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The Open Access Scientometric Web

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What would Eugene Garfield – now eighty-five and the founder of the Institute of Scientific Information (ISI) as well as the father of scientometrics – have done if he had come of age in the online era rather than the paper era?

There was a hint of what this might have been in his keynote address at the 11th Annual Meeting of the International Society for Scientometrics and Informetrics (ISSI) in Madrid: '*From The Science of Science to Scientometrics: Visualizing the History of Science with HistCite Software*'

HistCite uses the ISI citation database (Web of Science) to trace the lines of influence in research via citation and co-citation links. But in the online age citation links are just a special form of web link between a citing article and one or more cited articles. If he had been starting now, Dr. Garfield would not have been working on a proprietary database descended from the cut-and-paste paper era: he would have been developing *Open Access Scientometrics*.

Two very important new online developments are currently converging in the UK: (1) authors making their research accessible online, free for all ('Open Access' OA), in order to maximise its usage and impact, and (2) research funders ranking and rewarding research contributions on the basis of online measures of their usefulness and impact ('metrics'). These were the subject of my own keynote at the ISSI Meeting : 'Open Access Scientometrics and the UK Research Assessment Exercise'.

So far, about 15% of researchers – across disciplines and around the world – make their published research articles OA by'self-archiving' them on the web of their own accord. In the UK, however, 5 out of the 7 public research councils (RCUK) (and several further private ones) now officially require their grant recipients to self-archive their findings as a condition of funding ; and some UK universities are likewise beginning to require it.

The UK is also unique in having a Dual Support System of research funding : Competitive research grants are just one component; the other is top-sliced funding, awarded to each UK university, department by department, based on how each department is ranked by discipline-based panels of reviewers who assess their research output. In the past, this costly and time-consuming Research Assessment Exercise (RAE) has been based on submitting each researcher's 4 best papers every 6 years to be 'peer-reviewed' by the appointed panel, alongside other data such as student counts and grant income (but not citation counts, which departments were forbidden to submit and panels were forbidden to consider, for either journals or individuals,).

For a variety of reasons, it has been decided to phase out the panel-based RAE and replace it instead by 'metrics'. The main reason for the change is the expense and time demanded by the panel review, both for the departments, in preparing their submissions, and for the panels, in 'peer-reviewing' them.

A second reason for replacing RAE panel review by metrics was that in almost every field tested, the panel rankings turned out to be highly correlated with metrics. So why not let the metrics do the work, rather than burden departments with the onerous chore of preparing research assessment submissions every six years,

instead of using the time and money to do more and better research ? The same is of course true of the time and expense of the panel reviewers, duplicating peer review that had already been done by the journal referees.

(One might have added as a third reason for conversion to metrics that all of the submissions were already published, hence most had already been peer-reviewed . And in the case of those that were published in the best journals, they had already been peer-reviewed by the world's best and most qualified specialists in their specific subject matter. A generic UK RAE panel was very unlikely to consist of the world's best and most qualified specialists in all or most of the specialties of UK researchers. And in any case it is not clear why research that has already been peer-reviewed once would need to be peer-reviewed again; nor why the RAE would need to be based on only four papers (a restriction clearly intended as a deterrent to salami-sliced publishing of minimal bits to inflate publication counts) rather than each researcher's total output during the 6-year RAE interval under assessment.)

For a conversion to metrics, the only problem was determining which metrics to use. In some fields it had been noted that there was an extremely high correlation between the RAE rankings and the grant-income metric. But that correlation was probably the result of an explicit bias on the part of the panel, since the grant-income metric was already a visible, countable component of the submission. Hence relying only or mostly on that particular metric would be tantamount to jettisoning the Dual Support System altogether and simply putting a multiplier on the competitive-grant component.

In contrast, it was a surprising retrospective finding (based on post-RAE tests in every discipline tested) that the departmental RAE rankings were also correlated (highly, but not as highly as it was with grant-income) with the citation counts for the total research output of each department. This outcome could not have been the result of an explicit bias on the part of the panel, because citations were not submitted or counted. It was all the more surprising because the citation counts were based on total publication output during the RAE interval, and not just on the 4 submitted publications (which could have been biased toward high citation counts by selectively submitting only articles published in high-citation count journals).

Why would citation counts correlate highly with the panel's subjective evaluation of the four submitted publications? Each panel was trying to assess quality and importance. But that is also what fellow-researchers assess, in deciding what to risk building their own research upon. When researchers take up a piece of research, apply and build upon it, they also cite it. They may sometimes cite work for other reasons, or they may fail to cite work even if they use it, but for the most part, citation reflects research usage, and hence research impact. If we take the panel ranks to have face validity, then the high correlation between citation counts and the panel ranks validates the citation metric as a faster, cheaper, proxy estimator.

But are one-dimensional citation counts the best we can do, metrically? There are in fact many other metrics waiting to be tested and validated: Publication counts themselves are metrics. The number of years that a researcher has been publishing is also a potentially relevant and informative metric. (High citations later in a career are perhaps less impressive than earlier, though that no doubt depends on the field.) Total citations, average citations per year, and highest individual-article citation counts could all carry valid independent information. So could the average citation count ('impact factor') of the journal in which each article is published. Nor are all citations equal: By analogy with Google's PageRank algorithm, citations can also be recursively weighted by how highly cited the citing article or author is. Co-citations can be informative too : Being co-cited with a Nobel Laureate surely means more than being co-cited with a postgraduate student. Downloads can be counted in the online age, and could serve as early indicators of impact; we have already found that in Physics early download counts are predictive of later citation counts.

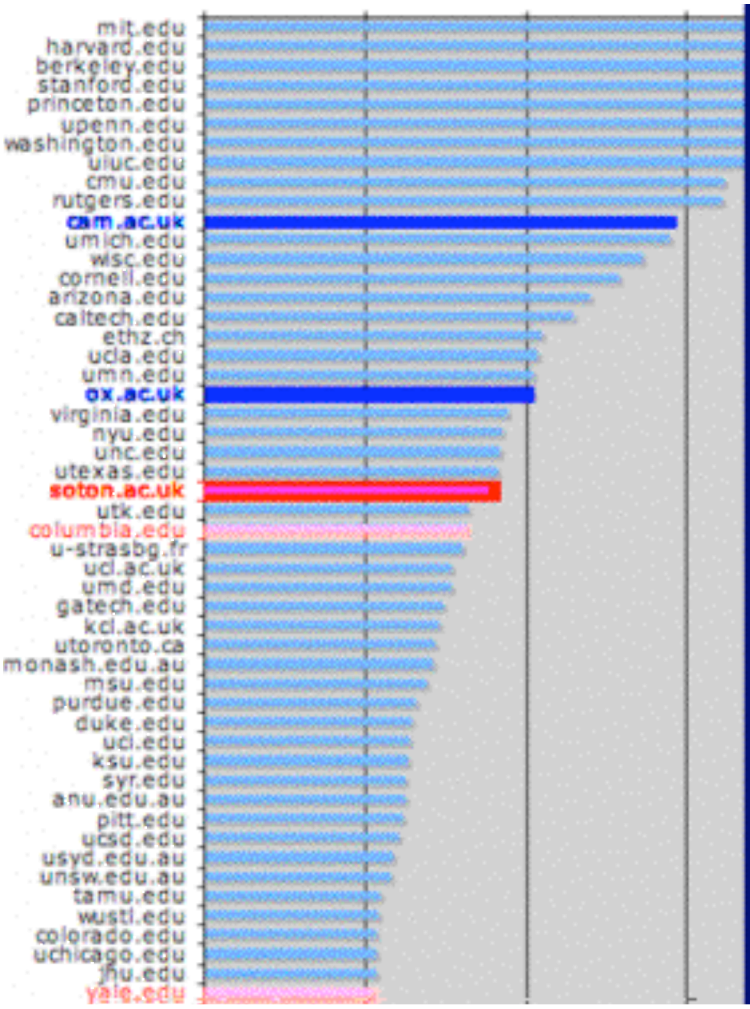
Citation metrics today are based largely on journal articles citing journal articles – and mostly just those 8000 journals that are indexed by ISI's Web of Science. That only represents a third (although probably the top third) of the total number of peer-reviewed journals published annually, across all disciplines and all languages. OA

self-archiving can make the other two-thirds of journal articles linkable and countable too. There are also many disciplines that are more book-based than journal based, so book citation metrics can now be collected as well (and Google Books and Google Scholar are already a potential source for book citation counts). Besides self-archiving the full-texts of their published articles, researchers could self-archive a summary, the bibliographic metadata, and the references cited by their books. These could then be citation-linked too and harvested for metrics too. And of courses researchers can also self-archive their data, which could then also begin accruing download and citation counts.

Many other things could be counted as metrics too. We have already mentioned grant income and student counts. Co-author counts may also have some significance and predictive value (positive or negative: they might just generate more spurious self-citations). It might make a difference in some fields whether their citations are in a small closed circle of specialists, or broader, crossing subfields, fields, or even disciplines: an 'inbreeding/outbreeding' metric can be calculated. Web link analysis suggests investigating metrics such as 'hub' and 'authority' scores (hubs are like review articles, not reporting new findings, but highly cited, because they lead users to other articles; authorities are the substantive findings that are highly cited as primary sources for en of research). The patterns of change across time ('chronometrics') may be important and informative in some fields: the rate of growth of downloads and citations, as well as their rate of decay. There will be fast-moving fields where quick uptake is a promising sign, and there will be slower-paced fields, where staying power is a better sign. 'Semiometrics' can also be used to measure the degree of distance and overlap between different texts, from unrelated texts on unrelated topics all the way to blatant plagiarism.

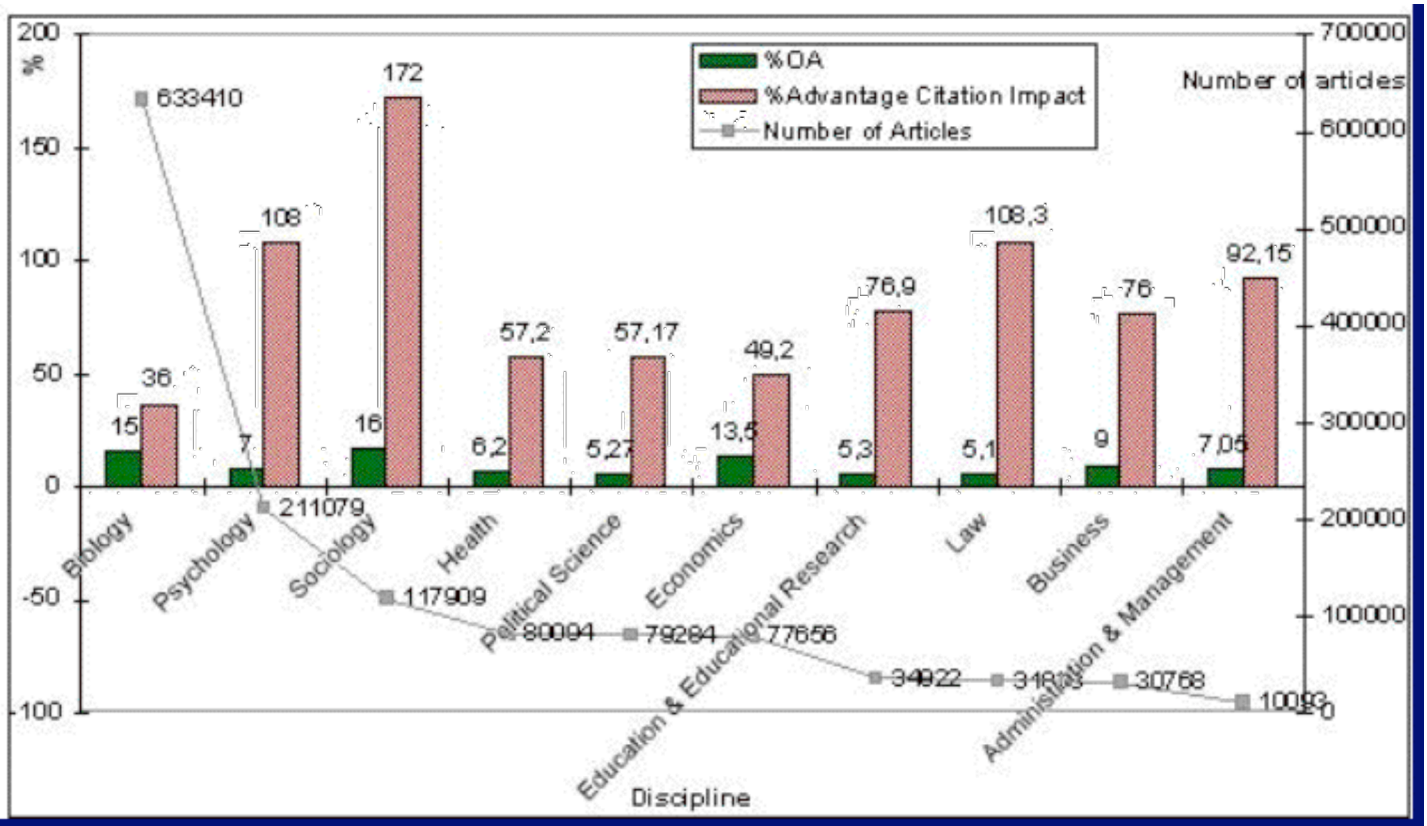
To allow research and researchers to reap the full benefits of the OA era the only thing still needed now is the approximately 85% of current research output that is still to be self-archived. Research funders and institutions are beginning to require self-archiving. Study after study in field after field has demonstrated that self-archiving increases research usage and citations. And now, the one last parallel panel/metric RAE in 2008 will provide a unique natural testbed for validating the rich new spectrum of Open Access metrics against the panel rankings. A statistical technique called multiple regression analysis computes the contribution of each individual metric to the joint correlation of all the metrics with the RAE panel rankings. The relative weight of each metric can then be adjusted and optimised according to the needs and criteria of each discipline.

The EPrints group at the University of Southampton has created the free and widely used Eprints software with which institutions can create their own interoperable OA repositories for their researchers to self-archive in. Southampton was also the first in the world to adopt a departmental self-archiving mandate and helped demonstrate that OA enhances research impact. It also helped initiate the movement that led to the adoption of the RCUK funder mandates and contributed to the movement to convert the RAE from panels to metrics. Tim Brody, in his doctoral work, also created Citebase, the first scientometric ranking search engine, which has already piloted several of the metrics discussed in this article. If Eugene Garfield had come of age in the online era, he would be at Southampton (alongside colleagues like Sir Tim-Berners Lee, inventor of the Web) designing the Open Access Scientometric Web.



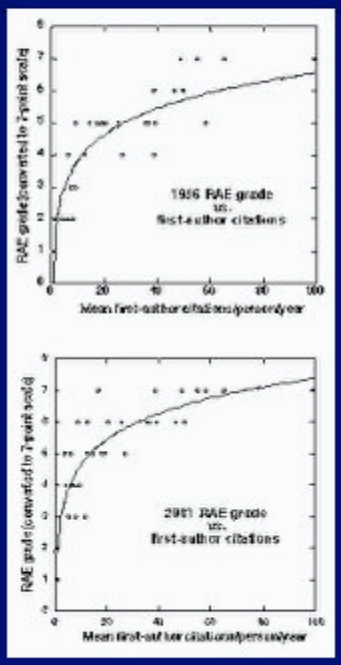
The G-factor International University Ranking measures the importance of universities as a function of the number of links to their websites from the websites of other leading international universities.

Why is Southampton ranked 3rd highest in the UK and 25th in the world, above Columbia (27th) and Yale (51st)?



By discipline: total articles (OA+NOA), gray curve; percentage OA: (OA/(OA+NOA)) articles, green bars; percentage OA citation advantage: ((OA-NOA)/NOA) citation, red bars, averaged across 1992-2003 and ranked by total articles. All disciplines show an OA citation advantage (Hajjem et al. IEEE DEB 2005)

Research Assessment, Research Funding, and Citation Impact



"Correlation between RAE ratings and mean departmental citations +0.91 (1996) +0.86 (2001) (Psychology)"

"RAE and citation counting measure broadly the same thing"

"Citation counting is both more cost-effective and more transparent"

(Eysenck & Smith 2002)

http://psyserver.pc.rhbnc.ac.uk/citations.pdf