Communicating Research — Past, Present and Future

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Editor's note: *Professor Meadows' inaugural lecture, which has never previously been published, provides fascinating insights into the process of communicating research. Although it was delivered in 1989 it remains relevant to all those in the information chain.*

HOW researchers communicate with each other can be studied from a variety of viewpoints — sociological, psychological, etc. I looked at the topic initially from an historical viewpoint and, although I hope I now take a wider view, historical factors still seem to me to be more important than is generally realised.

My interest in this area started when I was a research student. I was then already fascinated by the history of science and, in between reading contemporary research papers, I used to glance back at much older material. One day, in a chemistry journal published just before the First World War, I came across the following words about research journals:

> "(There is) a plethora of commercial publications; these doubtless find sufficient sale to justify their production, owing to the large number of libraries which are practically forced to subscribe to them. Little discrimination seems to be exercised in choice of matter and diffuse writing is not only permitted but encouraged."

The interest for me was that these complaints seemed identical with what was frequently being said to me over coffee half a century later by my elders and betters. Did this simply reflect the typical grouses of an older generation, or was there more to it than that? Illumination dawned when I went to the United States for a couple of years after receiving my doctorate. There I came

across Derek Price, an historian of science at Yale University, who was working on the growth of science. What he had found was that the number of scientific research journals published had grown more or less exponentially with time from the seventeenth century to the mid-twentieth century.

This immediately cast light on contemporary researchers' responses to the literature; for it meant that the rate of expansion in journal titles before the First World War was much the same as post-Second World War, even though the total number of journals in existence differed at the two times. Price, himself, was more concerned with another implication of this growth. More journals meant more research papers, which meant, in turn, more researchers; and, indeed, the data did seem to indicate that a roughly exponential growth in number of research workers had also occurred. Price pointed out that the growth was now such that, if maintained, everyone in the world would have to be involved in research in the twenty-first century. This meant, in practice, that, during the last decades of the present century, growth in number of researchers, and so in amount of research, would have to slow down.

Parkinson's Law

Derek Price was not the only person I met in the USA: another was C. Northcote Parkinson. This was about the time that Parkinson's Law was first enunciated:

> "Work expands so as to fill the time available for its completion."

Parkinson was effectively saying that growth in

numbers does not necessarily imply higher quality of work. It was only some time later that I discovered that both Price's work and Parkinson's Law derived from the same event. They had both been lecturers at the University of Malaya after the Second World War, where one of the few lengthy runs of periodicals had been the Philosophical Transactions. It was in contemplating and discussing together the way this journal had expanded with time that they were led to their separate ideas.

For me, Price and Parkinson (and others whom I met then or a little later) opened up a prospect on how to study research and, more especially, the communication of research. It seemed to me that, using the research paper as the basic object of study, it should be possible to study the communication of research in terms both of quantity and quality. One type of approach was clearly historical. Early research journals derived partly from the exchange of letters and partly from the example of newspaper publishing. A detailed study of the development of research journals shows how they progressed from these relatively disorganised beginnings to the highly formalised structure of today. The important deduction is that this structure has been imposed by the research community to serve its needs. For example, the date of submission came to be added to research papers in order to reduce controversy over claims of priority.

Sir Peter Medwar was wont to call the research paper a fraud, because its presentation of material did not correspond to the way in which the research had been carried out. He was wrong. Research papers are not meant to reflect the research process in detail; they are stylised representations intended for particular purposes. One of these purposes is the rapid communication of information. This may sound rather odd, since it is easy to show that many research papers are highly unreadable by ordinary standards. But the important question is whether information can be acquired rapidly by skimming, and for this purpose, especially where

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the material is in a foreign language, research papers are well designed.

Information Titles

If we accept that the structure of research papers is a reflection of community needs, it follows that a study of the various components making up the structure may shed light on the activities of the community. The first component of any paper is the title, and this is, of course, one of the key elements in the retrieval of published papers. Since the

Average number of words per title for papers in each journal and year indicated			
Title		**Year**	
	1947	**1962**	**1973**
Lancet	6.2	8.2	9.0
Journal of Organic Chemistry	7.2	7.4	10.2
Economica	6.7	7.4	8.9
Philosophy	4.8	5.0	4.5

Second World War, the information content of the titles of research papers has increased appreciably in a number of subjects — basically in those where the number of papers in circulation is the greatest. One can see this as a response by authors,

conscious or not, to try and elevate their papers above an increasingly 'noisy' retrieval level. That researchers recognise the increasing problem of tracking down information is suggested by a recent study carried out by John Martyn (currently a Senior Visiting Fellow in my department). He compared data from the mid-1960s with a similar survey in the mid-1980s, and showed both that use of various retrieval techniques had increased over the twenty-year period and that researchers were now, on average, consulting more papers than hitherto in preparing their own papers.

Growth in information-seeking activities

Activity	Percentage involved	
	Mid-1960s	Mid -1980s
Follow up references cited in relevant articles	80	96
Reading current publications	77	95
Use of abstracts journals	58	68
Use of personal index	47	54
Use of library catalogue	10	31
Search by librarian/information officer	8	24

Number of documents required before start of research project

Number	Percentage involved	
	Mid -1960s	Mid-1980s
Half -a -dozen	40	28
A dozen	39	38
Twenty	10	22
More than twenty	11	13

Easily the most analysed component of research papers, however, has been their end rather than their beginning. Detailed examination of the references appended to most research papers has produced the now extensive research field of citation studies. One of the first pieces of work I did back in the 1960s was in this area — looking at the way in which citations from a number of papers, all published in a single journal, varied according to the age of the cited journal. If the research literature is expanding exponentially, then there should be far fewer references to older literature, because there is much less older

literature to cite. This is, indeed, true, but it turned out on examination that rapidly growing research areas could be distinguished by the fact that they cited older literature even less than exponential growth would suggest. This use of citations to try and determine something about the nature of different research fields has mushroomed since those early days. Computer analysis of citations now makes it possible to study links between different research areas, and to look for trends in the overall development of research with time.

Currently, the most discussed aspect of citation analysis is its application to the research publications of individual researchers or departments. In fact, this micro-scale type of study has long been recognised to be particularly fraught with danger. Gene Garfield, who has been directly or indirectly responsible for much of the work on citations, has made the point concisely:

> **"Citation frequency is a measure of research activity, or of communication about research activity. In itself, the number of citations of a man's work is no measure of significance."**

Despite this, it is clear that citing another researcher's work does often carry some imputation of value. For example, Darwin's Origin of Species is not only still cited frequently: the frequency of citation has actually risen appreciably over the past twenty years. This must surely say something about the ability the book still has to generate debate.

It is also only fair to ask how reliable other measures of research quality are. The refereeing of research papers began to become organised on a more regular basis in the nineteenth century. Again, this can be seen as a response to pressures acting on the research community, due not least to the growing number of people who wish to publish papers. Many journals make a habit of sending out submitted papers to two referees simultaneously. By comparing their assessments, it is possible to obtain some measure of how well independent experts agree on the quality of the research. It turns out that in some research fields the agreement is good, but, in others, the agreement is only slightly

better than would be obtained by chance, if each referee simply span a coin. In these latter fields at least, peer judgement may be as open to question as citation analysis. (This is the reason, of course, why current attempts to evaluate 'excellence' typically depend on a basket of indicators).

Degree of concurrence between pairs of referees

Subject	Frequency of Agreement
Physical Science	93%
Social Science	73%
Biomedical Science	70%

(Perfect agreement = 100%; chance agreement = 50%)

Sections of papers read by researchers

Section	Read by
Abstract	76%
Discussion	39%
Introduction	32%
Graphics	30%

Between the title and the references, research papers are typically structured into a number of sections (introduction, methodology, etc) and components (graphics, tabular material, etc). Very few researchers read a paper in its entirety. Most glance at a restricted range of the sections and components. For example, in one test we carried out a few years ago, three-quarters of the readers who decided to examine a particular paper looked at the abstract; a third went on to read the introduction, with a lesser number looking at other sections. The actual appearance of journals in times past has not always been designed to help readers. For example, the abstract was often set in type which was, if anything, less legible than the type used for the main body of the text, despite the greater importance of the abstract for most readers. Modern journal design is increasingly coming to terms with the actual habits of researchers. For the last couple of years, I have been one of the judges for an award which goes to the journal with the best typography and layout. The journal designs now appearing accord more closely with the needs of researchers, who are trying to 'gut' papers as rapidly as possible.

So far, I have talked as though all research literature consists of print-on-paper. Increasingly nowadays, opportunities occur to display research information on computer screens. This leads immediately to the query — can what has been learned from printed journals apply to electronic journals? The topic interests a number of departments at Loughborough. I suppose it first concerned me back in Leicester, when my colleagues and I were involved in setting up a bulletin board for humanities researchers. The answer can be summarised, rather unilluminatingly, as being that some things can be translated and some cannot. But, in a sense, the more important question lies deeper — can information technology accommodate the requirements of the research community, or must the latter change? At the moment, it seems that the research community is prepared to use the computer screen for informal handling of research information, because this fits in with its mores.

Looking towards the future, it is obviously this impact of information technology on the reseach community that raises the most intriguing questions. Looking backwards, it is easy to see that information technology has gradually been working its way into the whole research process for some time. In the 1960s and 1970s, relevant IT developments concentrated especially on the area of information retrieval. During the 1970s and 1980s, the field of communication between researchers had been opened up. Now, in the late 1980s and into the 1990s, the role of IT in helping researchers develop ideas and organise their work is coming to the fore. All of which raises a final query. Derek Price's prediction that research would run into serious problems in the latter years of the present century was based on the assumption that research productivity would remain constant (or even, on the Parkinsonian viewpoint, decline). In principle, a greater use of IT should lead to enhanced productivity, and so delay the time when research growth tails off. The question for the next decade will be whether IT can, indeed, produce the efficiency increases needed to do this. ❑