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Chasing Impact Factors, or Making an Impact on Technology?[1]

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As a past journal editor, I received many emails on the impact factor of various journals. Many people quantify the quality of a journal in terms of this metric, although it is well known that the impact factor metric results are widely misinterpreted [1].

The main problem is not the metric *per se*, but that the metric is stated as a measure of the *quality* of the journal. In fact, there is no aspect of the calculation of the impact factor that is a measure of quality. For example, the 2-year impact factor of CSM for 2016 is computed as follows:

> A = the number of times that articles published in CSM in 2014 and 2015 were cited by ISI-indexed journals during 2016.
>
> B = the total number of articles published in CSM in 2014 and 2015.
>
> 2016 impact factor = A/B.

While it could be argued that the measure of the number of times that an article has been cited is a measure of *popularity*, our everyday experience is that popularity is not necessarily correlated with *quality*.

> The impact factor is a measure of popularity, not quality

Although journal quality does not appear anywhere in the numerator or denominator of this expression, the belief that the impact factor is a direct measure of journal quality is pervasive, which is seen in such statements as

> *"The current gold standard for measuring journal quality [is] the Thomson Institute for Scientific Information (ISI) impact factors [2]."*
>
> *"The impact factor has moved in recent years from an obscure bibliometric indicator to become the chief quantitative measure of the quality of a journal, its research papers, the researchers who wrote those papers and even the institution they work in [3]."*

Several studies in particular disciplines have shown positive correlations between impact factor and some measures of journal quality, but have found that the correlations are often not statistically significant [4]. Furthermore, the measures used for journal quality in these comparative studies are typically based on surveys of researchers or other individuals [e.g., 5], whose rankings of journals are most likely distorted by having knowledge of the journal impact factors when filling out the surveys. That is, researchers know the impact factors of the journals when asked to rank order the journals by quality, which most likely biases their rankings. A strong correlation between impact factor and journal quality could be more of a measure of the

> The lowest quality results in the study were in the publications with the highest impact factor

[1] Adapted from Richard D. Braatz, Chasing impa *IEEE Control Systems*, 32(6):6-7, 2012

influence that ISI's reported impact factors have on readers' rankings of journal quality than a measure of the actual quality of the journals.

A study that reports an unbiased measure of the quality of journals in a particular field is provided by Brown and Ramaswamy [6]. Their study was an unbiased assessment of all protein crystal structures reported in the Protein Data Bank, which is the world repository of three-dimensional structural data of large biological molecules such as proteins and nucleic acids [7]. *While protein crystal structures seem to be a long distance from control engineering, they have the advantage that their quality can be quantified very precisely without being influenced by the subjectivity that would occur when trying to accurately measure, for example, the quality of a control engineering paper.* The study in [7] was unbiased, in that the quality of each protein crystal structure was assessed without any knowledge of the journal in which the protein crystal structure was published.

The researchers [7] discovered that the lowest quality protein crystal structures were published in the publications with the highest impact factor, namely, *Nature* (impact factor = 36), *Cell* (impact factor = 32), and *Science* (impact factor = 31). The highest quality protein crystal structures were published in lower impact journals for that field such as *Protein Engineering, Design and Selection* (impact factor = 2.94) and *Biochemistry* (3.4). In short, the lowest quality structures were in publications that had *an order of magnitude* higher impact factor than the publications that published the highest quality structures.

As that study only considered a specific field, such a large negative correlation between quality and impact factor does not necessarily occur for other fields such as control systems engineering. On the other hand, the example does demonstrate that it is possible for high-impact-factor publications in a field to contain results that are much lower average quality than publications with lower impact factor in that same field. The example also illustrates that comparing impact factors, even among journals in the same field, should always be done with a grain of salt.

> The impact factor is not even a good measure of impact.

Another consideration is that *the impact factor is not even a reliable measure of impact*, at least not in terms of many of the ways that impact can be felt on technology and society. For example, an industrial application of control in a manufacturing facility could increase the quality of billions of dollars in products, or in automobile design could improve the safety and energy efficiency of millions of cars. Such applications are examples of *truly making a positive impact*, but a paper describing such an application could result in no citations within the two-year window usually used to measure the ISI impact factor, and so *would reduce* the impact factor of the associated journal. All other things being equal, I prefer a paper that makes a positive impact on technology and society that lowers the associated journal's impact factor than a paper that raises a journal's impact factor but makes no positive long-term impact.

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[2] David R. Hodge and Jeffrey R. Lacasse. Ranking disciplinary journals with the Google Scholar h-index: A new tool for constructing cases for tenure, promotion, and other

professional decisions. *Journal of Social Work Education*, vol. 47, no. 3, pp. 579–596, Fall 2011.

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[4] Jeffrey S. Stonebraker, Esther Gil, Craig W. Kirkwood, and Robert B. Handfield. Impact factor as a metric to assess journals where OM research is published. *Journal of Operations Management*, vol. 30, no. 1–2, pp. 24–43, January 2012.

[5] Somnath Saha, Sanjay Saint, and Dimitri A. Christakis. Impact factor: A valid measure of journal quality? *Journal of the Medical Library Association*, vol. 91, no. 1, pp. 42–46, January 2003.

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[7] Helen M. Berman. The Protein Data Bank: A historical perspective. *Acta Crystallographica Section A: Foundations of Crystallography*, vol. A64, no. 1, pp. 88–95, January 2008.