THE COST OF KNOWLEDGE

This is an attempt to describe some of the background to the current boycott of Elsevier by many mathematicians (and other academics) at `http://thecostofknowledge.com`, and to present some of the issues that confront the boycott movement. Although the movement is anything but monolithic, we believe that the points we make here will resonate with many of the signatories to the boycott.

The role of journals (1): dissemination of research. The role of journals in professional mathematics has been under discussion for some time now (see, for example, [10], [4], [11], [12], [1], [9], [13], [2]).

Traditionally, while journals served several purposes, their primary purpose was the dissemination of research papers. The journal publishers were charging for the cost of typesetting (not a trivial matter in general before the advent of electronic typesetting, and particularly non-trivial for mathematics), the cost of physically publishing copies of the journals, and the cost of distributing the journals to subscribers (primarily academic libraries).

The editorial board of a journal is a group of professional mathematicians. Their editorial work is undertaken as part of their scholarly duties, and so is paid for by their employer, typically a university. Thus, from the publisher's viewpoint the editors are volunteers.[1] When a paper is submitted to the journal, by an author who is again typically a university-employed mathematician, the editors select the referee or referees for the paper, evaluate the referees' reports, decide whether or not to accept the submission, and organize the submitted papers into volumes. These are passed on to the publisher, who then undertakes the job of actually publishing them. The publisher supplies some administrative assistance in handling the papers, as well as some copy-editing assistance, which is often quite minor but sometimes more substantial. The referees are again volunteers from the point of view of the publisher: as with editing, refereeing is regarded as part of the service component of a mathematician's academic work. Authors are not paid by the publishers for their published papers, although they are usually asked to sign over the copyright to the publisher.

This system made sense when the publishing and dissemination of papers was a difficult and expensive undertaking. Publishers supplied a valuable service in this regard, for which they were paid by subscribers to the journals, which were mainly academic libraries. The academic institutions whose libraries subscribe to mathematics journals are broadly speaking the same institutions that employ the mathematicians who are writing for, refereeing for, and editing the journals. Therefore, the cost of the whole process of producing research papers is borne by these institutions (and the outside entities that partially fund them, such as the National Science Foundation in the United States): they pay for their academic mathematician employees to do research and to organize the publications of the results of their research in journals; and then (through their libraries) they pay the publishers to disseminate these results among all the world's mathematicians. Since these institutions employ research faculty in order to foster research, it certainly used to make sense for them to pay for the dissemination of this research as well. After all, the sharing of scientific ideas and research results is unquestionably a key component for making progress in science.

Now, however, the world has changed in significant ways. Authors typeset their own papers, using electronic typesetting. Publishing and distribution costs are not as great as they once were. And most importantly, dissemination of scientific ideas no longer takes place via the physical distribution of journal volumes. Rather, it takes place mainly electronically. While this means of dissemination is not free, it is much less expensive, and much of it happens quite independently of mathematical journals.

In conclusion, the cost of journal publishing has gone down because the cost of typesetting has been shifted from publishers to authors and the cost of publishing and distribution is significantly lower than it used to be. By contrast, the amount of money being spent by university libraries on journals seems to be growing with no end in sight. Why do mathematicians contribute all this volunteer labor, and their employers pay all this money, for a service whose value no longer justifies its cost?

The role of journals (2): peer review and professional evaluation. There are some important reasons that mathematicians haven't just abandoned journal publishing. In particular, peer review plays an essential role in ensuring the correctness and readability of mathematical papers, and publishing papers in research journals is the main way of achieving professional recognition. Furthermore, not all journals count

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[1]The editor in chief of a journal sometimes receives modest compensation from the publisher.

equally from this point of view: journals are (loosely) ranked, so that publications in top journals will often count more than publications in lower ranked ones. Professional mathematicians typically have a good sense of the relative prestige of the journals that publish papers in their area, and they will usually submit a paper to the highest ranked journal that they judge is likely to accept and publish it.

Because of this evaluative aspect of traditional journal publishing, the problem of switching to a different model is much more difficult than it might appear at first. For example, it is not easy just to begin a new journal (even an electronic one, which avoids the difficulties of printing and distribution), since mathematicians may not want to publish in it, preferring to submit to journals with known reputations. Secondly, although the reputation of various journals has been created through the efforts of the authors, referees, and editors who have worked (at no cost to the publishers) on it over the years, in many cases the *name* of the journal is owned by the publisher, making it difficult for the mathematical community to separate this valuable object that they have constructed from its present publisher.

The role of Elsevier. Elsevier, Springer, and a number of other commercial publishers (many of them large companies but less significant for their mathematics publishing, e.g., Wiley) all exploit our volunteer labor to extract very large profits from the academic community. They supply some value in the process, but nothing like enough to justify their prices.

Among these publishers, Elsevier may not be the most expensive, but in the light of other factors, such as scandals, lawsuits, lobbying, etc. (discussed further below), we consider them a good initial focus for our discontent. A boycott should be substantial enough to be meaningful, but not so broad that the choice of targets becomes controversial or the boycott becomes an unmanageable burden. Refusing to submit papers to all overpriced publishers is a reasonable further step, which some of us have taken, but the focus of this boycott is on Elsevier because of the widespread feeling among mathematicians that they are the worst offender.

Let us begin with the issue of journal costs. Unfortunately, it is difficult to make cost comparisons: journals differ greatly in quality, in number of pages per volume, and even in amount of text per page. As measured by list prices, Elsevier mathematics journals are amongst the most expensive. For instance, in the AMS mathematics journal price survey at `http://www.ams.org/membership/mem-journal-survey`, seven of the ten most expensive journals (by 2007 volume list price[2]) were published by Elsevier. However, that is primarily because Elsevier publishes the largest volumes. Price per page is a more meaningful measure that can be easily computed. By this standard, Elsevier is certainly not the worst publisher, but its prices do on the face of it look very high. The *Annals of Mathematics*, published by Princeton University Press, is one of the absolute top mathematics journals and quite affordably priced: $0.13/page as of 2007. By contrast, ten Elsevier journals[3] cost $1.30/page or more; they and three others cost more per page than *any* journal published by a university press or learned society. For comparison, three other top journals competing with the *Annals* are *Acta Mathematica*, published by the Institut Mittag Leffler for $0.65/page, *Journal of the American Mathematical Society*, published by the American Mathematical Society for $0.24/page, and *Inventiones Mathematicae*, published by Springer for $1.21/page. Note that none of Elsevier's mathematics journals is generally considered comparable in quality to these journals.

However, there is an additional aspect which makes it hard to compute the true cost of mathematics journals. This is the widespread practice among large commercial publishers of "bundling" journals, which allows libraries to subscribe to large numbers of journals in order to avoid paying the exorbitant list prices for the ones they need. Although this means that the average price libraries pay per journal is less than the list prices might suggest, what really matters is the average price that they pay per journal (or page of journal) *that they actually want*, which is hard to assess, but clearly higher. We would very much like to be able to offer more concrete data regarding the actual costs to libraries of Elsevier journals compared with those of Springer or other publishers. Unfortunately, this is difficult, because publishers often make it a contractual requirement that their institutional customers should not disclose the financial details of their contracts. For example, Elsevier sued Washington State University to try to prevent release of this information [3]. One common consequence of these arrangements, though, is that in many cases a library cannot actually save any

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[2]All prices are as of 2007 because both prices and page counts are easily available online.
[3]not including one that has since ceased publication

money by cancelling a few Elsevier journals: at best the money can sometimes be diverted to pay for other Elsevier subscriptions.

One reason for focusing on Elsevier rather than, say, Springer is that Springer has had a rich and productive history with the mathematical community. As well as journals, it has published important series of textbooks, monographs, and lecture notes; one could perhaps regard the prices of its journals as a means of subsidizing these other, less profitable, types of publications. Although all these types of publications have become less important with the advent of the internet and the resulting electronic distribution of texts, the long and continuing presence of Springer in the mathematical world has resulted in a store of goodwill being built up in the mathematical community towards them. This store is being rapidly depleted,[4] but has not yet reached zero.

Elsevier does not have a comparable tradition of involvement in mathematics publishing. Many of the mathematics journals that it publishes have been acquired comparatively recently as it has bought up other, smaller publishers. Furthermore, in recent years it has been involved in various scandals regarding the scientific content, or lack thereof, of its journals. One in particular involved the journal *Chaos, Solitons & Fractals*, which, at the time the scandal broke in 2008–2009, was one of the highest impact factor[5] mathematics journals that Elsevier published. It turned out that the high impact factor was at least partly the result of the journal publishing many papers full of mutual citations.[6] Furthermore, *Chaos, Solitons & Fractals* published many papers that, in our professional judgement, have little or no scientific merit and should not have been published in any reputable journal.

In another notorious episode, this time in medicine, for at least five years Elsevier "published a series of sponsored article compilation publications, on behalf of pharmaceutical clients, that were made to look like journals and lacked the proper disclosures" [8].

Recently, Elsevier has lobbied for the Research Works Act [6], a proposed U.S. law that would undo the National Institutes of Health's public access policy, which guarantees public access to published research papers based on NIH funding within twelve months of publication (to give publishers time to make a profit). Although most lobbying occurs behind closed doors, Elsevier's vocal support of this act shows their opposition to a popular and effective open access policy.

These scandals, taken together with the bundling practices, exorbitant prices, and lobbying activities, suggest a publisher motivated purely by profit, with no genuine interest in or commitment to mathematical knowledge and the community of academic mathematicians that generates it. Of course, many Elsevier employees are reasonable people doing their best to contribute to scholarly publishing, and we bear them no ill will. However, the organization as a whole does not seem to have the interests of the mathematical community at heart.

The boycott. Not surprisingly, many mathematicians have in recent years lost patience with being involved in a system in which commercial publishers make profits based on the free labor of mathematicians and subscription fees from their institutions' libraries, for a service that has become largely unnecessary.[7] Among all the commercial publishers, the behavior of Elsevier seemed to many to be the most egregious, and a number of mathematicians had made personal commitments to avoid any involvement with Elsevier journals.[8]

One of us (Timothy Gowers) decided that it might be useful to publicize his own personal boycott of Elsevier, thus encouraging others to do the same. This led to the current boycott movement at `http://thecostofknowledge.com`, the success of which has far exceeded his initial expectations.

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[4] See for instance the recent petition to Springer by a number of French mathematicians and departments at `http://www-fourier.ujf-grenoble.fr/petitions/index.php?petition=3`.

[5] Elsevier currently reports the five-year impact factor of this journal at 1.729. For sake of comparison, *Advances in Mathematics*, also published by Elsevier, is reported as having a five-year impact factor of 1.575.

[6] See [1] for more information on this and other troubling examples that show the limitations of bibliometric measures of scholarly quality.

[7] See `http://www.scottaaronson.com/writings/journal.pdf` for Scott Aaronson's scathing but all-too-true satirical description of the publishers' business model.

[8] Some journals were also successfully moved from Elsevier to other publishers; e.g., *Annales Scientifiques de l'École Normale Supérieure*, which until recent years was published by Elsevier, is now published by the Société Mathématique de France.

Each participant in the boycott can choose which activities they intend to avoid: submitting to Elsevier journals, refereeing for them, and serving on editorial boards. Of course, submitting papers and editing journals are purely voluntary activities, but refereeing is a more subtle issue. The entire peer review system depends on the availability of suitable referees, and its success is one of the great traditions of science: refereeing is felt to be both a burden and an honor, and practically every member of the community willingly takes part in it. However, while we respect and value this tradition, many of us do not wish to see our labor used to support Elsevier's business model.

What next? As suggested at the very beginning, different participants in the boycott have different goals, both in the short and long term. Some people would like to see the journal system eliminated completely and replaced by something else more adapted to the internet and the possibilities of electronic distribution. Others see journals as continuing to play a role, but with commercial publishing being replaced by open access models. Still others imagine a more modest change, in which commercial publishers are replaced by non-profit entities such as professional societies (e.g., the American Mathematical Society, the London Mathematical Society, and the Société Mathématique de France, all of which already publish a number of journals) or university presses; in this way the value generated by the work of authors, referees, and editors would be returned to the academic and scientific community. These goals need not be mutually exclusive: the world of mathematics journals, like the world of mathematics itself, is large, and open access journals can coexist with traditional journals, as well as with other, more novel means of dissemination and evaluation.

What all the signatories do agree on is that Elsevier is an exemplar of everything that is wrong with the current system of commercial publication of mathematics journals, and we will no longer acquiesce to Elsevier's harvesting of the value of our and our colleagues' work.

What future do we envisage for all the papers that would otherwise be published in Elsevier journals? There are many other journals being published; perhaps they can pick up at least some of the slack. Many successful new journals have been founded in recent years, too, including several that are electronic (thus completely eliminating printing and physical distribution costs), and no doubt more will follow. Finally, we hope that the mathematical community will be able to reclaim for itself some of the value that it has given to Elsevier's journals by moving some of these journals (in name, if possible, and otherwise in spirit[9]) from Elsevier to other publishers.

None of these changes will be easy; editing a journal is hard work, and founding a new journal, or moving and relaunching an existing journal, is even harder. But the alternative is to continue with the status quo, in which Elsevier harvests ever larger profits from the work of us and our colleagues, and this is both unsustainable and unacceptable.

Signed by:

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[9]One notable example is the August 10, 2006 resignation of the entire editorial board of the Elsevier journal *Topology* and their founding of the *Journal of Topology*, owned by the London Mathematical Society.

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Appendix: recommendations for mathematicians. All mathematicians must decide for themselves whether, or to what extent, they wish to participate in the boycott. Senior mathematicians who have signed the boycott bear some responsibility towards junior colleagues who are forgoing the option of publishing in Elsevier journals, and should do their best to help minimize any negative career consequences.

Whether or not you decide to join the boycott, there are some simple actions that everyone can take, which seem to us to be uncontroversial:

1. Make sure that the final versions of all your papers, particularly new ones, are freely available online – ideally both on the arXiv[10] and on your home page.

2. If you are submitting a paper and there is a choice between an expensive journal and a cheap (or free) journal of the same standard, then always submit to the cheap one.

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[8] M. Hansen, *Statement from Michael Hansen, CEO of Elsevier's Health Sciences Division, regarding Australia based sponsored journal practices between 2000 and 2005*, 7 May 2009, `http://www.elsevier.com/wps/find/authored_newsitem.cws_home/companynews05_01203`.

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[10]Elsevier's electronic preprint policy [7] is unacceptable, because it explicitly does not allow authors to update their papers on the arXiv to incorporate changes made during peer review. See, for example, [5]. When signing copyright transfer forms, we recommend amending them (if necessary) to reserve the right to make the author's final version of the text available free online from servers such as the arXiv.

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