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EDITORIAL

Science, scientists and scientometrics

Some thirty years ago when I had just begun a research career at the Indian Institute of Science (IISc), the library followed the practice of displaying the week's new journals on Friday afternoons. The most eagerly awaited arrival would be the copy of *Current Contents* (*CC*), already fragmented by discipline. *CC* Life sciences which had the largest readership was jealously guarded by staff at the counter; readers signing for its issue, before spiriting it away to a quiet corner to get a quick glimpse of the title pages of the world's science journals. Notebooks and reprint request cards were always in evidence, as the journals would arrive only several months later; attractive stamps on a request card might induce authors, with a philatelic bent of mind, to send copies of their papers by airmail. This was the era before xerox machines, e-mail, fax and the Internet. Networks and networking were words which were still to enter everyday use. Even as I waited, weekly, for my turn at *CC*, I must confess that the title pages of journals interested me only marginally; I was (and presumably am) a non-competitive scientist content with the enormous holding of old journals in IISc's venerable library. I really waited in line to read Eugene Garfield's weekly essay in *CC*; a column in which he was to lay the groundwork for disseminating the ideas of scientometrics and information science to an audience of practising scientists. Garfield's style was engagingly direct, uncomplicated and forthright. He explained the concept of impact factors, considered possibilities for their use and abuse, introduced the idea of *Journal Citation Reports* (*JCR*) and developed the ideas of citation analysis for identifying highly influential papers and their authors. The *Science Citation Index* (*SCI*) had a print edition, so outrageously priced, that there was only a sample copy in the IISc library, which remained forlorn and untouched on the shelves. Entries were made only on the basis of first author names, making the *SCI* a difficult and ineffective tool for ranking scientists. Garfield's Institute for Scientific Information (ISI) in Philadelphia was beginning to amass (capture ?) data about science and scientists. Citation counts identifying the '100 most highly cited' scientists would appear in Garfield's columns, sifted by discipline and specialization. Sitting in a corner of the library, I would devour the names of these superstars, some already legends in their fields. These lists seemed to reveal some history of science and uncover some of the major actors.

No one I met in the 1970s and 1980s, among those who mattered, seemed to have read Garfield's essays. 'Citation' was a word rarely heard in Indian scientific circles. Garfield himself, lectured at IISc, sometime in the early 1980s (but my memory may be playing tricks), to a largely indifferent audience, which had not yet begun to be mesmerised by citations and impact factors. There were occasions when the scientific impact of work done in India was revealed by citation analysis. In 1986 Garfield traced the impact of Sambhu Nath De's seminal work on cholera enterotoxin, establishing that De's paper published in 1959 in *Nature* (1959, **183**, 1533), was drawing over 30 citations per year in the decade between 1973 and 1983. This observation, which revealed a 'Nobel class' scientist in post-Independence India, attracted my attention, stimulating a special issue of this journal four years later (*Curr. Sci.*, 25 July 1990, **59**). De died in 1985, 'unhonoured and unsung in India's scientific circles'. Clearly even in the 1980s and early 1990s, scholarly citation analysis did not create any ripples in India and had little impact on our thinking. The arrival of the electronic versions of the *SCI* has dramatically changed perceptions in India and around the world. For a while the *SCI* was available only to a limited few; those who had CD versions or those whose institutions were devoted to analysing the output of science. The ISI as an organization grew into a commercially powerful entity, vigorously marketing its products, the *SCI* and Journal Citation Reports. The 'Web of Science' is now available, in the relative comfort of a scientist's office, in many of India's major institutions. Journals are also flooded with self advertising, where impact factors are prominently quoted. Even *Nature*, which one would presume is pre-eminent as an interdisciplinary journal, is constrained to immodestly proclaim: '30.4, No *Nature*, No impact'. The ambience in scientific circles has transformed so dramatically that it is hard to believe that there was a time when 'impact' was a word rarely used in a precise, quantitative sense in assessing science, journals, papers and their authors. In our surroundings, it has become com-

mon-place to sit in presentations where speakers project lists of publications, complete with the impact factors (presumably, current) of the journals listed. The message is clear, unambiguous and aggressive; the audience must judge the speaker and the science presented only on the basis of impact factors.

The tools and techniques of scientometrics have been used to make assessments of science in India; exercises which have proved controversial when the conclusions are pessimistic, as recently demonstrated by the reactions to a letter published in this journal (S. Arunachalam, *Curr. Sci.*, 2002, **83**, 107). On the pages of history books it was customary to execute those who brought bad news. Very few recall that over twenty years ago Garfield had turned his attention to analysing Third World research. Using articles published in 1973 and the 1973–1978 *SCI* as a source, Garfield placed India at position 8 on a list determined by the total number of papers. Even then the parameter 'impact' suggested that quantity was not correlated to quality, a conclusion that many would have drawn, intuitively (Garfield, E., *Curr. Contents*, 15 August 1983, **33**, 253–263). I suspect the situation has changed in the last two decades; the issue of course is, have we improved or has there been a 'relative decline'? In all rankings we must remember that the competition is not standing still and what we compare might be the relative rates of progress.

My thoughts turned to scientometrics when I was asked to speak at a recent congregation of 'information scientists', many of whom are traditional librarians in disguise. The meeting organized by those who market ISI's portfolio of products was held in a lavishly, opulent hotel. Armed, as I was, with a skimpy set of handwritten transparencies, I felt curiously out of place in a gathering largely bereft of practising scientists. Here was an audience whose primary purpose was to watch scientists, tracking their performance using formulae and indices, which they understood only imperfectly. But as I warmed to my theme, which forms the title of this essay, I was emboldened to attack the growing breed of 'Indian scientometrists', who have little understanding of science, with all its complexities, and an even more limited appreciation of the pitfalls of statistics; especially the statistics and inferences drawn from small samples. Carried away by righteous indignation I quoted Hilaire Belloc: 'Statistics are the triumph of the quantitative method, and the quantitative method is the victory of sterility and death'. Apparently stung by my, undoubtedly, overstated criticism of scientometrics as practised in India, a member of the audience asked rather pointedly: 'Are not information scientists only holding up a mirror in which scientists see themselves?'

Quantitative assessments of science based upon journal impact factors and citation counts have begun to influence the behaviour of scientists worldwide and in India in particular, especially in the high profile national institutions. Authors decide the journals to which they submit their papers on the basis of impact factors; IF 2.0 is considered superior to IF 1.5. While journals of the highest impact must be the media of choice, acceptance of manuscripts is decidedly uncertain, forcing authors to hunt for outlets which will boost the 'average impact factors' of their publication lists. The common wisdom that the science of a good paper remains independent of the journal in which it appears, does not find many supporters, nowadays. The greater visibility attached to high impact journals can also attract greater attention (mostly negative) to flawed papers. The spate of retractions in high profile journals, most recently in the area of cell biology (Strohl, G., *Cell*, 2004, **116**, 481), might suggest that the most extravagant claims are often made in the most visible journals. Citation counts which are used to rank authors have begun to influence citation behaviour. Authors, referees and editors pay great attention to reference lists for different reasons, of course. Authors use 'directed citation' to influence choice of referees improving their chances of acceptance; referees demand inclusion of citations, presumably to their own published papers and editors encourage excessive (and sometimes unnecessary) citation of their own journals, a device that can enhance impact factors. In the surreal world of quantum objects physicists worry about the effect that observations may have on the objects of measurements. In the more mundane and real world of scientometrics, measurements have begun to influence the subjects being studied.

In India the focus on citations and impact factors has begun to distort our perceptions about science and scientists. Every administrator, every librarian and every scientist who takes no joy in his science has now become a convert to scientometrics in its basest form. The sight of directors of national institutions and heads of agencies abdicating scientific judgement in the face of the juggernaut of the impact factor is distressing. Even otherwise rational scientists seem unaware that quantitative comparison across disciplines is ridiculous. For example, the 'mean impact factors' for journals in the *SCI* in different fields follow the order: Life Science ~ 3.1, Physics ~ 1.5, Chemistry and Chemical Engineering ~ 1.4, Mathematics and Computer Science ~ 0.5 (M. Amin and M. Mabe, *Perspectives in Publishing*, Elsevier Science). Clearly one should not compare individuals and institutions across fields. A degree of circumspection is also warranted in sprawling disciplines with many subfields. Scientometrics in India is a field in the grip of practitioners, who are largely devoid of the insights that are necessary for scholarly and thoughtful analysis. Many scientists, and more importantly, leaders of science have allowed themselves to be seduced by the promise of scientometrics in decision making. We have already begun to pay a price as reflected in the decided change in the ambience of our institutions. I cannot but look back with nostalgia on gentler times.

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