

free systems, in which one can hope to demonstrate enzymes that would confirm more of the postulated reaction steps, or possibly bring to light still unsuspected reactions. A better understanding of the control mechanisms might open to us the possibility of regulating the formation of lignin, whose presence in many plants often leads at present to undesirable consequences. Another decade of research on lignification, if as successful as the last, may well provide us with a quite clear conception of this important process and provide extra dividends in the form of significant practical applications.

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Scientific Societies

The members of the American Chemical Society met for their 94th national meeting in September 1937. The *Abstracts* of the meeting listed authors and titles for 469 reports that were presented. The *Abstracts* of the 132nd meeting, held in September 1957, listed 1408 reports; the growth was 939 papers over the 20-year period.

A study of the list of periodicals abstracted by *Chemical Abstracts* shows that the 1926 edition reviewed a total of 1246 periodical titles. The American Chemical Society reports that over 9000 periodical titles were reviewed in 1960. This is an increase of more than 7700 titles in 34 years.

A U.S. Senate committee report (2) of 1960 states: "The science and technology collections of the Library of Congress have doubled approxi-

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Improving Scientific Communication

Reprints directly available from the publisher at a reasonable fee could supplement today's journals.

Jack Alan MacWatt

Alexis de Tocqueville (1805–59) wrote (1), "Americans of all ages, all conditions, and all dispositions constantly form associations." If anything is to be done in America, from constructing churches to sending "missionaries to the Antipodes . . . they form a society." This society framework aided

the early scientists by bringing them together at regular meetings to exchange ideas and by giving them regular publications for reports on new discoveries. The growth of these two factors in the last century has changed the scientist and his methods of communicating.

mately every twenty years for the past century and now number more than 1.5 million volumes of books and periodicals. Statistics from other sources indicate that research literature doubles every 8½ years. Figures relating to the growth of scientific journals in all disciplines reveal that the 1924 edition of the *World List of Scientific Periodicals* cited about 24,000 titles, the 1952 edition gave 50,000, and it is estimated that the total will reach 100,000 by 1979."

Effect of Increase

The old pattern of attending the meeting of a scientific society of one's choice and subscribing to its journal is no longer satisfactory. The scientist can no longer get complete coverage of the important reports in his field in this fashion. The U.S. Senate committee report (2) states, "More and more he [the scientist] is finding that discoveries and developments of great potential pertinence to his work may turn up in research areas far removed from his specialty." The field of organic chemistry has become so broad that in October of 1958 the editors of *Chemical Abstracts* subdivided section 10 ("Organic chemistry") into ten categories.

This refinement of scientific fields or areas of specialization brought with it an increase in the number of journals published. Therefore, the greater the number of journals available, the greater the number of references missed by scientists. The first solution developed for this problem might be termed the index-by-journal system. This was the reproduction of all the tables of contents of journals of interest to a specific science or profession.

In the early 1940's, the country's physicians were the first to be offered this type of assistance by the Friends of the Armed Forces Medical Library. This independent group provided funds to permit the library staff to arrange and reprint the tables of contents of the medical journals as they were received by the library. The tables of contents of journals were reset in a standard type and reduced in size to get a maximum number on a single page. The resulting publication, called *Current List of Medical Literature*, was first issued as a weekly in 1941. It grouped the journals in classes—anatomy, physiology, and so on—to permit

a rapid review by the physician of a field or fields of interest.

Another venture into indexing-by-journal was the *Guide to Russian Scientific Periodical Literature*, started in January 1948 by the library at Brookhaven National Laboratories in Upton, New York. This provided English translations of the tables of contents of Russian periodicals.

Contents in Advance was one of the first index-by-journal ventures that used a direct reproduction of the tables of contents as printed by the journals. This was produced experimentally by Eugene Garfield. In 1956 he prepared a service for management: twice a month contents pages from over 100 management periodicals were reproduced. *Current Contents*, contents pages from pharmacomedical journals, was started in 1958, and this weekly publication now reprints the tables of contents of 550 foreign and domestic periodicals, covering more than 125,000 scientific articles annually.

Since 1949 many librarians for research organizations have introduced indexing-by-journal for the scientific staff. The scientists were asking to see an ever-increasing number of journals from routine circulation lists. The longer these lists became, the less able the librarians were to satisfy reader demands for current information. It usually took at least a month for each journal on such a list to reach three readers, and duplicate subscriptions provided only partial relief. With routine circulation lists, each reader had to wait until the journal reached his desk before he discovered new articles of importance to his work.

Reproduction of the tables of contents (3) was the best way to get information about new papers in the literature to all scientists at the same time. Methods available for the reproduction of print, such as the Xerox, were used to transfer the actual table of contents from a journal to Multilith plates. The Multilith plates and the Multilith machine then provided enough copies of each contents page. On request, an individual received copies of all the contents pages reproduced in this manner. This service gave each scientist the same information at the same time, and it put all circulation on a "first-come-first-served" basis.

Surveys were sometimes made after such a service had been available for a year or more. The following comments were typical.

1) "I've seen a piece of apparatus that I'm interested in mentioned in a magazine which I ordinarily wouldn't look at. This apparatus had modifications that have proved helpful to us."

2) "Consider 'table of contents' service practically equivalent to literature assistant. Keeps me up to the minute with work of competing groups. Well worth all the effort put into it."

New Problem from New Service

The index-by-journal service, whether supplied by a professional association, a commercial enterprise, or the organization for which the scientist worked, filled the need for access to newly published material. Articles and reports in many fields were now available to the scientist for checking on a routine schedule while in his own laboratory, office, or home. He soon discovered through this indexing-by-journal service, that the society journals he subscribed to were not carrying all the articles he needed for his work. His reaction to this knowledge was to drop his subscriptions. According to Richard H. Belknap (4), "the *J.A.C.S.* [*Journal of the American Chemical Society*] in 1933 had 17,500 subscribers but in 1958 had only 15,600." This is in direct contrast to the trend of society membership: there were 17,645 members in 1933 and 88,806 in 1959.

This index-by-journal service pointed up the fact that for an individual scientist to subscribe to one or two journals was not enough. Dropping a subscription was a financial relief but no solution.

Solutions Suggested

Scientists were cutting down on their subscriptions in favor of other methods of securing the articles they needed. The development of new machines for the purpose of making reproductions quickly, usually of printed office forms or letters, and the advertising and publicity given these commercial ventures, were noticed by scientists. They projected the uses claimed for these machines to their own literature problems. If reproductions could be made in an office why couldn't they be made in a library? There was an increase in the number of requests for copying facilities in libraries, and a portable machine that a scientist could take directly to

a library for making his own copies was developed.

A need of this magnitude usually erupts in the form of criticisms and suggestions. One such suggestion was made by Rinehart S. Potts in a "letter to the editor" (5). He stated: "We have all noticed how certain trade magazines include a postpaid return card, bound in with the material. By using this a reader may request copies of literature or sometimes even reprints of the articles. I have not noticed any application of this to the more professional journals or abstract journals and would like to suggest consideration of this idea: that such a card be bound in with an abstract journal, and arrangements be made to send the requestor a copy or photocopy of the full article referred to by a given abstract."

The suggestion of a cooperative solution to the problem was made by Eugene Garfield (6). He recommended that publishers in the United States organize an association to administer a royalty system and to grant permission for the reproduction of articles from all scientific journals.

Commercial Answers

A problem in one field often has a counterpart in another. The need for copies of single articles was noted by publishers of management periodicals early in 1959. The *Management Guide* announced in that year that reprints of articles would be made available in a special cost-per-reprint basis, or in groups according to subject area. *Sales Meetings* announced in its issue of 18 September 1959: "Perforated pages—to make it easy to tear out articles—proved to be a boon to readers. Now we've gone one step further. We've eliminated staples in the binding so that the magazine now opens up flat. New slotted binding offers improved 'tear-out', too. (Try it. See how easy it is to tear out the articles you want to file or pass on.)"

Current Contents established a special tear-sheet service to make articles from any table of contents printed in *Current Contents* available by direct request. This "original article tear sheet," or OATS, request was originally filled by tearing the actual article from the original publication. When a second request for the same article was received from a second reader, the *Cur-*

rent Contents organization purchased a second copy of the journal from the publisher and sent tear sheets to the second reader.

The scientist now has access to bibliographic indexes that permit him to scan many publications. One such index was developed in 1960 and another has been promised for 1961. But when he needs a copy of a specific article from a specific journal he does not want to have long correspondence with the publisher in order to obtain it. The suggestions and the commercial trend point to the reprint as an answer.

New Problems

The increase that has occurred in the demand for reprints or copies of articles focused attention on the copyright question. Action on this question has been taken in Europe, where a German court case in 1955 (7) established that, under German copyright law, the reproduction of printed material for internal use by a corporation is illegal without permission of the copyright owner. An agreement reached between the Borsenverein des Deutschen Buchhandels and the Bundesverband der Deutschen Industrie provided that a higher subscription rate be paid if copies are to be made or that stamps be purchased and placed on separate copies as they are made. The Borsenverein sees to it that the authors and publishers get their share of the funds collected. No published analysis of the practicability of this system has appeared.

A reprint system as an alternative to the periodical system was the subject of a recent article by Ralph H. Phelps and John P. Herlin (8), who present a review of all the proposals made on this subject over the last decade. Phelps and Herlin report that objections to the idea of a reprint system have always been raised because such a system has been considered an attempt to change the present methods of scientific communication. The periodical system has too many basic advantages and too long a history to be tampered with at this time. No attempts have been made, according to these authors, to introduce a reprint service as a supplementary or additional service of the sort required by today's scientists.

The "working scientists cannot be bothered even to make a mark on a

form to get the paper they are interested in," says J. D. Bernal in discussing the reasons for the nonacceptance of a reprint system. In 1948, at the Royal Society Information Conference in London, he had suggested the use of reprints as an alternative to scientific periodicals for the communication of scientific information. He reversed his position on this matter in 1959 at the International Conference on Scientific Information, in Washington, D.C., in part for the reason given in the statement quoted.

Another obstacle is the fact that two of the groups that should be most concerned with this problem, librarians and publishers, have made no attempt to come up with a solution. The two groups got together at a rare roundtable discussion of general problems at the 1954 Cincinnati convention of the Special Libraries Association, but no representatives of the scientific press were on hand.

Conclusion

This is a new era, and the scientist of today is not working under the same conditions as the scientist of de Tocqueville's society. This is clearly stated in the recent *Outline of Long-Term Policy* of the Fédération Internationale de Documentation (9): "The problem of primary publication in science is becoming continually more aggravated as specialization proceeds. Many scientists, members of the appropriate learned society in their own country, receive its journal but are in fact interested in (and perhaps capable of understanding) only a small proportion of the papers it contains, while they do not receive directly contributions of immediate importance to them in a whole range of other journals published in other parts of the world."

The scientist has moved away from concern with a specific field of scientific interest in the direction of subject interest. A different type of access to scientific information is needed. The index-by-journal system was the tool that increased the scientist's ability to scan many journals. He was weaned away from the tradition of subscribing to one or two society journals. Through use of this scanning tool and of the newer ones introduced or announced in 1960, *Index Chemicus* and *Chemical Titles*, this trend of scanning by subject will be continued.

What are the chances of getting a reprint if you are interested? The chances are good if you are a manager, but if you are a scientist you must be patient. *Harvard Business Review* makes available reprints of any article in an issue for \$1, but the entire issue costs only \$2. *Chemical and Engineering News*, in its issue of 23 May 1960, announced the availability of reprints at a cost of 40 cents a copy; the complete issue costs 50 cents. *Dunn's Review* offers reprints for 20 or 30 cents a copy; the full issue costs 75 cents. These journals are not scientific, but their example points to a possible trend. Publishers of scientific journals may be able to utilize some of the new printing

methods to bring reprint costs more in line with economic reality.

It should be possible to set up, in the near future, a procedure whereby one can either subscribe to scientific journals on a yearly basis or purchase single articles at a unit price. Such a system would give scientists greater opportunity to select reading material on the basis of subject and would provide greater return for publishers. It would also make the new scanning tools more valuable by increasing the availability of items discovered in them. A meeting of publishers, librarians, and scientists should be called to consider this next step, so necessary for improved scientific communication.

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Science and the News

The Test Ban Hearings: Congress Presses for Kennedy's Decision

The Joint Committee on Atomic Energy held three days of hearings on the problem of detecting underground nuclear tests, which added nothing to hopes of reaching a solution of the problem. As happened in a similar set of hearings last year (*Science* 29 Apr. 1960), the testimony was dominated by evidence that even if the control system embodied in the draft treaty presented by the U.S. and the British were put into effect, it would not guarantee that there would be more than a modest possibility that any given violation would be detected and exposed. There seems to be no serious dispute on this point among the scientists who have worked on the problem. Neither of the two scientists who produced the greatest impact at last year's hearing appeared this time. At the earlier hearing Hans Bethe, of Cornell, argued vigorously in favor of going ahead with a treaty; Edward Teller, of the Livermore weapons laboratory, argued equally vigorously against the treaty. But the two men were in general agreement on the tech-

nical points involved, with Bethe, in effect, agreeing with Teller that the proposed control system could not, by itself, assure that a violation would be detected. The disagreement between the two men stemmed from broader considerations of national policy affecting the wisdom of striving for an agreement rather than from a dispute over the technical adequacy of the control system.

These broader considerations included such things as the value to the Russians (and hence the temptation) to attempt clandestine testing, and the importance of test-ban agreement as a step towards broader disarmament agreements.

This year's hearings drew less public attention, partly because both Teller and Bethe declined invitations to appear again, on the grounds that they were not closely familiar with the research that has been conducted since the earlier hearings. The essential point of the testimony of those who did appear was that as yet no major technical breakthrough had been made that would greatly simplify the problem of detecting tests.

On the political side, Arthur Dean, the chief American negotiator at Geneva, appeared at the closing session to outline what presumably is the Administration position. He reviewed the dismal course of the negotiations since they resumed last March. He said we were still prepared to sign the draft treaty we had offered, and that despite the technical testimony on the adequacy of the control mechanism, both British and American scientific advisers agreed that it would provide "reasonably adequate" controls, presumably when supplemented by intelligence from outside the technical system which would help decide which unidentified events should be investigated. Dean described how, after the Russian scientists had agreed on the need for a research program, including nuclear explosions, the Russian political leaders, after the summit collapse last spring, had overruled their scientific advisers and decided that the research program was not necessary after all; how the Russians had, since March, not only failed to offer any counterconcessions to the concessions included in the Western draft treaty on the number of inspections and other matters, but had backed down on agreements already reached, most notably through their new insistence on a veto over the administration of the control mechanism.

Dean, nevertheless, argued that the talks should continue, and that Project Vela, the Defense Department's detection research program, should be pushed. Dean stressed, as he has in private briefings with reporters in recent weeks, that there is always a pos-