FERRETING OUT FACTS ON FERROMAGNETISM

These remarks on scientific literature and the use of references to obscure the past—which the author is against—were taken from a paper presented before a meeting of the New England Section of the American Physical Society at Williamstown, Massachusetts on October 22, 1949 and repeated at the meeting of the Metropolitan Section of the same Society at Brookhaven National Laboratory on March 31, 1950.

by ***L. W. McKeehan***

Oliver Herford wrote a poem about the dinosaur in which the advantage of having two widely separated brains of low quality is emphasized approximately in these words:

"For he could think, without congestion,
Upon both sides of any question."

In respect to the literature of ferromagnetism, I find myself equally gifted. I have often argued that science does not depend upon the personal history of the men who build it, nor upon the order in which its parts have appeared in the history of this planet. Now that interplanetary travel is just around the corner we must face the fact that Martians, for example, may know as much as we do about mechanics without ever having heard of Newton, and as much as we do about atomic bombs without ever having heard of General Groves. And yet I have chosen a subject in which names and dates are pre-eminent.

The resolution of this paradox depends upon the well known fact that science is, as yet, incomplete, and so takes a lot of study to find out what limits it has reached along any line of growth. Until and unless we can get any and all valid general statements about the universe by pushing the right buttons, we must continue to extract them from

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When *L. W. McKeehan*, professor of physics at Yale University, was a graduate student at Minnesota forty years ago, his desk was in the departmental library and looking up a reference was so easy he deserves, he says, no credit for getting the habit. McKeehan writes: "My chronic addiction to bibliographical work, however, can be traced to Karl K. Darrow, who shared an office with me when I was a freshman in the Western Electric Engineering Department at 463 West Street, New York City in 1921. Stimulated by his shining example, I became much interested in bibliographical work, especially in my then new field of interest, ferromagnetism. Upon coming to New Haven six years later, my library hours became both pleasanter and more profitable, being no longer preceded and followed by subway rides, and I was pleasantly surprised to discover that Jared Eliot (Yale 1706) had devised a magnetic separator for iron ore before 1762 while he was a Fellow of the Yale Corporation. (So far as I can now determine, no other ferromagnetician has ever adorned that body.) As I have grown older and more irascible I have restrained myself with more and more difficulty from sounding off on the sins of authors who make it harder to trace the development of physics by skimping or garbling their references to prior work, and when I was tapped for a speech by the New England Section of the American Physical Society last fall, I finally took my opportunity to let off steam and revert to my normal low pressure urbanity."

scattered records, in order to decide where to apply time and money devoted to the advancement of science.

Even with the most complete information about what has been established, we must spend some time in repeating experiments and in re-analysis of data. If we ignore the past, we are very likely to spend all our time in these exercises, and to be most unpleasantly surprised and chagrined when a brilliant discovery turns out to be an old story.

The other horn of our dilemma is not so likely to gore us, but it does account for some casualties on the research front, even in physics. There is a lot of quiet fun to be had in historical research, and some people who take it up forget to look ahead at all, spending many happy hours turning pages upon which little or nothing was written in the first place and still less remains.

After these generalities I want to become very particular indeed in discussing the record of a small part of physics and its applications in the literature of ferromagnetism.

Curtains

The first point to make is that a good review of ferromagnetism tends to hide more facts than it discloses. Two books, in particular, nearly stopped progress altogether. I refer to William Gilbert's *De Magnete*, published in 1600, and to James Alfred Ewing's *Magnetic Induction in Iron and Other Metals*, published in 1891. After each of these classics appeared, it was assumed, incorrectly in each case, that all previous work had been duly considered, and that, if not mentioned, it was worthless. There will be a new and compendious book, by one of my former colleagues, out within a few months, and this is fair warning that even after it appears there will remain something for ferromagneticians to consider in the literature of their subject between 1891 and 1950.

In reading old papers there is one serious mistake to be sedulously avoided. (Our contemporaries in another country have not avoided this mistake in recent years.) To avoid it, every author must always be read in the language of his times. If a Greek refers to a magnet, he means a bit of stone, and he does not associate with this word all that has been put into its technical connotation since the time he wrote. It is astonishingly easy to find sentences in early documents that could not possibly have meant, when written, as much as they would mean if written today, and it is a prime mistake to attribute to any writer a background of knowledge years ahead of his time.

On the other hand it will surprise most of you to know that some papers more than one hundred years old contain data of first class quality that have never been incorporated into science. Later data, sometimes much poorer, have been chosen for review, and the earlier work is then as if it had never been done. At the present time the chance of overlooking useful facts is getting greater, and the amount of current work that will never be used except to adorn an obituary is believed to be considerable.

How can we do better, how can we save some of our overlooked assets? By taking more pains in finding the relations between new and old publications, and by indicating these relations more skilfully, so that the readers, both this year and fifty years from now, can trace the relations claimed, and agree or disagree with the conclusions more intelligently. As far as the past is concerned we must rely upon elderly eager beavers, like myself, to poke around and record relations not made clear by authors now inaccessible to public pressure.

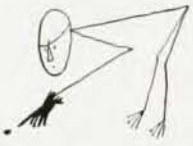
That-a-way

This brings us to "references". Almost every modern paper has a few, and even casual inspection brings out some evidence that their insertion is habitual rather than thoughtful. Different habits are easily noted.

Reference to Own Papers: There is some sense to this, since there is often a real connection between what *A* now reports and what *A* reported yesterday. He may also be best informed about his own relatively inaccessible papers, and *may* be the only person who has read them. If it goes too far the practice becomes slightly ridiculous. I once found an example in *The Physical Review* in which all fourteen footnotes refer to earlier papers by the

same contributor. This author, like Robinson Crusoe, could truthfully sing: "I am monarch of all I survey."

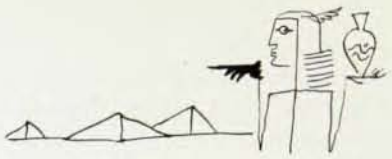
References to Recent Papers Only: This is very easy, and is allowable if a hot controversy is going on, but in most cases only laziness and resulting ignorance account for the practice. Dissertations are written, and accepted in some cases, where the author has only the vaguest notion of background, or none at all, and has literally read nothing but his own lecture and laboratory notebooks. Observing this gap, he fills in his thesis by referring to a few papers—five to ten is the standard—which sound as if they mattered. This is a good time for the candidate to mention papers by his faculty advisor, who will enjoy seeing his name in print and thus be favorably impressed, at very small expense, by the student's erudition.



References to One Periodical: If an author refers only (or mainly) to one periodical, he is not a ferromagnetician in good standing. Our subject is scattered all over the place, being half science and half technology, and has been dabbled in by almost everybody. The resultant diffusion of notable work is very striking.

Irrelevant References: These are most common in review articles, which offer a quick substitute for real study. Engineering magazines are full of this kind of paper. At the end will be found a list of books and papers from which the author has, possibly, picked a few facts. The reader will not be told where any given fact was found, and we can classify this kind of reference list as another form of self-advertising which has little value. It is about as useful as listing the Bible and the Book of Common Prayer as references in a book of sermons.

Exhausting References (and I mean exhausting, not exhaustive): Here the learned author piles up such enormous lists of authorities that the reader is perfectly certain to give up before he checks many of them. As a horrible example I may mention one of my own papers, published about twenty years ago, in which there were seven full pages of references.



Antique References: Here the author really goes to town and finds the origin of his subject so long ago that nobody can prove he is wrong. This is all right in papers that are frankly historical, but not otherwise. The best that anyone can do, until Chinese sources are more generally accessible, is to go back to Petrus Peregrinus, or Peter the Pilgrim, who suffered more from editorial delay than any of his successors in our subject since it took 289 years to get his paper printed.

Once in a while an antique reference is forced upon one. Here's an example. The late Ernest Fox Nichols invented a magnetic mine firing device during World War I. It depended upon the angle between the magnetic axes of two little steel magnets mounted like compasses on pivots one above the other. This angle is a sensitive function of the local value of the horizontal component of the earth's magnetic field. In trying to find out if anyone had anticipated this device, I looked back a long way and found two papers with titles that suggested much the same arrangement, one by Daniel Bernoulli, in 1758, and one by Etienne Nicolas Blondeau, in 1773. Several years of poking around disclosed no copy of either paper, and no reference to either later than 1880 in the case of Daniel, 1805 in the case of Etienne. The poking covered New York, Washington, Boston, New Haven, and the British Museum. After about ten years, I asked Mr. Louis H. Bolander, the librarian at the Naval Academy in Annapolis, if he had ever heard of the periodical presumably containing Blondeau's papers. He was able to hand me the volume in a few minutes. The volume I had to find in this case is so scarce and so rarely opened that, if the device in question had turned out better, its early description would still be secure in the official sense. I may also remark that Nichols had improved greatly on Blondeau with the aid of the intervening 145 years of technical development. I have not yet seen a copy of Daniel Bernoulli's paper on this subject, but I am still looking for it.

Form of Reference: Everybody in this business, and especially every editor, tries to compress references into minimum space. This often makes them not merely incomplete but tantalizing also. It is much better from our present point of view to be redundant rather than cryptic. If there are several clues to the right man, the right publication, the right place in it, the right date, the right title, etc., etc., the chance of losing everything by one wild misprint is very much reduced. In any one period the scientific public may easily recognize an abbreviation, may easily read Roman numerals, etc., but, as time goes on, styles change, and it needs hard work to win back the discarded details. The references in a fine treatise published in 1867 are now a series of puzzles because of ellisions and abbreviations that were probably clear enough to early readers. The omission of initials is sometimes most irritating. For example, there are at least nine Schmidts in our subject at one time or another, not to mention three A. W. Smiths.

Secondary References: The extracting of references from abstract journals, or from other people's footnotes, and the recording of hearsay items as if they were primary rather than secondary, makes most of the trouble in backtracking to sources. Besides plain garbling (which can, in fact, be extremely fancy) there is an occasional transposition which sends later students barking up the wrong tree for years. The engineering fraternity is always committing this crime. Even a pretty good reference book like Mes'kin's monograph on ferromagnetic alloys makes a lot of blunders of this kind. It is likely that the principal difficulty here is in conversion from the original language first into Russian, and then into German. Transliteration of authors' names, especially, tends to deviate from the straight and narrow path in such a process. I am the more inclined to this explanation because the most recent Russian treatise on ferromagnetism is a mine of variants on relatively simple names. (My own is spelled three ways.)

Pages and Titles of Periodicals: Editors are an uneasy people. They are always changing the names of journals, or the method of issue, or of paging, and it takes a lot of attention to keep up with them. New Haven has one of the worst cases. The *American Journal of Science*, after getting up to volume 36 of its fifth series, in 1938, suddenly dropped the series idea and published volume 237 for 1939. What has been done with what is now the *Akademiya nauk, SSSR*, in the past 123 years, beggars description. The Royal Society in London started off its *Philosophical Transactions* in 1664/5. This was paged straight through 8 volumes, in 9 years, except that the printers could not count very well, omitted as many as 900 page numbers at a time in the middle of a single part, and used 180 page numbers twice.

Dates: Even when dates are given, they may not tell what we want. Some societies publish papers when the money comes in, not when the papers are submitted. The American Philosophical Society, for instance, was seven years in arrears by 1790. In difficult cases we may have to distinguish between the date a manuscript was submitted, the date the paper was "read", the date the publication was intended, the date the editor closed the entries, and the date of issue. What to do about preprints and reprints also presents some special troubles. Fortunately we don't have very much privately printed or typed (unpublished) material which needs to be commemorated.

Limbo

The current practice of issuing reports under government contracts is going to make bibliography in the future an even greater tax on the little gray cells than it has been in the past. If they go into high security classifications, papers are likely to suffer the fate of the Boojum who, you may recall, softly and silently vanished away and never was heard of again.

In conclusion I would like to emphasize the point that the facts of physics, buried in print, should not be like pirate gold, rumored to be somewhere in the sand on the coast of the Americas, but like money in the bank with location and ownership neatly docketed.