Scientific Publishing

Its complex and restrictive economics are essential to understanding and evaluation.

Tinsley Crowder

Scientific publishing is essential to science, for the written word is still the basic means of communicating knowledge. Only through printed records can science avoid having to make the same discoveries over and over. No memory tube or magnetic tape can replace ink and paper.

Until I entered the field of scientific publishing I was under the impression that the writing of a book begins with an idea on the part of the future author or editor. I quickly learned that for scientific books this is the exception, not the rule. Involved as they are in research and teaching, scientists rarely get around to writing more than the essential journal articles, unless they are prodded by a publisher. Contrary to the opinion of nonwriters, the primary motivation of most authors and editors of books is neither money nor prestige, for the financial return on the time invested is negligible, and frequent journal articles bring greater prestige. Both the writing and the editing of books are, in the main, labors of love, motivated by a man's interest in his subject and his desire to contribute to his field. In many ways the relatively thankless task of gathering all the information on a subject into one place, with a full bibliography, is one of the greatest contributions a scientist can make to his field.

I make these points at the beginning, at the risk of being obvious, because they are essential premises in examining scientific publishing.

"Science" and Advertising

For 4 years my work was that of bringing advanced scientific books and journals to the attention of readers for whom they were intended. Although my work is now entirely in other fields, I still have enough interest in science to be deeply disturbed by the distortions which inspire such attacks as the one on *Science* made by Scott Nearing in *Monthly Review* (November 1963). The concluding paragraphs follow:

> On the yardstick basis, *Science,* like so many of its magazine contemporaries, has become a house-organ of United States advertisers, carrying enough reading matter to tempt the scientifically minded to thumb through the advertising refuse in search of pay dirt.
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> A journal dedicated to science still publishes articles, notes, and announcements of interest to scientists. This task, however, is quite incidental to its chief function—enabling the hucksters to bawl their profit-yielding wares into the ears of an incredibly patient and long-suffering public.

This attack is an extreme case, but it is an excellent starting point for examining the economics of scientific publishing, and most of the antagonisms against publishers which I have found among scientists are grounded in misconceptions concerning the costs involved. The view that the high prices of scientific books are evidence of opportunistic profiteering ignores the facts and complicates an already extraordinarily difficult operation.

In examining Nearing's charges, I have taken the 7 February issue of *Science,* which I chose completely at random, and have compared the relative amounts of advertising and editorial matter. After excluding the Reader's Service Cards, which are counted as four pages, and adding the four pages of the cover, I find that there are 120 full pages of space in the issue. In addition to the front cover, 74 pages are devoted to editorial material and 45 to advertisements. With the exception of the four center pages, there is no advertising from page 531 through page 598, the section in which the major articles appear. When these 68 pages are deducted from the total space, there remain 51 pages, 41 of advertising and 10 of editorial matter. Two of the editorial pages are the table of contents, two are letters, and one is an editorial. The other five pages of editorial matter are devoted to a continuation of the minutes and announcements of meetings and are spread from page 600 through page 621. Thus the major editorial material is almost entirely separated from the advertisements.

The advertisements are, by and large, informative and in good taste. One naively blares "BUY THIS," and one brightens the issue with a lovely lady holding up a nearly invisible plastic tube. Nearly all the others are without any "hard-sell" or "gimmick" aspects. They present their information positively, but respectfully, obviously aware that their audience is well informed and deliberate in making its decisions. Almost all of them urge the reader to request additional information, if he is interested.

Of the advertisements, 35½ pages are devoted to equipment and supplies, 15 of these covering measuring instruments of various types. Four and a half pages advertise books—40 different titles. One page is a "public relations" ad for a major industrial research laboratory, obviously intended to attract employees. One-third of a page is an index of advertisers. Two-thirds of another describes a nonprofit insurance group for teachers. One full page offers a highly specialized service. Two full pages are devoted to classified advertisements: five positions wanted, 18 positions open, six assistantships and fellowships open, one summer conference, one source for books and magazines, and two equipment and materials suppliers.

In no case has any advertisement been placed with an editorial illustration on the same or the facing page. No advertisement which does not have direct relevance to science or scientists has been included. In fact, the advertisements are so integrated with science that, if advertising were not allowed, the editorial coverage would have to be expanded to list sources of information on gas chromatography equipment, on recent changes that have been made in microscopes, and on what books will be published in the weeks ahead.

It is not necessary to defend *Science* against such an attack; the only effective defense is inherent in the maga-

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zine itself. No publication can indulge in the wish to be only editorial and remain alive. *Science,* in its role of promoting exchange of information on a broad basis, can serve its function only by maintaining a subscription price which makes it generally available. Without consulting any figures, I would guess that a subscription to *Science* would barely pay for the paper, postage, and handling of a year's issues, if for that. All of the costs of printing, of editing, and of other steps in production must be met from some other source. It must be recognized that the alternatives to carrying advertising are higher subscription rates, heavy subsidization, or discontinuation. When the advertising is as informative and pertinent as that in *Science*, carrying advertising seems the best choice.

Realism in Publishing Economics

Commercial publishers of scientific material have been facing economic reality for many years. This has brought them to the unavoidable conclusion that essential books must be published, whatever the necessary price. The only alternative is not to publish such books. In my own experience, publishers in other fields have been surprised, not that scientific books are so expensive, but that they have been published at all. In general, each book is priced to pay for itself, the publisher believing that the purchaser of one book should not be penalized to subsidize publication of a book in a more limited field. I know of one case in which the publisher, before publication, decreased a book's announced price by more than 20 percent when prepublication orders far exceeded expectation, but to make such a reduction after publication would penalize the first purchasers or involve the publisher in an impossible refund project.

The difference in financial point of view between the publisher and the scientific reader has lead to severe misunderstandings, as any publisher's representative who has tended a display of scientific books knows. I have stood proudly before a shelf of treatises, products of years of editorial struggle and coordination, which cost several times my yearly salary to produce and which are priced at a level that places recovery of the investment long after publication, only to be constantly rebuked about the price. If a publisher failed to face the realities of costs, such books could not be published at any price.

To explore the areas of cost in scientific publishing, let us take a hypothetical advanced treatise as an example, tracing it from inception to publication. The idea for this particular treatise originates with a house editor, one who works in the publisher's office. After preliminary discussion in that office, the idea is referred to one of the consulting editors, a scientist retained by the publisher for the evaluation of such ideas. The consulting editor agrees that this is a worthwhile project and suggests that the publisher discuss it with scientists A, B, C, and D, all of whom turn out to be too deeply involved in research to undertake such a project. The consulting editor then suggests E. He agrees in principle, but suggests B as a coeditor. After further consultation with B on the part of the publisher, and a strong entreaty to him from E, it is agreed, 18 months after the original suggestion was made, that the treatise will be edited jointly by B and E, with E taking care of all the editorial details of correspondence with authors and the publisher.

By this time the publisher has paid for the two or three trips his house editor has made in trying to arrange for editing of the work, and has agreed to pay the secretarial expenses of E. (If the publisher, and the purchasers of the completed treatise, are exceptionally fortunate, E is on the staff of a philanthropic institution which believes that the treatise will be enough of a contribution to warrant its meeting the cost of E's secretarial needs.)

Two years after the original idea was presented the publisher receives from B and E a full outline of the projected treatise. They estimate that it will require three volumes of 400 pages each, with roughly 20 articles to a volume. There will be, in all, 75 or 80 contributors. The publisher refers the outline to the consulting editor who recommended the editors, then returns it to E, gently suggesting changes in titles and prospective authors (on the advice of the consulting editor), cautioning that illustrations should be kept to a minimum, and urging the editors to get in touch with the prospective authors as soon as possible.

Confidently B and E invite their colleagues to contribute to the treatise, only to meet with the same difficulties the publisher faced in finding *them*. They also have special problems of their own, as when colleagues enthusiastically reply, eager to write on a research area on which someone else has already agreed to write, but not on the one for which they were asked. The editors thus have both too many and too few authors.

Meanwhile, the publisher has been busily prodding the editors. It has now been 2½ years since the project was undertaken and a full year since the publisher began paying E's secretarial expenses, yet not even the list of authors is complete. This is the stage at which the publisher gets ulcers, for some of the authors are already writing their chapters while authors for other chapters are yet to be found. The coordination of the manuscripts is threatened, and once the coordination is lost the expenses multiply. The publisher refuses to believe what his experience has taught him—that all treatises lose their coordination and become multiply expensive. In his dreams he remembers the rare work that has moved so smoothly that the neat, complete manuscript surprises him, the proof with only a few authors' alterations surprises him, and the finished book surprises him. In his imaginaton his shelves are lined with such books, and he conveys this picture to B and E as vivid reality.

However, the reality of their task is more stubborn. Despite all their efforts, key chapters still need authors, although other chapters are near completion. By the time authors are found for the remaining chapters, many manuscripts are already in the house, being copy-edited (checked for clarity and style and marked for the printer), and already getting out of date. The editors eagerly follow the progress of the final authors and receive their manuscripts with great relief, only to discover that one of the authors who was signed up earlier is in some remote corner of the earth doing an experiment which cannot be interrupted and which makes him unable to finish his manuscript in less than 3 months. After cablegrams and finally a transoceanic telephone call, the manuscript arrives, only 60 days later.

By this time 12 months or more have passed since the earliest of the manuscripts were written, so they require considerable rewriting. If the authors and the purchaser are fortunate, none of the manuscripts have yet been sent to the printer. However, it is more than likely that they are already in proof and that the proofs have been corrected. The enormous costs of making major changes at this stage leave the authors in the frustrating position of

trying to make their chapters up-to-date at the same time that they try to keep changes to a minimum. Finally, the book goes to page proof, only to be held up once more because of delay in the receipt of corrected galley proof from an author who has migrated with a cultural-exchange program.

When the first volume finally appears, 5 years or so after the idea first occurred, it consists of ten chapters, the other ten of the original outline having become volume 2. The publisher tries to believe that the original three volumes and the original 1200 pages will now be only six volumes and 2400 pages, but he really knows that by the time the final volumes are out, in another 2 to 5 years, the treatise will have grown to eight or nine volumes, and to 3000 to 4000 pages. Volumes 1 to 3 will already be in need of revision (this will be undertaken in supplement 1), and the publisher is already being rebuked by the reviewers for the price of the treatise. He, on the other hand, thinks of the 5 years during which he paid heavily for the treatise before volume 1 went on sale, and of the additional 4 years necessary to recover his investment. He is pleased that the reviewers regard the work as a classic (because of the editors and authors, and despite the publisher), but he wishes just one reviewer would point out the simple miracle of its having been published at all.

This is, of course, an oversimplified history of the publication of a treatise, but it is a true picture of the type of work involved and the problems encountered. The expense and labor involved are enormous, but the result may well be truly monumental.

The Elements of Cost

The costs of publishing a book are many, and they are by no means ended when the book appears. The purchaser tends to think in terms of the cost of the physical object plus profits—$8 for paper, ink, cloth, glue, the bookseller, the publisher, and the author. However, these items make up probably no more than half the price. Costs of editing, storage, rent, advertising, distribution, and ordering and billing make up the other half. The effects of these expenses on publishing costs are less controllable than the effects of the more obvious elements. The cost of paper and binding, for example, can be high or low, depending upon the requirements. The cost of editing, on the other hand, can be lowered only at the risk of lowering the essential value of the work.

Editing, expensive as it is, is one of the most important steps in bookmaking. In scientific publishing it is of unusual importance. Not only must a publisher have editors with whom a scientist can talk about his subject in depth and detail, he must also provide his authors with copy editors who understand the terminology and do not take up valuable time by raising insignificant questions. At some stage in copy editing each reference cited must be made to conform in style with the listings in *Chemical Abstracts* or some other standard—each journal abbreviation must be verified, discrepancies in citing an author's name must be corrected, and so on. The entire manuscript is checked for grammatical faults and ambiguities. The degree of care of his editorial and production staffs determines the significance of a publisher's name on a book.

In production—the actual manufacturing processes—the major costs of scientific books are incurred in setting type and in making halftones and linecuts for reproducing photographs and drawings, respectively. The more mathematical the book, the more it costs to set it in type. Insofar as possible, the type for books full of mathematical symbols and formulas is set outside the United States. Such books may also be printed outside the United States, but frequently they are printed in this country from plates prepared from photographs of the type set overseas, since shipping the completed books to the United States would take a number of weeks, whereas air-mailing proof of type, ready for photographic plating and printing, takes only a few hours. Advantageous as this method is, from the standpoint of cost, it is generally used only when the subject of the book is such that the additional delay which may result from working abroad is not of serious consequence.

It is entirely conceivable that the rate of growth in knowledge in some fields could keep a book perpetually in the proof stage, each set of revised proof having become outmoded by the time it is received by the author. It sometimes seems that this will happen even when the book is being produced by the most rapid means possible. I know of one work which contained a long chapter on a single enzyme whose structural formula was modified overnight, through the publication elsewhere of a short note, after the book was all but on press. This meant that 100 or 200 structural formulas in the chapter in question had to be redrawn, and new plates had to be made, while the other chapters aged.

This type of occurrence is far from rare in scientific publishing. It is especially likely to happen in works, like the hypothetical treatise described earlier, involving many authors. A delay in receiving one contribution may necessitate last-minute corrections in many others. These must be kept to a minimum to avoid additional delays. I find it ironical that reviewers so often praise the tardy author for the up-to-dateness of his contribution, criticizing his fellow authors for not having covered the literature during the period their articles sat in type awaiting his chapter.

Any such delay may considerably raise the price of the published book, mostly because of direct expenses resulting from the delay, but also because of the steady rise in book-manufacturing costs—any delay places the book higher on the steadily rising curve of costs. If a major delay occurs late in the production of the book, the publication date may already have been announced. As anyone familiar with the use of federal funds knows, orders under government funds must be canceled if the material cannot be shipped in the month specified. Similar cancellations occur under library purchases when funds cannot be carried from one fiscal period to another.

The cost of such cancellations is surprising. In highly specialized publishing houses the costs of processing an order, shipping the books, billing the purchaser, and receiving payment to be processed against the account make up a startlingly large part of the price of the book. Although exact costs are difficult to calculate for these operations, I know one scientific publisher who estimates the cost of billing procedures to be from $1.50 to $2 *per book sold*. These costs are high for scientific books because the books are sold, on the average, in such small quantities. The most time-consuming parts of the billing and shipping operations are not appreciably lengthened by the number of books in the order. The large number of orders for single copies of scientific books keeps the average cost of billing procedures per copy unusually high.

Publishers of specialized books try in various ways to keep the billing cost per book low. One such means is energetic competition for college-textbook

manuscripts, since textbooks sell in far higher average quantities per order. Another is increased emphasis on bookstore sales. In several cases, publishers of specialized books have merged with publishers whose books in more general areas sell in larger quantities. The advantage to the publisher whose sales volume is small is obvious. The larger publisher finds it advantageous to have a greater number of titles at all levels in various fields. For him there is little additional cost involved in having his bookstore salesmen represent more titles, salesmen that the publisher of specialized books could not afford.

In a very real sense, increased bookstore sales are becoming essential to the vitality of scientific publishing in the United States. In Europe and other parts of the world most purchases of scientific books are through local booksellers, rather than directly from the publishers. The purchaser is thus able to order all books, regardless of publisher, from the same source. This method lowers costs to the publisher, and scientists can benefit from the services a bookstore can give but a publisher cannot give. The bookseller is close at hand, knows the individual requirements of his customers, and will adjust his stock to suit his clientele. He can take special orders, locate any title that is in print, and keep scientists informed of new and forthcoming works in their fields, for he frequently has information in advance.

Myths and Misconceptions

Probably the greatest myth concerning publishing is the idea that issuing a book as a paperback automatically makes it cheaper. In truth, the binding of a 500-page volume in fine cloth covers, in the quantities in which scientific books are published, costs 50 to 75 cents, and the cost of binding it in paper covers is not appreciably less. A saving of the entire cost of binding would have little effect on the book's price. To be successful, a paperback must sell in fairly large quantities. The average edition of advanced scientific books is 2500 to 3000 copies; thus, to issue such works originally in paper covers would be unrealistic—a hardbound book at $17 would not be a bargain in paperback at $16.

By and large, it is only in reprinting an existing book as a paperback that savings are possible: the costs of editing and typesetting are eliminated, and costs for binding and paper are decreased. If the copyright has expired, the book is in the public domain and no royalties need be paid. These savings are most dramatically evident in the "pirated" editions produced mainly in the Far East. The "pirateer" chooses books for which there is a known demand, capitalizes on the international advertising of the original publisher, and issues the book at a fraction of the original selling price. Even at his price, he is able to pocket a large profit—no royalties, no staff of copy editors, no advertising, a small investment, no typesetting, no adviser's fees, and no financing of expensive new works. I would make a rough guess that the pirateer's profit is equal to the profit of the original publisher, and the latter must take his reinvestment capital from this small amount. It is a fact that each sale of a pirated scientific book works to the detriment of science as a whole.

The profit myth is equally false. There are no large profits for anyone —publisher, author, or bookseller—in publishing of any kind, except in the case of the rare bestseller. One editor pointed out to me that in a recent year profits from *all* trade books (hardcover books published for general distribution through booksellers) totaled less than the advertising budget of one major soap manufacturer. A publisher makes a profit, but if profit were his only motive he would certainly choose another field. He is a businessman, but he is also a publisher, a man with a devotion to his work and his publications. Publishing is still a field that attracts idealists, for starting salaries are too low to attract anyone interested primarily in economic status. If starting salaries for college graduates in scientific publishing were to be increased to the level of starting salaries in the sciences, the average price of scientific books would dramatically increase. And if idealism were measured solely in earnings, publishing would be rated among the most idealistic fields.

Current Developments

Much present and future progress in the production of scientific books is, or will be, based on offset printing. Letterpress printing is an impression process, ink being pressed onto the paper by metal type or plates. In letterpress work, fine-screen halftones, necessary for such illustrations as electron photomicrographs, fill with ink and must be cleaned after every few hundred impressions. This uses up expensive printing time. In offset printing, both type and illustrations are photographically reproduced on an inexpensive plate, so treated that its surface rejects ink except where the image appears. This plate is then placed around the roller on the offset press. During each rotation of the roller the plate is coated with ink, which is then transferred (offset) onto another roller, then onto the paper. Offset printing is a contact process rather than a pressure process, and consequently it is rapid. There is no appreciable pressure to force ink into the minute spaces of halftones, hence washing of the plates is largely eliminated.

Offset printing has made reproduction of photographs far simpler than it used to be, and in many cases books and journals are quickly and inexpensively reproduced by photographing typed manuscripts exactly as they are submitted. This practice assures rapid publication but provides no means of eliminating inconsistencies and repetitions that are usually eliminated before publication in carefully copy-edited material—a disadvantage in printing reference works and other books intended for long-term use.

In order to take full advantage of the economies offered by offset printing it will be necessary, also, to eliminate the steps of setting the text in metal type, then printing sharp impressions to be photographed. The development of processes for reproducing type images on photographic paper (photosetting) holds great promise of eliminating metal type for some kinds of publications. Photosetting produces an exact photographic image of the type, ready for offset plating immediately, at a saving in time and material. Moreover, the photosetter reproduces any image. When scientific material is set in metal type, the constant creation of new scientific symbols is a significant problem. A matrix, or mold, must be cut and the type reproduced from it, or else, in the offset process, each symbol must be drawn or pasted in before plating. One carefully prepared symbol can be inserted in the photosetter and reproduced as often as required.

Photosetting is still under development, and there will undoubtedly be many problems to be solved before it is fully usable. But with the cooperation

of such organizations as the American Mathematical Society, now actively engaged in developing photosetting techniques for reproducing mathematical material, these problems will be eliminated and photosetting will become a standard process. Ten years ago offset printing was, at best, a substitute for good letterpress work. Now many of the most exacting scientific works are printed handsomely by offset. Photosetting undoubtedly will develop as competently.

Scientists and Scientific Publishing

The course of scientific publishing remains in the hands of scientists, rather than of publishers. No publisher can do more than follow the lead of science—a good publisher quickly, a lesser one more slowly. There is great appreciation among scientists for individual publications, for which the author is justly praised, but there is generally little awareness of differences between publishers. Yet the publisher constantly sends out advertising brochures, and these provide the best means of learning not only about his subject matter but also about his attitudes toward his audience.

Essential advertising is a great expense. Whatever a conscientious publisher advertises to a scientist, whether by mail or in journals, he has chosen because he expects it will be of at least secondary interest to the scientist. In mail advertising he may sometimes add information on a book of peripheral interest simply because it costs him hardly more to mail it than to keep it, because of the complex economics of printing and mailing, and he believes it will be of at least secondary interest to the scientist. Sometimes one individual may receive two or three copies of the same material through the mail. This means simply that the publisher is doing a good job and has gotten the recipient's name from several sources. Checking the lists for duplication, if this is even possible, is a hand operation that is far more expensive than mailing in duplicate.

Publishers differ widely, obviously, in subject matter, more subtly in price and quality. The only way meaningfully to compare pricing practices between publishers is by the cost-per-page for books on the same level and of approximately the same size. As the length of a book increases, the increase in price reflects not only the greater cost of producing it but also the decrease in sales which higher prices bring about. Yet the publisher faces a real dilemma; either he must publish two-volume works at a lower price per volume or single volumes at a very high price but a lower total cost to the reader.

The costs of publishing, and therefore the price of books, will continue to rise indefinitely. Private contributions toward publication costs may make individual books cheaper, but only in isolated cases. I know of one book, one that required many pages of electron photomicrographs, for which the cost of making the plates was supported by a scientific organization. The result was "exemplary" and "superb," as judged by the reviewers. In another instance the authors' employer made a contribution toward the costs of nearly 800 plates in a book on neurology. In both cases prohibitively high selling prices were avoided by the serious interest of generous organizations.

The cost battle is constant. The most that can be accomplished is a slowing of the pace of cost increase. Irritation with publishers over these increases is usually unjustified, for they are caught in price cycles over which they have regrettably little control.

The interaction between science and scientific publishing is dynamic, constantly changing to meet the requirements of new fields and new areas of study. Publishers are dependent upon science for the material they publish, and science is dependent upon the printed record of its accomplishments. But scientific publishers are much more than mere recorders. The dissemination of knowledge is the purpose of its being recorded. Only through his efforts to make his publications known can a publisher fulfill his role in the spread of knowledge. Thus, some of the most important information a scientist receives may well be in publishers' announcements.

In the dissemination of information about books scientific organizations can be of great importance. Reviews of new books are not enough, for seldom is a book reviewed earlier than 6 months after it is published, and usually the reviews appear between 9 and 12 months after publication. Organizations that permit the use of their membership lists for the publicizing of books perform a real service to the progress of science. Most groups permit the mailing of approved material to their members, but a few allow no mailings of any kind, or they charge prohibitively for such use of their membership lists. When publishers have to pay unusually high prices for mailing lists, they must consider the excessive cost of reaching scientists in such fields and adjust the prices of their books accordingly.

Since the advance of science is so closely interwoven with the viability of scientific publishing, a critical understanding of publishers on the part of scientists can be of great significance to the future of both science and publishing. I hope this brief and necessarily limited description of scientific publishing, its outlooks, and its problems will be of some use to scientists in evaluating individual publishers and their contributions to science.