Is the literature about to be readable?

Dissatisfaction with the standard of today's scientific literature is rife. It does not follow that change will happen, but only that it might.

If the scientific literature is indeed the chief way of setting and maintaining professional standards in science, there is at least a chance that beneficial changes are on the way. The article by J. D. Watson and F. H. C. Crick on the structure of DNA, which appeared in *Nature* in 1953, would probably not now be publishable. That article occupied just over half a printed page. While there are references to other work on the storage of genetic information, the suggestion that it must be DNA emerges like a rabbit from a hat. There is no substantial discussion of the implications of the proposal, merely the now-famous sentence: "It has not escaped our notice that the specific pairing we have postulated immediately suggests a possible copying mechanism for the genetic material" (*Nature* **171**, 737–738; 1953). Today's referees would have clamoured for a fuller account of the reasons for considering the proposed structure seriously and an account of the implications.

The reasons why the conventions of the scientific literature have so radically changed are well-known, as are the consequences. Most scientific communications have the same ingredients. Authors describe their problem and discuss its antecedents, give the rationale for their own attack on the problem and the techniques which they have used and finally discuss the significance of the results. There are, of course, many minor variations on the theme; experimental details may be printed separately from the rest of the text, or appear as figure legends. But the general architecture of a paper is constant.

Or, at least, it has been. There are now signs of discontent with the literature as it is. The sheer bulk of it is not what matters most; it matters more that the literature may not be suited to its purpose. The prospect for change may now be brighter than for decades.

While electronics will have an important influence on the speed and efficiency of publication, electronics and computer technology are not the central issues. For while there are certain to be some fully electronic journals which can be read only by sitting at a keyboard, most of the literature is likely to remain for a long time as ink on paper. People like to see what they have done; an accession number from a data-bank is not a sufficient substitute.

Meanwhile, it is likely that the changes (if any) that come about will consist of a

reordering of the priority at present attached to the conflicting functions of the literature, which are several. Thus the published literature is a kind of record of the accumulation of discovery from which, for example, historians may reconstruct the development of innovation. The literature is also a means by which those who would make use of science can gain access to original research, although most technology transfer of this kind entails the use of specialized magazines or trade journals. But there are strictly peripheral functions. The published literature is the means by which the research profession's scepticism is brought to bear on new developments, helping to tell the wheat from the chaff; the claim is undoubtedly correct, but would be more easily accepted if the process were more explicit.

None of this explains why the format of the standard scientific article is what has now become conventional. Historians, for example, would prefer detail of a different kind, those concerned with the application of science would prefer that the literature should be more intelligible, and so on. But the more substantial reason why the literature is in its present form is that the research profession, like other scholarly professions, but more so, has come to rely on the published literature for the continued setting and maintenance of professional standards. Bibliographies are a prominent part of job and promotion applications, while a published 'track record' helps in telling which applications for research grants will succeed.

Researcher's assessments of each others' qualities rest, in the last resort, on the published record. Naturally, there are other ways in which the same job might be done; engineers, physicians and the like have professional associations for setting and maintaining standards, for example. In science, where surprising innovation from unexpected sources is welcomed, the use of the published literature for this purpose makes more sense, but also gives it its distinctive characteristics and makes it hard to read.

This is why referees so often give authors a hard time and usually do so gladly, even though theirs is the most thankless of all tasks. In a profession which is necessarily elitist, paying close attention to the quality of what others do is plainly a professional task transcending particular questions of which articles

should be published in which journals. This is the spirit in which referees demand that references to earlier work should be fair (whatever that may mean) and that authors should be restrained in canvassing the implications of their work: unbridled speculation is a means of laying claim to all kinds of ideas not directly suggested by the data gathered.

Sadly, these are precisely the points on which the contradictions of the literature are most clamant. Speculation of the kind that referees dislike may nevertheless help enormously to define an author's long-term objectives or to explain why he set about his task in a particular way. Detailed accounts of experiments, necessary so that others can set about the repetition of published work (but rarely quite sufficient), are not often the details that most users of the literature would wish to have. And the literature would be written differently, and more palatably, if its function in setting standards was not as dominant as it has become.

The signs that changes may be under way are, admittedly, only straws in the wind. Some appointments committees in the United States have begun limiting the allowable size of a candidate's bibliography. There is also a growing uneasiness that the literature may sometimes be manipulated, especially in relation to the assessment of attainment, illustrated by the several cases of fraud brought to light in the United States during the past few years.

There are also more substantial considerations working for reform, one of which is the huge amount of data now unpublished in any formal sense, in fields as different as geophysics and the projects for collecting the nucleotide sequences of genes. Can the long-term interests of the process of discovery be properly served if the bulk of this data remains unanalysed and unpublished because of the convention that the Minimum Publishable Unit should include at least an attempt to make sense of some problem in science. The fact that, in other fields, preprints have replaced the published literature as means of communications is another sign of the pressure on the present system.

Luckily, these are all fields in which electronics may provide both solutions and new opportunities. Whether the literature will ever fully revert to its literary purposes is, of course, another matter.

John Maddox