Forum

Scientific Publishing: A Mathematician's Viewpoint

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We are in a time of ferment with regard to the ways in which mathematical research is being communicated throughout the world, and in particular with regard to the nature and cost of scientific journals. This topic has been discussed in articles in the *Notices* by a commercial publisher [1] and by two research librarians [2] and also in numerous letters to the editor. This article examines these and related issues from the point of view of a mathematician who has been actively involved in the journal editorial process.

My main goal is to address the issues raised by the fact that the publishers of some of our best journals (but by no means all of the best ones) have begun to charge such high prices for library subscriptions that to continue with them means to threaten the rest of the collection, but to drop them means to create a big hole in the collection. The situation is puzzling, because the price that publishers charge varies greatly from journal to journal. It is also serious because the most expensive journals include many of the top ones in the field. I want to explore with you the contributing causes, as I see them, and the ways I see for the mathematical community to address them. The principal point I hope to make is that if the people who do the research (the leaders and future leaders in the field) are prepared to act, then the entire system can be changed and the problems solved.

To begin, I will review what we already know: that the essential value in a journal article comes from the excellence of the work of the author and the value added by mathematical colleagues. That is where we *must* begin. The issue of journal subscription prices will be explored next. After that I will describe two ways in which the issue of journal prices has been addressed successfully. The first concerns an example from the neighboring field of theoretical computer science, the *Journal of Logic Programming*.

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Its entire 50-member editorial board resigned and founded a new journal, *Theory and Practice of Logic Programming* (TPLP), with a new publisher whose prices were 45 percent of those of the old publisher. The second is the story of a new electronic and paper journal, *Geometry and Topology* (G&T), which was started by a group of mathematical colleagues with the express purpose of competing in quality with the best journals in the field at the lowest possible price. After that I will mention a new library initiative called SPARC, which is relevant to both TPLP and G&T. In the last section I will summarize my conclusions.

The Articles in a Journal

Let us review what happens from the moment when a mathematician gets the essential idea that will lead to a new paper up to the moment when it is "sent to the publisher" in order to see how value is added at each step by mathematicians.

- Doing the work: Computers have given us new tools, and we can compute examples which were once beyond our reach. Mathematical collaborations between people who are physically far apart has become very easy because of e-mail. But those changes have not made it easier to prove theorems. That is where every paper begins.
- Consulting with colleagues: Most of us test out our ideas with close colleagues as the work is progressing. Thus several experts may have made contributions to the work in question before a manuscript is complete.
- Manuscript preparation: We have learned to "typeset" our own papers, do our own graphics, and in general deliver beautiful manuscripts that are printer-ready when we submit our paper to a journal. Indeed, these days the published version is often precisely the author's TeX manuscript.
- Choosing a journal: Most of the time we want to choose the "best" refereed journal that is likely to accept a paper. Of course the notion of "best" is imprecise and open to interpretation. By and large mathematics is served by a mix of journals which accept papers at many levels, most of them adding to knowledge. Journals have reputations based on the reputations of the members of the editorial board, the quality of the papers they have

published in previous years, and of course the field in which they specialize. So when the moment comes to choose a journal, others in the mathematical community have already contributed, via their expertise, to the reputation of the journal.

- Refereeing: In mathematics, papers are refereed in a careful and serious way. It is part of the culture and of the scholarly process in our field, and it has served us well in the past because the literature is solid and enduring. Consultations will be made to locate a referee who has the skill and time to do the job. But finding a referee is minor compared to doing the job, which can be hard work. The refereeing process adds value to the paper, not in an easily quantifiable way, but clearly it is there.

- Assembling the collection: This part of the workload falls especially heavily on the shoulders of the editor in chief (EiC) or the managing editor (ME).

The owner of a journal owns the journal title and copyright. The moment when a paper is accepted is also the moment when the author is asked to sign a copyright agreement. Since profits, if any, go to the owner of the journal, I wondered whether dollar costs had been incurred by the owner of the journal at any point up to this moment?

- From conversations with many colleagues, I verified that essentially all the work described above is done pro bono, with the possible exception of the contributions of the journal editors. The EiC of the transactions of a professional society journal told us that he asked for a secretary, and the society offered $12,000 to the department to help pay for one. The director of a major professional society added that his organization also provides credit (very small) to editors for the purchase of its books. Largely, however, he said that editors contribute their work without personal remuneration. He then added that to his knowledge the chief editors of most commercial journals are paid, although the amount is "typically quite modest, compared to the cost of a subscription." But the president of a different professional association told us, "One thing which keeps the current publishing system stable is that the EiCs of commercial journals receive financial support from the publishers, so that they do not have an incentive to argue with the publisher about pricing." Two EiCs denied this vigorously. One said, "The financial rewards never played any role with me; however, I do know EICs who regard the money as important." A second said, "The job is lots of work; however, I would gladly take a lower salary if it would reduce journal prices. The publisher said it would not."

- I asked about the salaries of the EiCs of a sampling of commercial journals. I learned about four journals: three with a single EiC, and the fourth with two MEs. Individual salaries were $6,000, $12,000, $14,000, and $22,500. In one interesting example, discussions between the EiC and the publisher about price quickly led to offers of salary increases (which were declined).

Journal Prices

As it turns out, mathematics journals are not all alike. We distinguish four categories of ownership:

(i) Journals whose ownership is grounded in an essential way in the university system. Examples are *Annals of Mathematics*, which is owned jointly by the Princeton University mathematics department and the Institute for Advanced Study, and *Pacific Journal of Mathematics*, which is owned by a consortium of West Coast U.S. and Pacific Rim mathematics departments.

(ii) Journals owned by one of the learned societies, e.g., the AMS's *Mathematics of Computation* or *Journal of the AMS*.

(iii) Journals owned by a university press, e.g., *Ergodic Theory and Dynamical Systems* (owned by Cambridge University Press) and *Quarterly Journal of Mathematics* (owned by Oxford University Press).

(iv) Journals owned by a commercial publisher, e.g., Springer's *Inventiones Mathematicae*, Elsevier's *Topology*, and Wiley-Interscience's *Communications on Pure and Applied Mathematics*.

Roughly speaking, category (i) is the least oriented toward profit, because it is tied solidly to academia, whereas (iv) is oriented in an essential way toward profit, but in between those two extremes there are gradations. Learned societies are not profit-making, but income from the sale of journals impacts on the overall budget: if income goes down, member dues would probably go up. As for university presses, some seem to operate very much like universities and others very much like commercial publishers. In the survey in [3] of the 148 journals in the collection of the University of California Berkeley Mathematics Library, I counted 17%, 13%, 10%, 60% journals in categories (i), (ii), (iii), (iv), surely making mistakes concerning the distinction between (i) and (iii). My count shows clearly that mathematicians will not be able to do very much about the journal price issue unless they learn how to tackle the problems raised by the instances of very high-priced journals in category (iv).

There has been litigation about the rights of professional societies (who are themselves publishers) to publish comparative price data for journals. As a result, at this writing the only comparative data available to the author are from a private survey conducted by Robion Kirby in 1997 and updated in 2000, giving figures for the journals in the Berkeley Mathematics Library [3]. Kirby gave three numbers: the 1996 (respectively 1999) subscription price to libraries; the number of pages published in the same year; and their ratio, the cost per page. Other relevant information that Kirby did not obtain is the number of libraries subscribing to a given journal. We simply do not know the extent to which price has forced cancellations. Kirby's data showed that in 1999 the price to libraries for a one-year subscription to the journal *Annals of Mathematics* was $220 for 2,290 pages, about $.10/page, whereas the corresponding figure for the Springer-Verlag journal *Inventiones Mathematicae* was $2,838 for 2,881 pages, or just under $1.00/page! Both are top-quality nonspecialized journals. One might think the explanation is that we are comparing categories (i) and (iv), but that fails to explain the many examples in Kirby's list of commercial publishers with well-known names who

appear to be thriving with charges of $.76/page, $.65/page, $.48/page, $.32/page, $.23/page. Market forces, as we normally understand them, do not seem to be working at all.

The chaotic journal price situation had developed in an atmosphere of general panic about the effect of the Internet on journals. Nobody really had a clue as to whether mathematical journals would survive the electronic revolution intact. Some of the commercial publishers began a spiral of steadily increasing prices, and a crisis situation quickly developed in the libraries. The academic community was very hesitant to trash its "best" journals because prices were too high. Instead, many libraries made decisions to cut other journals, and therein lies the problem that is still with us today.

What to do? Kirby's initial suggestion was that mathematicians meet this challenge to our libraries by individually boycotting the most expensive journals, refusing to referee for them, and submitting their own papers elsewhere. He suggested resignations from the editorial boards (EBs) of the most offending journals. I think that more is needed.

A Solution to the Price Problem: Shop for a New Publisher

In November 1999 the complete EB (50 editors total) of the *Journal of Logic Programming* (JLP), published by Elsevier Science, collectively resigned after sixteen months of unsuccessful negotiations about the price of library subscriptions. They founded the new journal TPLP, which will be published by Cambridge University Press. Its subscription price will be 45 percent of that of JLP. How did this come about? I wrote to Krzysztof Apt, president of the Association for Logic Programming (ALP), and received an informative and extremely interesting answer from him, which is the basis for what follows.

The Association for Logic Programming was founded in 1986 in London. Currently it has more than four hundred members worldwide. The journal JLP was founded in 1984 by Alan Robinson (now retired) and was adopted by ALP as its "standard" journal. The publisher, Elsevier, appointed consecutive editors in chief, as proposed by ALP. The contracts were always between Elsevier and the EiC. During the past eight years the EiC was Maurice Bruynooghe, of the University of Louvain, Belgium. The EB of JLP (and now the EB of TPLP) includes among others Alain Colmerauer (University of Marseille), the creator of Prolog, the most known logic programming language; Robert Kowalski (Imperial College, London), the creator of the logic programming paradigm; Jeff Ullman (Stanford), a member of the U.S. National Academy of Engineering and, according to ResearchIndex (`http://citeseer.nj.nec.com/cs`), the most cited computer scientist in the world; and John McCarthy (Stanford), one of the founders of the field of artificial intelligence and winner of the Association for Computing Machinery's Turing award, the most prestigious award given to computer scientists for their research. He is also the winner of the prestigious Kyoto Prize, given to outstanding scientists, and the U.S. National Medal of Science; and is a member of the U.S. National Academy of Sciences.

The price of JLP for libraries in 1984, the year the journal started, was about $.28/page; in 1986 it was about $.26/page (lower); in 1996 it was $.67/page. This is about a 158% increase in ten years. Apparently in this period the Consumer Price Index increased in the U.S. by 44%. In 1999 prices had gone up to about $.88/page. In June 1998 Apt contacted Elsevier, asking to discuss the issue of excessive subscription prices for the libraries. He met with their representatives in Amsterdam in July 1998. They informed him that the price for 1999 was already fixed. Concerning prices for 2000 they promised a reply to Bruynooghe, the EiC. This eventually happened in March 1999. They asked the editors and the Association to form a committee that would discuss the matter.

In his first e-mail to the committee, in the beginning of May 1999, the representative of Elsevier apparently mentioned that the price for 2000 was already fixed and would be 7.5% higher. Further discussions turned out to be fruitless. The committee concluded its work at the end of June 1999. Bruynooghe resigned as the EiC (his resignation being effective at the end of 1999) and declined to name a successor. The Association agreed to name a successor only under condition that Elsevier substantially lowered the prices for the libraries.

In autumn 1999 Apt informed Elsevier that he was in touch with another publisher to launch a cheaper logic programming journal if negotiations failed. This eventually led Elsevier to some concessions. These were, successively: (i) increasing the prices for libraries in 2000 by the inflation rate 2.5% instead of 7.5% that had been announced earlier; (ii) various involved schemes concerning a lower price for electronic access only; (iii) some advantages to the members of the Association; (iv) doubling the size of the journal without increasing the price. But the editors rejected all concessions, demanding a price reduction of at least 40%. The Elsevier representative called several editors, proposing to them the position of EiC. Nobody broke rank.

In November 1999 the EiC organized a vote among all editors concerning the matter. This led to a unanimous decision to leave Elsevier. The editors collectively resigned and moved to found the journal *Theory and Practice of Logic Programming* (TPLP) with Cambridge University Press. The price reduction will be 55%. Jack Minker of the University of Maryland was asked by the editors to become the founding editor in chief of TPLP. Minker agreed, with the understanding that shortly after the first issue of TPLP appears he will resign in the expectation that Bruynooghe would then become EiC of TPLP. Bruynooghe followed the board and terminated his work for Elsevier by the end of 1999. As a sign of good will, he and the editorial board allowed Elsevier to keep their names on the masthead of the JLP throughout 2000, until all papers handled by them have been published.

In February this year the Elsevier representative informed the founding editor, Robinson, that they would like to continue to use his name on the masthead of the JLP beyond 2000. He categorically refused. In March Apt placed an announcement on numerous Internet newsletters explaining the formation of TPLP and requesting that libraries and individuals now support TPLP. He has received several

congratulatory e-mail messages from a number of prestigious libraries.

Apt made specific what I had guessed might be true: "Our move was possible thanks to the leadership of the former editor in chief, Maurice Bruynooghe, who put the interests of the community over his own interests."

A Different Solution to the Price Problem: A New Nonprofit Journal

Most new journals are started when a group of mathematicians senses the need for a new one. The journal *Geometry and Topology* (G&T) was no exception, but this time the felt need was genuinely new: to run a journal of top quality essentially free, using authors' labor for the typesetting and the Internet for distribution of its electronic version.

G&T was started by Colin Rourke, Brian Sanderson, and John Jones of Warwick University, with the help of Kirby. As a member of the initial editorial board, I add that Rourke communicated his enthusiasm to the rest of us, so that we all felt a little bit like pioneers with a mission. It was very exciting! Members of the EB of G&T currently include three Fields medalists (Michael Freedman, Simon Donaldson, and Vaughan Jones) and a long list of other very distinguished mathematicians. Since one of the missions was to establish very high standards, the ground rules called for extensive discussions among members of the editorial board, with all correspondence carried out by e-mail. As it has turned out, the collegiate e-mail discussions have been both broadly based and at an extremely high level. This rather prosaic use of the e-world is perhaps the most innovative aspect of the journal. The electronic version of G&T is published in PostScript and PDF. One may look at it by going to `http://www.maths.warwick.ac.uk/gt/`. Hardcopy is printed by International Press, which also fills orders and mails the journal.

Knowing that I was planning to write this article, Rourke offered to tell me about his experience with the costs, both in dollars and in time, to get G&T up and running:

> There were no secretarial or setting-up costs. Computer costs for running a journal the size of G&T are negligible, given the fact that universities are already networked and provide good computing facilities for their staff. I estimate that the size of the Warwick Maths computing system is about four orders of magnitude greater than that needed to run G&T. But then this is the whole point: journals are firmly based in the academic world and all piggy-back to a great extent on that world.

> Academic time costs to set things up: I would guess 500 hours, with ten weeks of really hard work. It was done in bits over a long period, so it is difficult to be accurate—I could be off by a factor of 2 either way. If we were setting up again now, it would be much less—we've been on a steep learning curve. Brian has done the Web site and PERL scripts (see below), and I've

> done all the TeX stuff: designing formats, writing macro files, etc. Most of this is replicable, and we could very quickly set up another similar journal or help others to do so.

> Academic time costs for day-to-day running: A great deal of this is automated. We get authors to submit their papers by a WWW submission form. This comes to us as an e-mail message, which we process by a PERL script. This little program moves files to the correct places and generates e-mail messages to the author and the responsible editor (we can edit these messages as they fly past!) and updates the journal mainlog. If all goes well, this takes about 10 minutes total. Then there is sending out reminders to responsible editors, circulating discussions around the EB, sending out rejection/acceptance letters to authors, etc., which probably take around 15 minutes total per paper—some more, some less! We have templates for all standard letters. Once a paper is accepted, there is the preparation of the TeX file for publications. If a paper is in good format, it can take very little time to prepare; on the other hand, one of the excellent submissions we received was in dreadful shape. Averaging, I'd guess one hour of my time (I do most of this bit by bit) per 10 pages. We could cut this a lot by (a) leaning more heavily on authors or (b) accepting a greater variation in appearance between different papers. We could cut the preparation time to zero by doing what some of the e-print servers do, which is to accept anything that TeX will accept. Finally, publication is also automated with another PERL program, which moves files around and announces publication to the EB. So an outside estimate of the total bill (in academic time) is two hours per paper plus one hour per 10 published pages. This is all very difficult to translate into cash. Using graduate student labor for some of the more routine work makes sense. One good TeXie ought to be able to do all this for several journals the size of G&T.

> Archiving costs: The printed version of G&T provides the same level of permanence as for print-only journals, but there should also be a permanent electronic archive. For our needs LANL [4] (also known as "xxx" or "the arXiv") seems to be a natural choice, and G&T is now setting in place mechanisms to use it. LANL is supported by U.S. government funds and seems to be a secure place for the archiving of journals if anything should go wrong at Warwick. At the very least LANL seems as secure in its future as the commercial publishers. (We all know many examples of former commercial giants who have disappeared from the scene.)

Printing costs and return from sales: The only place where G&T incurs dollar costs is in the printing of hard copies. In order to print efficiently we need to print approximately 200 copies. If we sell at $.10 per page (a target cost to keep costs to libraries to the minimum), then after adding handling and postage this grosses up to around $.13 per page. We break even at 80 sales. If we sell all 200, we generate $12 per page profit, more than enough to pay for the formatting, with an efficient setup.

The Libraries and SPARC

When a new mathematics journal is launched, it must face the problem of how to get into mathematics libraries. I discussed this matter with Barbara List, the director of the Columbia University Science-Engineering libraries, and she told me about SPARC, the Scholarly Publishing & Academic Resources Coalition, whose Web site is `http://www.arl.org/sparc/`. SPARC is a consortium of 182 major North American and international research libraries (including Columbia), with new ones signing up every month. Founded in 1997 by a group of members of the Association of Research Libraries, an institutional professional society, its goal was to address library problems caused by rising journal prices.

Here is one of the things SPARC does. When a new journal appears that might be a high-quality, low-cost alternative to a well-known high-priced journal (e.g., G&T vs. Springer-Verlag's *Topology*), consultations are initiated with members in the discipline, and a judgment is made as to the viability of the new journal. If SPARC signs a contract to *partner* with the new journal, the advertising and publicity needed to get it into member libraries will be handled by SPARC, whose members have agreed to promote the new journal among faculty members and to commit funds from their annual budgets to buy partner journals that fit their collections. This and other SPARC activities are supported by member dues.

An example of a SPARC partner is the journal *Evolutionary Ecology Research*, which had a history very much like that of TPLP. With the SPARC "seal of approval" and member support, it achieved break-even at the end of its first year. For comparison's sake, I was told by librarians that an excellent new journal typically needs five years from launch to become self-supporting. Today SPARC has eleven partners, the newest being G&T , whose SPARC subscriptions have begun to come in. Discussions are under way between SPARC and TPLP.

Summary and Conclusions

We are currently witnessing what must be properly identified: a battle for the ownership, transfer, and dissemination of scientific information. The issue is extremely serious, and it reaches across many disciplines. Yet we have seen by examples that we are not powerless to fight it:

1. Individuals who are in a leadership position can put community interests ahead of their own interests and work seriously with their colleagues on editorial boards and with the publishers to lower prices. If that fails, it is time to go shopping for a new publisher. That is what a market economy means, and there is nothing shameful in shopping for the best buy. To fail to do that is to put our literature and our libraries at risk.

2. Every new journal in mathematics begins with a group of mathematicians who sense a need and decide to work together to get it going. Interested mathematicians, perhaps a subset of those who are already on the editorial board of an overpriced journal if the full board cannot agree, can get together and start a new journal with the express purpose of competing with the old one. SPARC is there to support exactly such an enterprise. Electronics has made it much easier than it was fifteen years ago. Yes, it is a very big commitment of time and energy, but it has been done over and over in the past. The only new feature is that these days mathematicians can go shopping for the publisher, whereas in the past the publishers went shopping for the mathematicians. Yes, any such mass movement would lead to new forms of resistance from old-style publishers, but I expect that it would also lead to opportunities for new-style publishers who see a chance for a profitable business in the inexpensive assembly and distribution of mathematics journals.

3. Library committees can also make a difference. If they simply have the courage to end subscriptions to the very expensive (and often excellent) journals, these journals will die. If they simultaneously vote to support new journals with high-quality editorial boards and low prices, these new journals will have a chance to live and grow.

4. Authors can help too by considering journal price along with other factors when deciding on a journal in which to publish.

5. The issue of copyright has not been addressed in this article because it has been discussed extensively elsewhere in the *Notices*, but it is relevant to our discussions. With respect to copyright the AMS Consent to Publish form (which is a proper subset of its Consent to Publish *and* Copyright Agreement) is particularly author-friendly. "Copyright" transfers ownership to the publisher, whereas "Consent to Publish" allows the author to retain ownership of his/her work. Authors are advised to read copyright agreements carefully and to tell the publisher if they wish to give consent while retaining copyright. This matter appears to be more negotiable than most mathematicians think it is.

References

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