COMMENTARY

The future of mathematics publishing*

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It is extremely difficult to see the future, especially in an era of rapidly changing technologies. So, I will confine myself to a look at the recent past, and to an expression of some concerns about the future.

Publishing mathematics includes text books at the undergraduate and the graduate level, research monographs, journals and also a few books for the lay public. The focus of this discussion is on journal publication. I will make just one comment on text books at the end.

A conspicuous feature of modern industrial society is a gross overproduction of goods, that are cheap but not durable, and use processes that damage the ecology. Their abundance leaves the customer bewildered, not knowing which way to look. These features are shared by present-day academic research and publication. There are far too many universities all pushing their faculty to publish, too many journals, too many conferences, too many talks at these conferences, and too many panel discussions as well, each leading to more publications.

Among conspicuous features of modern economy are the domination of the belief that the good of corporations is the good of society, and the bigger the corporation the better it is. We see frequent acquisitions and conglomerations leading to formation of monopolies and oligopolies. The same is happening in academic publishing. This is a matter of great concern, as historically such monopolies have been exploitative, ruthless and unethical.

At the same time there are some peculiar features of academic publishing that do not seem to fit into economic and sociological reasoning. Some of these are:

1. There is no correlation between quality of the product and its price. To make my point clear I have to go back 30 years, when journals existed only in print and their prices were known to all. One could divide mathematics journals into three kinds: (i) Low-priced; these were published by societies and university presses; (ii) Reasonably priced; two major publishers of these were Springer and Academic Press; (iii) Exorbitantly priced; most of the journals published by Elsevier, Marcel Dekker, Kluwer, Pergamon Press, and Gordon and Breach would have fallen in this category.

   The most highly regarded mathematics journals belonged to categories (i) and (ii). Usual economic theory would tell us that goods of low quality and high price do not survive in the market. Why did that not happen here? The reason perhaps is that research workers want 'everything' available for consultation. Of course, this wish has to be matched by the library budget, which big libraries managed to get.

2. Advances in technology lead to lower prices for most goods. Academic publishing seems to be an exception. Thirty years ago higher prices for mathematics journals were justified because of the difficulties of typesetting. This is now mostly done by authors themselves. Copy editing and language correction, that used to be a standard service provided by the publisher, has now been abandoned. New technologies have also reduced printing costs. All this should have reduced journal subscription costs. In contrast, one could look at the prices of mobile phones or clothes over the last few years.

3. A large part of the labour that goes into the production of research journals is free. This includes the labour of authors, referees and members of editorial boards. (It was mentioned during the ICM Panel Discussion that Chief Editors of journals published by commercial publishers do get paid.)

4. Customer opinion is important for most businesses. This does not seem to be so for academic publishers. They have been insensitive not only to their ordinary customers, but even to those who helped them start their business. For instance, quite a few founding editors of journals made serious and protracted efforts to engage their publishers in discussion about unreasonable pricing policies, and ended up resigning in frustration. (A letter written by D. E. Knuth to the Editorial Board of *Journal of Algorithms* on 25 October 2003 is available at www-cs-faculty.stanford.edu/~uno/joalet.pdf. This is one of the finest documentations of some of the issues we are discussing. In particular, the relevance of my three categories in point 1 above will become clearer here, as of my point on the effects of acquisitiones and oligopolies.)

5. In their programme of expansion and acquisition, publishers do not seem to be conscious of their brand image. Elsevier acquired Academic Press, and as a result improved the average level of its mathematics journals. (It does not seem to have done anything to preserve the assiduously built green, blue and red book series of Academic Press.) Springer has gone around buying everything it can, and the average quality of its journals has come down drastically. When a company long known and respected for the quality of its products seems no longer to care about its imprint, what business strategy is at work? Creating bigger 'bundle' offerings? Fudging bundled prices? Creating monopolistic control?

Commercial publishing companies have played a very significant role in the development of our subject. Before 1950 a majority of research journals were published by universities, societies and academies, and some (a few distinguished ones among them) by publishing houses. A massive expansion occurred in the 1960s with publishing companies moving into the business. If this was a consequence of the big expansion of research progammes at that time, the question arises why the universities, societies and academies did not simultaneously expand their publication programmes. Could it

have been a lack of resources? One reason that I have heard both from colleagues and from publishers is that established societies were slow to react to emergence of new areas that were being pursued by a significant number of research workers. In other words, whereas the leadership of national societies and the editors of their journals were not open to accommodating some areas of research, commercial publishers saw an opportunity there. If this is true, then are there lessons here for the community? Can we do better now with changing technologies, and with the growing resentment against commercial publishers?

A major danger to the integrity of scientific publishing now is the proliferation of low quality journals. Many of these are by new publishers, and their job is made easier by new technologies of publishing. But quite a few of these are being published by reputed major publishers. Can we come to some understanding of what should be regarded as publishable quality? For this we may have to answer the question: why do we publish? To communicate advances in our subject to others? (This, in turn, raises the question what advances are worth communicating.) To gain recognition and respect from colleagues? (If our names were not put on our papers, how much will we be writing?) To fulfil the demands that our profession puts on us? (Even if our research is of ephemeral interest, it keeps us fit and in contact with our subject.)

A parallel with a sport like tennis may be appropriate here. To have one player like Pete Sampras or Roger Federer we need about a hundred players at the Wimbledon level. To have those hundred, perhaps we need about ten thousand serious players playing good hard tennis in clubs and tournaments. In addition, there will be those who play tennis to relax and to keep fit. Something similar is the case with mathematics. To have mathematicians at the level of the four Fields Medal winners we need about a thousand mathematicians working at a very high level. For these, in turn, we may need another ten thousand mathematicians active in research. The work expected from these ten thousand could be a reasonable bench mark for what constitutes 'publishable' research, and our professional societies and institutions should have the resources and structures to publish this work.

The analogy with tennis may be carried a bit further. In addition to the kinds of players mentioned earlier, if a few thousand more start running around, hitting the ball at random, it will not contribute anything to the game. A fairly substantial part of mathematics publishing has become an activity of this kind. To some extent this is a consequence of the demand on each teacher of mathematics from college level upwards to demonstrate research activity. The wisdom of this demand needs to be assessed, and other tests of ability need to be devised.

Many low-quality journals list very eminent mathematicians (some at the very top of the profession) as advisory editors. Their willingness to lend their names is puzzling. Of late we are witnessing a new phenomenon. Rich universities are enticing top level mathematicians to lend their names to their faculties. If this was to be for the purpose of using their services to organize courses and seminars, and to uplift the mathematics culture in the neighbourhood, it would be a noble cause. Will money also start buying joint authorship? If this happens, it would be the reverse of the practice (prevalent in some sciences) of seniors putting their names on the work of juniors.

I mentioned earlier that there is no correlation between the quality and the price of a journal. Nor is there any relation between quality and the 'impact factor', or the reputation of the publisher. Examples are well known by now. It may still be instructive to look at two. These are from publications of the two major companies who dominate the current publishing scene.

The first example is from a journal that has existed for decades, has a high impact factor, and in some leaflets of the publisher has even been advertised as a flagship. Here is the first paragraph of a paper in this journal.

Let $A = (a_{ij})$ be an $n \times n$ symmetric matrix with all positive entries. Then the Hadamard inverse of A; given by $A^{\circ(-1)} = (1/a_{ij})_{i,j=1}^{n}$ is positive semi-definite, and the Hadamard square root by $A^{\circ 1/2} = \left(a_{ij}^{1/2}\right)_{i,j=1}^{n}$.

For the life of me I cannot make out what the second part of the second sentence means. But the first part seems to be saying that if $A = (a_{ij})$ is a symmetric matrix with positive entries, then the matrix

$(1/a_{ij})$ is positive semidefinite. An undergraduate will take a few seconds to see that this is false. The editors would be routinely failing students who write this. How do they see their responsibilities as editors if they pass such writing for publication?

I am not taking cheap shots at anyone and should assure you that I did not pick out *one* bad part of *one* bad paper from this journal. Also, there are 'major' journals with eminent editors publishing comparable stuff. One of the serious problems this is creating is the extra difficulty of peer review, a process that is complex to begin with. In many committees (appointments, then promotions, then prizes) one is faced with long lists of publications with all the 'right' parameters (major international journal, high impact factor) that could impress a neutral but innocent dean.

Incidentally, this is one of the journals which was fooled into publishing a paper generated by SCIGEN, a program that can create serious-looking gibberish. But, of course, it was not the only one so fooled.

My second example is the first paragraph of a book (length less than 250 pages, price more than 100 euros) from another major publisher, long respected for high quality. This book, an English translation from another language, begins with

The statistical theory of the linear regression analysis (Borovkov 1984, 1984a, Cox and Hinkley 1974, Draper and Smith 1981, Demidenko 1981) offers the most spread method of parameter estimation. Consequently, naturally rushing to compare results of own researches to the results obtained with the help of the classical theory. It causes to devote the first paragraphs of the given chapter to a summary of the basic part of this theory to accent its merits and demerits, moreover with the purpose to have a possibility to apply some specially obtained outcomes in the further account. The material of the chapter, for brevity, we explain in language of the matrix theory.

Another para in the middle of the book reads:

Apparently from previous, the problem in such aspect is easy enough for

putting, but uniform computing process as in regression model, already is not present. So development of such approach any more so is interesting as does not leading to use of already available program package as it takes place in the regression analysis where can be used the same standard program….

Translation software on the Internet may do a better job than this. Again the questions arise: Did this pass editors? Are they responsible to publishers and to readers? How many publications of this kind are routinely appearing now? Where does this leave the traditional argument used by publishers for their high prices that they add value to a work by their scrutiny, validation, editing, copyediting, etc.

I have said earlier that advances in technology have not led to lower prices. This seems to have happened because publishing corporations moved faster than academic establishments – not surprising, as that is often the case. The publishing company X knew how much the University A was paying for their journals in the year T. It then created a 'bundle' of all journals A was subscribing to, added to it a few more, and asked A to pay in the year $T + 1$ a few per cent more than it had paid in the year T. Further the publishing company argued for and got multi-year contracts with no cancellations and regular price escalations. The contracts were confidential and pricing now became completely opaque. Subscriber consortia have been formed at various levels, each negotiating a different contract. Recently when some economics authors, writing a scholarly article, tried to find out how much certain universities were paying as journal subscriptions, both Elsevier and Springer contested the request. Elsevier even brought a law suit against the public-funded Washington State University on the grounds that the pricing policy was a trade secret. The Court ruled against this contention[1]. This is a kind of *deja vu* of the infamous law suit in the 1980s that Gordon and Breach brought against the American Mathematical Society and the American Institute of Physics for publishing in their newsletters figures on the comparative prices of journals. (Incidentally, in the ICM panel discussion on 19 August 2014, the Elsevier representative warmly recommended the article of

Bergstrom *et al*. He also said that the subscription price of each journal was available somewhere, though not on the first pages of the journal as it used to be.)

Is Elsevier doing anything that other publishers are not? A little bit of investigation led me to some figures that are interesting. They can be easily retrieved from various articles on the Internet. I present them with the caveat that they may not be the latest figures. This does not matter too much for the present impressionistic discussion.

1. The price per page of various journals was reported as $0.13 for *Annals of Mathematics*, $0.24 for *Journal of the American Mathematical Society*, $0.65 for *Acta Mathematica* and $1.21 for *Inventiones Math*. Elsevier mathematics journals were said to 'average' at $1.30 (ref. 2).
2. In 2011 Elsevier is reported to have made 36% profit, Springer 33% and Wiley 42% (ref. 1).
3. For choosing the Open Access Option Elsevier is typically charging $1500 per article for many of its mathematics journals. Springer is charging $3000. The fee charged by *Compositio Mathematica* published by the Cambridge University Press on behalf of the London Mathematical Society is also $2950. On the other hand the same Cambridge University Press has started two new Open Access journals, *Forum of Mathematics*, *Sigma and Pi*. Their fee is $750 per article. (Figures as of September 2014, on the websites of *Journal of Algebra*, *Journal of Functional Analysis*, *Archiv der Mathematik* and *Mathematische Annalen*.)
4. The income from each science article received by a major publisher is estimated to be $5000. The cost of putting an article on the Arxiv is approximately $10 (refs 3, 4).
5. The American Mathematical Society earns $100 per review in the MathSciNet. The cost to it is estimated at about $50 (ref. 4).

An alternative to high prices for subscribers is high publication fee from authors. This is essentially the 'Open Access' system. Here the major concerns that arise are:

- the mushrooming of parasitic publishers who exist to charge publishing fee.

- the motivation for existing publishers to expand, if their profits depend so directly on the number of papers they publish; this is something akin to doctors performing more surgeries.
- in case of limited budgets, who in a department decides which paper will get publication support? Can this lead to stifling of some areas?
- what happens to papers from less endowed institutions and countries who may not be able to afford high publication charges? Could we have a situation where poorer authors do all the work and then have to get richer coauthors who pay the charges?

I conclude with my wish list for the future:

1. Universities, academies and professional societies should expand their publication programmes. They should devise quality checks. At the same time they should show more sensitivity to the broad spectrum of mathematics pursued by a large number of their members.
2. The role of research publications in assessing individuals working at different positions should be debated and clarified.
3. The misuse of 'metrics' like journal impact factors and citation indices for individual assessments should be protested against. It is heartening that not just the IMU but also the ICSU have taken a clear position that they regard these metrics as unreliable[5].
4. Several respected and established journals have recently been taken over by commercial publishers, either for distribution alone or as joint publications. It will help the community if a 'model contract' is discussed and adhered to. Handing over control of archives to private operators may have unforeseen risks.
5. The developing adversarial relation between scientists and publishers should take a turn for the better. The onus for this lies on publishers at this time.
6. Editors, and especially chief editors, of journals should demand more of the publishers.
7. All mathematicians should learn more about, and become sensitive to, these issues. One test of this awareness could be to demand and get a calculus text book that costs $25 in

North America and weighs less than 750 g. It will be good for the mind, for the wrists, and for the environment.

1. Bergstrom, T. C. *et al*., *Proc. Natl. Acad. Sci. USA*, 2014, **111**, 9425–9430.
2. Aaronson, S. *et al*., The cost of knowledge, http://gowers.files.wordpress.com/2012/02/elsevierstatementfinal.pdf
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