

The Comprehensive Review Article in 2000

As one of the members of the Editorial Advisory Board for *Chemical Reviews*, I was approached by Josef Michl in the spring of 1999, asking me to share some of my own thoughts about the future of review journals. I immediately replied that I could not possibly find the time this year to do so. But as anyone who knows Josef is well aware, he is a person to whom it is extremely difficult to say no, and I have only rarely been able (or willing) to do so on chemical topics, whether the request was posed as a next-door colleague or by e-mail request from wherever he was pursuing science anywhere around the world. Besides, I was reminded of an excuse once offered to me when I served as a Senior Editor of the *Journal of the American Chemical Society* and had asked a prominent chemist to act as a referee for a submitted manuscript. The response I received from his secretary was the "Professor X is simultaneously traveling in Great Britain and in France and is obviously stretched too far to take on this task". Not even I am stretched that far, so what follows are a few thoughts jotted down in the waning months of the last year before the millennium.

It is a good bet that spectacular advances in information technology will revolutionize scholarship more significantly than did the invention of the printing press in 1455. Exemplified by Internet communication and by facile access to software for sorting and searching published work, the new access to a broad range of information will undoubtedly change the way research is conducted and may alter significantly the way students learn. These tools will dramatically increase the proportion of our lives during which formal education takes place, with lifelong learning becoming the norm rather than the exception. The accelerating pace of innovation occurring as a consequence of global information exchange will also challenge the way scientists process information and how they attain access to colleagues' data, whether collaboratively or competitively.

The "information age" has provided exponential growth in accessibility to data of all types and in current trends for knowledge generation in complex systems. It is likely that this information overload will make the need to order and sort the available data correspondingly more important. In that environment, aids to synthesizing and critically evaluating the connections between directly or even peripherally related experiments will increase rather than decrease in importance. A focus on integration of related work across time, across national boundaries, and across chemical structure types that has long been the hallmark of the chemistry review literature will therefore continue to be highly valued.

It is indeed appropriate under these circumstances to think deeply about the future of review journals that specialize in scientific reviews. For years they have served the chemical community very well.

Numerous surveys have shown that review journals now enjoy among the highest per-publication citation rates of any scientific journals, an observation that implies broad readership and apparent usefulness. But prudent planning for the next generation's needs is necessary, of course, as we continue to develop and archive the science that will form the basis for our successor's discoveries.

There are those who argue that the increasing ease of literature searching by the more frequent use of Internet protocols makes the scientific review irrelevant. This argument, however, overlooks the crucial contribution of a well-written review. Besides providing a new encyclopedic compilation of the recent literature relevant to a scientific topic (a feature that sometimes can be duplicated by a well-defined computer search), the structure of the review defines the search parameters and provides a much more cogent coverage of work on related compounds whose similarities might not be so obvious to structural search engines. A good review will also provide a critical evaluation of a subject and discuss topics that are crucial to a fundamental understanding of the chosen subject but that may not be accessible by computer searching because of limitations on access to descriptive keywords. It's also likely that a clever reviewer will see connections between published works that would be missed by a computer, particularly if they originate in different subdisciplines.

Two styles of reviews have emerged in the post-WWII years: the comprehensive review and the individual investigator review. Among journals published by the American Chemical Society, these are exemplified, respectively, by *Chemical Reviews* and *Accounts of Chemical Research*. Unlike the encyclopedic list of references whose thoroughness is the basis of a key evaluation criterion for *Chemical Reviews*, articles in *Accounts of Chemical Research* are length-restricted and focus on the intellectual contributions of a specific contributing author who seeks to place his or her work into context. A major review criterion for such articles is whether a fair and balanced presentation has been attained by reference to other contributors to that topic. This balance is achieved automatically in a comprehensive review that adequately discusses the relevant literature and illustrates the contrasting contributions from various groups.

Both types of articles are important. I cannot imagine organizing an international scientific conference on an area described by a thematic issue of *Chemical Reviews* without thoroughly surveying the contributions cited. But equally, the personal article provides an illuminating context within which to view and understand the aspirations and scientific motivations of one's scientific friends and colleagues. Neither goal can be easily duplicated by an Internet search.

Whether comprehensive or individual, the scientific review provides the contributing author a unique chance to explain a specific field in relationship to broader questions in science. This opportunity must be a compelling one, for the world's most highly cited review journals (among them *Chemical Reviews*) typically have a scheduled backlog of many months in order to accommodate publication of the best of the proposals submitted for reviews. This backlog is a particularly telling evaluation of the review, because a contributing author writes a review only with his or her eyes wide open, understanding that the writing and library research will consume hundreds of hours, as any published review author can attest. The willingness of authors to undertake such a Herculean task for *Chemical Reviews* also argues for the respect enjoyed by this journal and its editors, as well as for the persuasiveness of the dedicated guest editors.

In choosing a topic for review, a prospective author makes a major intellectual contribution. He or she must evaluate for himself or herself a range of key questions: whether the field is sufficiently innovative to attract a readership and to stimulate future experiments; whether the subject area bears relationship to a broad range of chemistry rather than to a narrow niche; whether the coverage will provide enduring value and insight into new scientific possibilities; whether the defined breadth of the article provides an adequate overview but still sufficient depth to illustrate the sophistication of key contributing works; whether the chosen topic bears intuitively on related topics that might profitably be combined in a typical issue; and, indeed, whether the article can make claim to being a definitive snapshot of the basic science undergirding the topic being reviewed.

Indeed, the organization each year of several issues of *Chemical Reviews* to focus on one topical area of current chemistry has been an important contribution of the journal. The selection of thematic issues has been the subject for lively discussions among the Editorial Advisory Board (at least over the entire period during which I have been privileged to serve *Chemical Reviews* in that capacity), and I can truthfully say that these conversations have been extremely informative in providing each participant with a greater appreciation of the pioneering work being done outside one's own field. It is beyond my imagination to conceive that this task could ever be handled adequately by even the best of the scientific search services. The thematic issues also provide a concise monograph at a very low cost. As such, these special issues have often served as the basis for graduate-level special topics courses.

Another reason for the importance of the comprehensive review is the current tendency to publish short articles in specialized journals. The rapid proliferation in the number of short articles and communications appears to be driven both by perceived standards of quantitative accountability for career advancement at research-intensive (and other) universities and by what can only be described as greed by some (not a majority) of commercial publishers. Whatever the reason, the result is the same:

a larger number of shorter, less comprehensive publications in a wider array of journals. Indeed, this proliferation has been so acute that many universities are actively encouraging junior faculty to submit a small number of their best (more substantive) articles as the basis for promotion and academic advancement. Sadly, however, the prevailing tendency toward "thin-sliced science", the so-called "salami science", seems to retain its stronghold over publishing customs. So long as Communications to the Editor or the strictly length-defined short articles of the general scientific journals such as *Science* or *Nature* are perceived as representing the highest standards for quality within the scientific community, it seems likely that similar proliferation will continue.

If it does, it carries important consequences for scientists. First, short communications published in highly specialized journals will often be invisible to those outside that specialty. These may be precisely those people who would benefit most by thinking more broadly of the place their own work occupies within the spectrum of the study of nature. Second, the highly specialized journals are expensive and fail to attract a sufficiently numerous readership for most local libraries to justify subscription. When budget cuts come, wise librarians select these journals for termination, with the consequent effect being that some faculty do not have access to the range of journals in which they themselves publish. These faculty may, in fact, have never seen their own published work apart from reprints they have purchased. Third, the inaccessibility of these specialized journals is a particular problem in developing nations, where library budgets are even more constricted than in a typical university library in an industrialized nation. Finally, the rapid proliferation of short articles published in multiple venues makes it virtually impossible for even the most dedicated scientist to keep up. This failure to embrace up-to-the-minute mastery of one's own field by a thorough reading of the relevant literature exerts a highly negative effect, I believe, on the standards and work ethic of our current student apprentices. Great review literature, on the other hand, could at least partially compensate for these publication trends.

Thus, I believe scientific reviews to be even more important now than in the last several decades. It is possible that the future will include breathtaking advances in artificial intelligence that will allow for such efficient data mining and such precise information processing that a summary of a quality equal or superior to a well-written scientific review may result. However, I do not expect to see that achievement in my lifetime, given the still elementary level of practical artificial intelligence so far attained. So I will place my bet on *Chemical Reviews* for the remainder of my productive scientific years. *Chemical Reviews* is a primary source for concise but comprehensive reports on the status of emerging areas of chemistry at a very affordable price.

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