operation with Public Press, TV and Radio. Many of the practices that as recently as 5 years ago would have landed a practitioner before his ethics committee are now not only permitted but encouraged. Programs of the learned societies have speakers and discussants from universities and hospitals side by side with workers from the pharmaceutical companies' research laboratories. Major investigators freely acknowledge by footnote the support of commercial grants.

In brief, if research is dominated by big business with all its great resources, its drive toward the practical, its profit motive, let us realize also that its life blood and success are a sober recognition of the value of top names, top people, top authority, top quality of work. The bigger the business, the more certain can you be that it has grown through the complete realization that honesty pays off! This pattern is completely typical of the pattern of our entire economy and is one of the most potent proofs of its value.

The next time any one of our physician leaders gives an injection of his 40-ct penicillin, I hope he will look at it and visualize the business that made it possible for him to have it. Maybe we should try to throw off the shackles of some of our traditional attitudes and try to examine the activities of big business with the same detached and objective evaluation that we habitually give to our test-tube and laboratory bench work.

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4 November 1954.

R. W. Lippman is a practicing physician who also is engaged in research; he is a former fellow of the John Simon Guggenheim Memorial Foundation. Philip Reichert, ex-Rockefeller Institute, and still maintaining a consulting practice in cardiology, is currently director in a large advertising agency of a division that prepares promotional material directed to the medical, dental, and auxiliary professions.

Forms for Literature Citations

McCasland's proposed telegraphic system of literature citation [Science **120**, 150 (1954)] would certainly be convenient for compilers of bibliographies. I should like to consider it from the point of view of the users of bibliographies. What does the user want from a reference? Unless he is merely engaged in the reprehensible practice of copying it into a bibliography of his own, he wants to find out more about what the cited paper contains. To do this, he must consult either the original paper or, if this is not possible, an abstracting journal. In the latter case the author's name is essential, and, therefore, since not all libraries receive all journals, McCasland's suggestion of eventually omitting the author's name seems impractical. If the original paper is to be consulted, a minimum reference would seem quite satisfactory.

Here, however, we come up against the fact, well known in communication theory, that a message which is subject to distortion by "noise" must contain an appreciable amount of redundancy if its meaning is to be sure of surviving. When the message is a citation, the noise is furnished by the bibliographer's mistakes, his secretary's errors in transcription, the printer's errors, and even the blunders of well-intentioned editorial assistants. Actual experience in checking thousands of literature citations made by professional mathematicians has shown that these sources of noise are quite serious. The commonest mistake is a one-digit error in a date or a volume number; more baffling problems arise when the author writes, for instance, *Math. Z.* when he intends *Math. Ann.* In such cases redundancy saves the day: it is easy to find out whether the impossible **12** (1936) really means **22** (1936) or **12** (1926). Again, since volume 56 of *Math. Z.* was roughly contemporaneous with volume 125 of *Math. Ann.*, it is easy to decide, given both volume and date, which journal was intended.

A four-letter code for the journal name suffers badly from lack of redundancy. A single garbled letter may make the name unintelligible or even impossible to reconstruct. An abbreviation like *Trans. Am. Math. Soc.* is recognizable even with several bibliographer's or printer's errors, while **AMST** is not. Experience again shows that authors are rather careless in writing abbreviations of journal names. This particular one would probably frequently come out **TAMS:** the transposition would be obvious to an alert reader, but hardly so to an automatic sorting device.

Some apparently redundant items are not really redundant, and are likely to remain indispensable until that millennial day when all editors of journals do just what McCasland recommends. The year does not always determine the series: there are journals that have started series 3 before completing series 2. There are also journals that have appeared several years later than their dates or (more remarkably) before their dates. Since it is sometimes desirable to know in what year a paper actually appeared, it would be helpful if the present citation system were on occasion extended (rather than contracted) to indicate both the official date and the actual date of publication.

I even hope for one other expansion in citations, namely the citing of inclusive pages. This is now customary in mathematical journals, and there are several good reasons for it. One is that if one wants to order a microfilm or photostat copy, one needs to know in advance how long the paper is.

In general, it would seem that citations are already so brief that little space could be saved by shortening them still more, whereas any further compression is against the interests of the people who use the citations and for whose benefit they presumably are intended.

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3 August 1954.

The recent communication by G. E. McCasland (*1*) concerning condensed literature citations will, I hope, provoke general discussion. Similar proposals have been advanced before (*2*), and it seems likely that such a condensation *could* be carried out, but *should* it?

These and similar proposals contemplate using sets of alpha-numeric characters having essentially zero redundancy. This means that if any single character is wrong, the citation is lost.

Hundreds of years of experience have gone into vernacular languages which show a high degree of redundancy (*3*) and this is reflected in current methods of literature citation. Should not this fund of experience continue to guide decisions that affect scientists so directly?

The situation at present is bad enough, mainly because of the older practices in abbreviation and citation. McKeehan (*4*) has some pertinent remarks on this subject.

> 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 . . . 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 . . . 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 elisions and abbreviations that were probably clear enough to early readers.

Dyson (*5*) gives some entries under "Iodine" from the Gmelin-Watts translation that are quite unfamiliar and these also contain no indication of date.

The subject of periodical abbreviations has been treated recently (*6*).

Finally, anyone who has read the excellent review of *A Bibliography of the Research in Tissue Culture: 1884 to 1950,* made by P. R. White (*7*) can have only the greatest respect for the compilers, Murray and Kopech. They had 5500 ghost references for 29,000 actually found and used! Any practice that might tend to increase this figure should be examined carefully before adoption.

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2 September 1954.

Table 1. Three proposed forms for literature citations.

Proposer	Name	Example	Remarks
McCasland		799-**AJBC**-48.3	First letter of journal abbreviation has geographic significance
Reid	Sigil	48 JBC 3, 799	Number of letters in journal abbreviation not fixed
Bishop	Coden	JBCH-173-799 or 48JBCH-173-799	Prefixing of year is optional

In the 23 July 1954 issue of *Science,* G. E. McCasland proposed that scientific literature be cited by a concise designation that includes the page number, an arbitrary four-letter abbreviation for the journal, the year and part of the volume number where necessary. I made a similar proposal in *American Documentation* **4**, 54 (1953). Since then I have prepared a separate list of approximately 2500 journal abbreviations, which I have distributed informally. As a result of this, the Committee on Spectral Absorption Data and the A.S.T.M. Committee E-13 on Absorption Spectroscopy have asked and been granted permission to use the system on their keysort file of 13,000 compounds. Several other groups have indicated that they are trying the system. Thus as McCasland suggests, the idea of a concise and direct literature citation has considerable utility.

My "coden" differs slightly from the form proposed by McCasland in that I cite full volume number and no year. Also, my journal abbreviation is completely arbitrary but mnemonic wherever possible. The year can be incorporated if desired by prefixing it. Combining the year and part of the volume number as McCasland suggests is similar to the practice of J. B. Reid [*American Documentation* 5, 26 (1954)], who lists year, journal abbreviation, last digit of volume number if necessary, and page. Reid points out that by citing the year first, one automatically throws the references into chronological order. Table 1 shows how the proposed forms will be applied to an article in *Journal of Biological Chemistry,* volume 173, page 799, year 1948.

Regardless of the form used a direct, concise method of citation has many uses. One is in organizing bibliographies or review articles, for articles can be added or withdrawn without altering an arbitrarily numbered list of references. Furthermore, two bibliographies can be combined with the automatic elimination of duplicates. In our laboratory we prepare 3- by 5-in. reference cards using the coden, authors, title, number of pages, and year. All the cards constituting one bibliography are laid out and photographed. The cards are then returned to the "coden" file and brought out in a different combination for the next

bibliography. A bibliography on any subject can be prepared rapidly and with no subsequent errors, once the original cards are error-free. We use the same cards to prepare tables of contents of journals; and we find this quite a time-saver.

It appears that several people have independently "discovered" the merits of a concise literature citation. If such a designation could be made universal, a great deal of duplicated effort in bibliography could be avoided. Perhaps the first step is to agree on the exact form of the citation. Then the list of standard journal abbreviations should be compiled and published. This latter task is too time consuming for one individual to accomplish but would not seem anything more than a routine chore for an organization that is processing journals continually. Once a list is published, everyone can reap the benefits of a concise, universal literature citation.

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7 September 1954.

It is not entirely correct to assume that the "minimum information necessary in principle to specify a certain article" is the page, journal name, and year. Patents have long been identified by serial numbers. In theory, published articles could be so identified.

Another approach—different from Bishop's or Reid's—is to identify the individual article by a serial number of two parts: the first part identifying the journal, similar to the identifying numbers used in the *World List of Scientific Periodicals* or the *Bibliographie der Fremdsprachigen Zeitschriften Literatur*; the second part a serial number as exemplified by those used in the *Proc. Soc. Exptl. Biol. Med.* or the reprint order number in the *J. Chem. Soc.* (*London*). The serial number has its obvious disadvantages as would an approach based on the use of secondary publication references, such as the volume and column number in *Chemical Abstracts* or the numbers in publications like the *Current List of Medical Literature* and the *Bulletin Analytique*. The disadvantages increase as one gets further away from the original complete citation. Communication engineers face similar coding problems. Both brevity and redundancy have shortcomings.

It is necessary to determine the function of any proposed citation system. If a unique identification tag is all we require, then the patent system is enough. If the tag is to contain journal identification, then the two-part serial number is sufficient and far more desirable for punched-card applications, where the sorting of numbers is less time consuming than the sorting of letters. In "The preparation of printed indexes by automatic punched-card equipment—a manual of procedures" (*Medical Indexing Project Report,* Johns Hopkins Univ., Mar. 1953) I have demonstrated the feasibility of using such numerical identification tags for the compilation of scientific indexes.

If the tag is to have mnemonic, as well as classificatory features, then the difficulties increase. It is questionable whether the space saved by reducing the already abbreviated citations compensates for the time lost in trying to identify the citations in published articles. The retention of the journal title in the accepted abbreviated form will probably continue for many years, since most libraries must ultimately deal with the journal title, volume, page, and even year for verification. However, the *addition* to the established citation form of a unique tag such as a serial number would not be an excessively heavy burden on an author or editor. Such tags could help in speeding up communication between scientists and help particularly in facilitating the compilation of many types of compendiums, where uniqueness and brevity are compulsory.

EUGENE GARFIELD, *Documentation Consultant*
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13 September 1954.

When I wish to enlarge my knowledge on any subject, I go through a process that I call "browsing." My point of departure usually is a paper in my own library, and often it is not on the subject of interest but only treats it incidentally. However, study of the list of literature cited many times reveals at least one paper that *is* on the subject. I can recognize the paper by its title and judge the thoroughness of treatment by the number of pages included. If this information is omitted then each paper must be found and examined in the library in order to determine its nature.

The process would be still further slowed if a coded form, such as that proposed by McCasland, were adopted, for then it would be necessary to consult a code book, as well as the library, in order to learn what a paper is about and how comprehensive it is. I for one hope that journals giving full references will retain them and that those using abbreviations will not resort to coding.

The final step, of course, is the push-button information center envisioned by McCasland, which I shudder to contemplate. The quiet stacks of our libraries remain one of the few easily accessible refuges from modern, souped-up, gadget-ridden civilization. Must they too go?

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22 September 1954.

Those who oppose the abbreviated citations claim that an increase in errors would result. To enjoy the benefits of abbreviation, as we all do in one way or another, we must accept some increase in the risk of errors. Redundancy may protect against errors but is usually too expensive a protection for routine employment.

People who produce or use scientific literature should find a concise citation system useful, but anyone who is interested will need to balance the advantages against possible disadvantages for his particular purpose. In many cases it will be desirable to supplement the "minimum" citations, for example, by adding the authors' names.

G. E. McCasland

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22 September 1954.

Randomized Targets in Parapsychology

The report by Kendon Smith and Harry J. Canon on "A methodological refinement in the study of ESP, and negative findings" (*1*) is of interest in two respects. First, it reopens some questions about the use of random numbers in experimental work; and second, it challenges a series of experimental studies which for the most part have gone unchallenged. The central point at issue is whether properly safeguarded tests of extrasensory perception, in which stimulus materials are made by tables of "random numbers," are valid.

The authors state that some findings "raise the suspicion that tables of random numbers may not be entirely random; that such tables may, in some small degree, actually embody conventional preferred sequences of digits." So far as I know, absolute randomness has never been claimed, and it is theoretically difficult, in view of sampling theory, to see what the concept could mean. What is meant by preparing random numbers is that one takes pains that each digit be followed by each of the 10 digits in haphazard order. When, as is usually the case, hundreds of such digits are employed in making up "targets" for subjects to guess at, it is hard to see how such material, kept out of all known sources of knowledge of experimental subjects, could significantly coincide with the orders in which subjects make their guesses, except by a process that, by definition, is extrasensory. It is true and important that from time to time a subject may by chance alone call a few items that are related to the actual "target" order; and it is true that in *control* series, brief periods of such parallelism of subjects' calls with targets at which the subjects are *not* aiming is occasionally observed. This is what would be expected from the theory of probability. When one is dealing, as in the case of the Schmeidler experiments (*2*), with hundreds of thousands of experimental calls, it is hard to see what could be meant by saying that failure of randomness in the targets could be responsible for the positive findings consistently obtained in guessing experiments.

In the experimental work reported by Smith and Canon, there were two kinds of targets—a pair of squares in which the left-hand one was blackened, and a pair of squares in which the right-hand one was blackened. The only task for the subject was to guess in each case whether it was the left or the right square that was blackened. This seems to have been an unfortunate choice of target material, since earlier work suggests that the right-left dimension of choice often means little in the type of visual or kinesthetic imagination involved. At least with pictorial material, reversal from right to left, as in a mirror, has been reported (*3*). This is not to suggest that it occurred here; only that no conclusion can safely be drawn from this type of target. The task involved, moreover, in making a choice of one out of two appears from some experimental work (*4*) to be sometimes too insensitive to mobilize the interests and energies of subjects in such experiments; the choice of one out of five seems, as in the work of Soal and Rhine, to be a more sensitive and suitable procedure.

It is of interest to know that there was no significant difference in the scoring levels of those who believed in and those who disbelieved in the reality of paranormal phenomena. Unfortunately, the method chosen by the experimenters is one that makes it difficult to compare the present findings with those of the extensive earlier work reported on this problem.

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13 October 1954.

Slide Technique for Bacteriophage Typing of *Staphylococcus aureus*

The phage typing of *Staphylococcus aureus* has become a useful tool in epidemiology, particularly in tracing outbreaks of food poisoning. An agar-petri plate method for typing was devised by R. E. Williams and J. E. Rippon [*J. Hyg.* **50**, 320 (1952)]. An agar-slide method that is simpler and less expensive has been developed in this laboratory.

Twelve 14-mm paraffin rings are simultaneously placed on a serologic slide (2 by 3 in.) by means of an electric ring-making apparatus. (The slides are placed in wooden racks designed for the purpose. These racks may be stacked for convenience.) Nutrient agar (0.5 to 0.7 percent) that has been filtered is pipetted by an automatic serologic pipetting machine (cleaned but not sterilized) in approximately 0.2- to 0.25-ml quantities into each paraffin ring. The agar hardens immediately. One drop of a 24-hr nutrient broth culture of *Staphylococcus* from a 0.2-ml serologic pipette (approximately 0.03 ml) is placed on each agar convexity. The culture dries in 15 to 20 min. Then a similar drop of each phage to be tested is placed on each of the culture-on-agar preparations. After drying 15 to 20 min, each slide is placed in a sterile covered petri dish and incubated overnight at