *Science* is too large for us to list here. So instead, we have listed in Figure 1 the top 20, all of which have been cited more than 700 times. Each of these qualifies as a *Cita-*

tion Classic. Although only five papers from *Science* have actually been covered in *Citation Classics*, many more would appear if we could obtain the authors' cooperation. But all of the papers in Figure 1 are in the life sciences, and the list is dominated by the field of molecular biology.

In Figure 2, we have listed the 20 most-cited papers in the physical sciences, many of which are in the earth sciences. However, there can be no doubt that *Science* and *Nature* are cited primarily for their life sciences content.

But *Science* is increasingly recognized not only as a primary journal. For some time, *Science* has maintained a staff of competent science journalists who cover the news of science. They focus on such matters as how government decisions will affect research, or how a given line of research will affect society. A good percentage of the pages of *Science* are devoted to these news articles. Thus, *Science* qualifies as a news-magazine of science.

Science is the official publication of the American Association for the Advancement of Science (AAAS), but it wasn't always so. *Science* began 101 years ago as the result of a collaboration between a New York journalist, John Michels, and the famous inventor, Thomas Edison. The history of the magazine was described in a series of articles published in the centennial issue of *Science* last year.⁸⁻¹⁰

The first issue of *Science* appeared in July 1880, with Michels as editor and

Figure 1: Life sciences papers published in *Science* which were most-cited during the period 1961-1980.

Total Citations:

Bibliographic Data

1961-1980

- 872 **Benacerraf B & McDevitt H O.** Histocompatibility-linked immune response genes. *Science* 175:273-9, 1972.
- 767 **Blobel G & Potter V R.** Nuclei from rat liver: isolation method that combines purity with high yield. *Science* 154:1662-5, 1966.
- 850 **Brazeau P, Vale W, Burgus R, Ling N, Butcher M, Rivier J & Guillemin R.** Hypothalamic polypeptide that inhibits the secretion of immunoreactive pituitary growth hormone. *Science* 179:77-9, 1973.
- 820 **Britten R J & Davidson E H.** Gene regulation for higher cells: a theory. *Science* 165:349-57, 1969.
- 1,696 **Britten R J & Kohne D E.** Repeated sequences in DNA. *Science* 161:529-40, 1968.
- 832 **Britten R J & Roberts R B.** High-resolution density gradient sedimentation analysis. *Science* 131:32-3, 1960.
- 813 **Cahn R D, Kaplan N O, Levine L & Zwillig E.** Nature and development of lactic dehydrogenases. *Science* 136:962-9, 1962.
- 3,236 **Eagle H.** Amino acid metabolism in mammalian cell cultures. *Science* 130:432-7, 1959.
- 851 **Eagle H.** Nutrition needs of mammalian cells in tissue culture. *Science* 122:501-4, 1955.
- 1,762 **Jerne N K & Nordin A A.** Plaque formation in agar by single antibody-producing cells. *Science* 140:405, 1963.
- 740 **Kornberg R D.** Chromatin structure: a repeating unit of histones and DNA. *Science* 184:868-71, 1974.
- 809 **Littlefield J W.** Selection of hybrids from matings of fibroblasts in vitro and their presumed recombinants. *Science* 145:709-10, 1964.
- 806 **Melzack R & Wall P D.** Pain mechanisms: a new theory. *Science* 150:971-9, 1965.
- 716 **Morris D L.** Quantitative determination of carbohydrates with Dreywood's anthrone reagent. *Science* 107:254-5, 1948.
- 1,029 **Nirenberg M & Leder P.** RNA codewords and protein synthesis. *Science* 145:1399-407, 1964.
- 710 **Ollins A L & Ollins D E.** Spheroid chromatin units (*v* bodies). *Science* 183:330-2, 1974.
- 841 **Rasmussen H.** Cell communication, calcium ion, and cyclic adenosine monophosphate. *Science* 170:404-12, 1970.
- 2,543 **Singer S J & Nicolson G L.** The fluid mosaic model of the structure of cell membranes. *Science* 175:720-31, 1972.
- 757 **Udenfriend S, Stein S, Böhlen P, Dabman W, Leimgruber W & Weigle M.** Fluorescamine: a reagent for assay of amino acids, peptides, proteins, and primary amines in picomole range. *Science* 178:871-2, 1972.
- 1,158 **Wessells N K, Spooner B S, Ash J F, Bradley M O, Luduena M A, Taylor E L, Wrenn J T & Yamada K M.** Microfilaments in cellular and developmental processes. *Science* 171:135-43, 1971.

Edison providing financial backing. At the beginning, the magazine had trouble both in attracting articles from prominent authors and in making a profit. After 18 months of publication, Edison withdrew his support. But the magazine soon attracted other backers: Alexander Graham Bell, inventor of the telephone, and his father-in-law, lawyer Gardiner G. Hubbard, assumed ownership of *Science*. *Science* ceased publication in 1882 to reorganize. When it appeared again later that year, Bell had replaced Michels with Samuel H. Scudder, a Boston entomologist. But finan-

cial problems persisted. Publication was again suspended in 1894.⁸

The AAAS became unofficially involved with *Science* when Bell and Hubbard assumed ownership. Bell was a member of the AAAS, and his colleagues within the association greatly influenced him on such matters as selection of an editor and the location of the editorial office. In 1895, Bell transferred ownership of the moribund magazine to James McKeen Cattell, a professor in the nascent field of psychology. With Cattell also serving as editor, and with collaboration and financial subsidies

Figure 2: Physical sciences papers published in *Science* which were most-cited during the period 1961-1980.

**Total Citations
1961-1980**

Bibliographic Data

- 151 **Cicerone R J, Stolarki R S & Walters S.** Stratospheric ozone destruction by man-made chlorofluoromethanes. *Science* 185:1165-7, 1974.
- 158 **Clayton R N, Grossman L & Mayeda T K.** A component of primitive nuclear composition in carbonaceous meteorites. *Science* 182:485-8, 1973.
- 300 **Cox A.** Geomagnetic reversals. *Science* 163:237-45, 1969.
- 304 **Craig H.** Standard for reporting concentrations of deuterium and oxygen-18 in natural waters. *Science* 133:1833-4, 1961.
- 278 **Frant M S.** Electrode for sensing fluoride ion activity in solution. *Science* 154:1553-5, 1966.
- 149 **Gamble F R, DiSalvo F J, Klemm R A & Geballe T H.** Superconductivity in layered structure organometallic crystals. *Science* 168:568-70, 1970.
- 149 **Heezen B C, Hollister C D & Ruddiman W F.** Shaping of the continental rise by deep geostrophic contour currents. *Science* 152:502-8, 1966.
- 246 **Hoard J L.** Stereochemistry of hemes and other metalloporphyrins. *Science* 174:1295-302, 1971.
- 264 **Johnson H.** Reduction of stratospheric ozone by nitrogen oxide catalysts from supersonic transport exhaust. *Science* 173:517-22, 1971.
- 151 **Kellogg W W, Cadle R D, Allen E R, Lazrus A L & Martell E A.** The sulfur cycle. *Science* 175:587-96, 1972.
- 156 **Kulp J L.** Geologic time scale. *Science* 133:1105-14, 1961.
- 178 **Miller S L & Urey H C.** Organic compound synthesis on the primitive earth. *Science* 130:245-51, 1959.
- 174 **Milliman J D & Emery K O.** Sea levels during the past 35,000 years. *Science* 162:1121-3, 1968.
- 164 **Molnar P & Tapponnier P.** Cenozoic tectonics of Asia: effects of a continental collision. *Science* 189:419-26, 1975.
- 188 **Owens B B & Argue G R.** High-conductivity solid electrolytes: Mg_4I_5 . *Science* 157:308-10, 1967.
- 178 **Pearson R G.** Acids and bases. *Science* 151:172-7, 1966.
- 166 **Ross J W.** Calcium-selective electrode with liquid ion exchanger. *Science* 156:1378-9, 1967.
- 185 **Vaska L.** Oxygen-carrying properties of a simple synthetic system. *Science* 140:809-10, 1963.
- 413 **Vine F J.** Spreading of the ocean floor: new evidence. *Science* 154:1405-15, 1966.
- 186 **Wolbarsht M L, MacNichol E F & Wagner H G.** Glass insulated platinum microelectrode. *Science* 132:1309-10, 1960.

from the AAAS, *Science* was published anew. In January 1895, the third issue to be labeled Volume 1, Issue 1, appeared.⁹

Cattell is one of the most famous of *Science's* editors. It was under Cattell that *Science* became truly established. He had numerous contacts within the scientific community, so the quality of the articles that *Science* was able to attract improved immensely. The discovery of X rays in 1895 by Wilhelm C. Röntgen was to prove of tremendous importance to *Science*. For although *Science* was by no means the first American journal to publish articles on X rays, thanks to Cattell's contacts it attracted the most and best articles in

America on the subject. *Science* soon became the best source for articles on this new and exciting "research front."

Cattell, incidentally, published in 1906 the first edition of what would later become *American Men and Women of Science*, a multivolume compendium of thumbnail biographies of American scientists. Today, *American Men and Women of Science* has more than 100,000 listings. It is currently published by the Jaques Cattell Press, which was established by Cattell's son and is now part of the R.R. Bowker publishing house, a division of Xerox.¹¹

As the owner of *Science*, Cattell had complete control over formulating editorial policy. The editors of *Science*

since Cattell have enjoyed an almost equal degree of editorial autonomy. *Science* is published each week without any interference from the AAAS.¹² Neither the board of directors nor the membership of the AAAS have any input into editorial policy, although *Science* does periodically survey its subscribers for feedback. William D. Carey, executive officer of the AAAS, who is listed as the publisher on *Science*'s masthead, describes his relationship with the magazine thusly: "A publisher...assumes that a journal that has had 5,000 live births and is still going strong is likely to be around a while longer if he has enough sense to let the editors alone."¹² Not even the editorial board, which is selected by editor Philip Abelson, has much to do with editorial policy. It exists largely to maintain contacts throughout the scientific community, to advise on what types of original articles to solicit, and to recruit writers of book reviews.¹³

The general principle of editorial freedom is a good one, and needs no defense here. But too much emphasis on "going it alone" can sometimes have regrettable results. I believe that more than a few AAAS members resent the lack of participation in formulating editorial policy.

Regarding the journalism in *Science*, I recently received a letter from B. Raymond Fink, University of Washington School of Medicine, Seattle, Washington, who complained that the reporting is "too often biased by inadequate grip on the field. The principal shortcoming...is that the reports by *Science* staff writers are devoid of references to the literature. Pundits writing *ex cathedra* should have no place in a science journal."¹⁴

This point was made plain to me in dramatic fashion a few years ago when the *News and Comment* section contained a story about me and ISI.¹⁵ When I and others at ISI were interviewed, we had expected to see a draft of the article before it was published to ensure accuracy. This is not an unrea-

sonable expectation. I believe firmly in this principle. My essays in *Current Contents*¹⁶ are routinely sent to people close to the subject for reviewing, especially if they have been quoted. But the *Science* article about ISI appeared without review, and it contained avoidable errors. When I spoke to Abelson about this policy, he told me they had had bad experiences with reviewing in the past. Working with tight deadlines only aggravates the problem. But as long as *Science* reporters refuse to show drafts to their sources they are bound to make errors that will erode their credibility. This has nothing to do with the laudable tradition of editorial freedom established by Cattell. We are accustomed to errors in the general press, but we are less tolerant of errors in a magazine that speaks for scientists. Abelson as editor is entitled to express opinions. Reporters should not, unless their opinions are clearly labeled as such.

Upon Cattell's death in 1944, in accordance with an agreement made in 1925, the AAAS purchased *Science* from the Cattell family and paid subsequent annuities to Cattell's widow. The journal declined somewhat for a few years after Cattell's death, and a number of editors came and went in rapid succession.

Incidentally, it was Dael Wolfe¹⁶ who, as acting editor of *Science*, was responsible for accepting my first paper on citation indexing in 1955.¹⁷ That paper proved to be one of my most-cited. At the time, Wolfe edited *Science* while also performing his duties as the chief executive officer of the AAAS. Wolfe is now at the Graduate School of Public Affairs, University of Washington, Seattle, Washington. And as he confirmed recently, he continues to follow with interest new developments in citation analysis.¹⁸

The next editor of *Science*, Graham DuShane, was appointed in 1956. Previously, DuShane had been a research biologist at Stanford University. During his editorship, the journal improved

significantly. He left *Science* in 1962 to accept an appointment as chairman of Vanderbilt University's department of biology and as dean of graduate sciences. DuShane was succeeded by Abelson, who is currently editor. During the first decade of Abelson's tenure, the circulation of *Science* doubled to 150,000. There is general agreement that the quality of *Science* has improved greatly under Abelson.

Each issue of *Science* is divided into a number of departments, two of which are devoted to scholarly work: *Articles* and *Reports*. The *Articles* section usually contains three or four rather long papers which sometimes qualify as reviews. For example, C. Owen Lovejoy's recent anthropological paper, "The origin of man," was ten pages long and contained 104 references.¹⁹ The paper by Leland N. Edmunds and Kenneth J. Adams on cell division cycles was 12 pages long and contained 98 references.²⁰

The *Reports* section of *Science* features about 15 original but shorter research papers every week. All papers are refereed, and the final decision to accept or reject rests with the editorial staff. Assistant managing editor John Ringle acknowledges that the life sciences tend to be overrepresented in *Science*.²¹ Just how much the life sciences are represented in *Science* can be shown by a casual glance at 1980 *JCR* statistics. The three journals that cite *Science* the most, except for *Science* itself and *Nature*, are the *Proceedings of the National Academy of Sciences USA—Biological Series*, *Brain Research*, and *Biochimica et Biophysica Acta*. Of the 20 journals that cite *Science* the most, excluding interdisciplinary journals, 19 are life sciences journals.

Science receives more manuscripts from the life sciences than from any other field. But, according to Ringle, an informal survey by the *Science* staff showed that an individual physical sciences paper had twice the chance of being accepted for publication than,

say, a neurophysiology paper. "I guess there's an unconscious attempt on our part to equalize the representation in *Science*," says Ringle.²¹ Still, there is no disciplinary "quota system." Since Abelson himself is a geophysicist at the Carnegie Institution, he has helped attract papers from the earth and space sciences.

Occasionally, special issues of *Science* appear. In these issues, the *Articles* section is greatly expanded, sometimes at the expense of space devoted to other departments. All of the articles in a special issue discuss various aspects of a single topic. The March 20, 1981, issue, for example, featured the genetics of sexual development.²² There were nine articles on the subject. Discounting a brief introduction, the remaining eight papers contained an average of 79 references. Other special issues have featured advances in medical instruments,²³ recombinant DNA,²⁴ and advanced technology.²⁵

I suspect that the most frequently read portion of the magazine is the *News and Comment* section, which I mentioned above. *News and Comment* articles are written by staff writers, most of whom have had prior experience covering developments on Capitol Hill. This experience is important, since much of what appears in *News and Comment* concerns the actions of government and their effects on the research community. For example, the February 13, 1981, edition of *News and Comment* covered the change of leadership in key congressional committees.²⁶ And the March 27, 1981, edition contained two stories on the impact of the Reagan administration's budget cuts on social science research in particular,²⁷ and on science policy in general.²⁸ Barbara J. Culliton is the news editor for *Science*.

The *News and Comment* section, of course, does not exclusively concern itself with the politics of science. According to staff writer Nicholas Wade, "any story that has a scientific or technical

component can be judged suitable for inclusion in *News and Comment*.²⁹ (Incidentally, Wade's article on citation indexing is widely cited.³⁰) Stories include the US technology embargo against Eastern Bloc countries,³¹ the trend in scientific publishing toward more and shorter papers,³² and stories about people in science.

Although *News and Comment* stories are not in themselves primary literature, they are cited with surprising frequency. In 1980, stories in *Science* written by the nine staff writers were cited 241 times in scientific journals. One story, a 1976 article by Luther J. Carter on the widespread contamination of Michigan's livestock by PBB,³³ has been cited more than 70 times—11 times in 1980 alone.

Other *News and Comment* stories have discussed the Heritage Foundation, a conservative "think tank" that enjoys considerable influence within the Reagan administration;³⁴ efforts to identify every protein produced in the human body;³⁵ the comments of a former under secretary of state on technology and weaponry;³⁶ innovations in air pollution control;³⁷ and the efforts of clinical psychologists to have their services covered under Blue Shield medical insurance.³⁸

Another section of *Science* is called *Research News*. As its name implies, it reports on new developments in scientific research. *Research News* is written by a staff of seven writers who are separate from the *News and Comment* staff. Most of these seven hold doctorates. The research developments they have reported on range from the role of museums in anthropological research³⁹ to the search for free quarks.⁴⁰ Inevitably, there is some overlap between the kinds of stories that appear in *Research News* and those that would appear in *News and Comment*. Indeed, writers from both staffs sometimes team up on a story.

Recently, *Research News* has covered new developments in senile dementia research,⁴¹ which I also discussed;⁴² evidence to support the view that aster-

oids have their own satellites;⁴³ advances in learning the molecular basis of genetic diseases;⁴⁴ a new electron microscope center at the University of California, Berkeley;⁴⁵ theories on why there is more matter than antimatter in the universe;⁴⁶ acid from pollution that falls to earth without precipitation;⁴⁷ the possible long-term climatic effects of the Mount St. Helens eruption;⁴⁸ and coronary bypass surgery.⁴⁹

Each issue of *Science* also features an editorial. Many of these editorials are written by Abelson, although more often they are written by scholars who are not connected with the magazine. Recent contributors of editorials have included Norman Hackerman, president, Rice University, who described the mission of the National Science Foundation;⁵⁰ Kenneth Prewitt, president, Social Science Research Council, New York, who discussed the importance of social science research to society;⁵¹ and Philip Handler, president, National Academy of Sciences, who discussed the federal science budget.⁵² The editorials in *Science*, unlike those in *Nature*, are nearly always signed. They are usually interesting to read, but it irks me and librarians in particular that the editorial page is never numbered. If one photocopies the editorial, it is not possible later to complete a citation to it.

Another section of *Science* features letters to the editor, most of which address papers which appeared in either the *Articles* or *Reports* sections. The letters are not to be confused with "letters" that appear in *Nature*, which are equivalent to the *Reports* in *Science*. Still other sections include *Products and Materials*, which features descriptions of new products for researchers such as gas chromatographs and DNA synthesizers; book reviews, which are written by scholars not connected with the magazine; and classified ads, most of which announce positions open for professionals.

Science is published weekly except for the last week in December. The

cover price is \$2.00, though of course, newsstand sales account for only a tiny fraction of the magazine's circulation of 155,000. Subscription to *Science* comes automatically with membership in the AAAS, which is open to anyone for \$43.00 per year. The subscription price for US institutions is \$76.00. Institutional subscriptions outside of the US cost more, and prices vary according to location. About 14,000 of *Science's* subscribers are outside of North America. A full-page black and white ad in *Science* costs \$2,730. A full-page color ad costs \$3,630. Advertising accounts for about 40 percent, or more than \$3 million per year, of *Science's* revenues.

The average issue of *Science* contains about 100 pages. Of these, about 30 are full-page ads. Space advertising also appears on other pages, but not in the *Articles, Reports, News and Comment, or Research News* sections. Virtually all of the ads are professionally oriented. They promote such products as microscopes, laboratory chemicals, and yes, even products from ISI. There is no consumer advertising.

The importance and impact of *Science* is attested to by the fact that most of the *Science* staff have won writing awards of one sort or another.⁵³ Carter, for example, won the 1979 Science Communication Award sponsored by the National Wildlife Federa-

tion. Carter has been with *Science* since 1965, and has taken a special interest in environmental issues. Specifically mentioned in his award citation was his 1975 book *The Florida Experience: Land and Water Policy in a Growth State*.⁵⁴ This book also received a special award from the Florida chapter of the Sierra Club.⁵⁵

Four members of the *Science* staff have won the National Association of Science Writers Science-in-Society Award: Robert Gillette (1972), Philip Boffey (1976), Allen Hammond (1977), and R. Jeffrey Smith (1979). Jean L. Marx and Gina Bari Kolata both won the American Heart Association's Howard V. Blakeslee Award in 1977. *Science* staffer Eliot Marshall won the 1978 Sidney Hillman Prize for magazine writing. And this list is by no means exhaustive.

Although I am a year late, I would like to congratulate the staff of *Science* on its centennial. *Science* is now firmly established as a publisher of outstanding research. It is also an important source of news for the scientific community. In conclusion, I think we can all look forward to another 100 years of excellence from *Science*.

* * * * *

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