Scholarly communication in the 21st century – the impact of new technologies and models

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The basic model for scholarly communication in science and technology has remained unchanged for over three hundred years, with the journal playing the central role. However, over the past thirty years there has been growing concern as journal prices have increased faster than library budgets and fewer readers have had access to the journals they need, leading to the well-documented 'serials crises'. This paper will show how by harnessing the power of the internet, authors will be able to distribute their work to all interested readers. It will describe how universities can take responsibility for archiving their intellectual wealth and making it more widely available. Finally, the paper will show how the adoption of institutional repositories and open access journals could bring about a change in the financial model of journal publishing, bringing cost savings to society and improving communications, while still preserving the important functions of peer-review.

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Introduction – the situation today

There is little doubt that the current scholarly communication environment faces crisis. That this should be so is hardly surprising as the basic model for scholarly communication has remained fundamentally unchanged for over three hundred years. A process that was initiated in 1665 (with the launch of the modern scientific journal) to satisfy the needs of a few hundred 'scientists' (they would not have used the word to describe themselves!) continues today despite the exponential increase in research, the emergence of a science 'industry', and the migration to the internet.

Publication in scientific journals allows authors a means of communicating their new research while laying claim to the intellectual priority of their work. Readers have used journals as a means of keeping up to date with the latest research (quality controlled through peer-review) and as a discovery tool for research carried out in previous years (through access to the archive). These are clearly valuable functions.

Since the 1970s, however, there has been growing doubt cast on the ability of journals to fulfil these functions. The economic reality has been that journal prices over the past 30 years have increased significantly more rapidly than library budgets. (For example, the Association of Research Libraries (ARL) reports that the average cost of STM journals rose by 226% between 1986 and 2000, while the consumer price index rose by 57%. During this period, library spending on journals rose by 192%.) Libraries worldwide have had to cancel subscriptions, so reducing the circulation of the journals and, consequently, the number of readers with access. This brought about the well-documented 'serials crises' as decreasing circulation led to increased prices and further cancellations in a vicious circle.[1] Now, not even the wealthiest institutions can purchase access to all the information that its researchers require to be effective.

Since the 1990s the widespread adoption of the internet has resulted in some improvements in scholarly communications. Papers can often be published more quickly online than in print. More importantly, readers can access papers at their

desks rather than having to visit the library. Now, with site licences and consortia deals the downward trend in readers has been reversed for the first time in many years.

However, the fundamental problem remains. In many cases, the rate of increase in cost to libraries for electronic access continues to be greater than the increase in budgets for many libraries. Therefore, we will see the same pattern as has been observed over the past thirty years – the number of people with access will slowly decline as the price of electronic access increases and the information gap will once again widen.

SPARC Europe

Faced with the continued and growing problems described above the library community has looked at ways in which it could positively influence the communications process for the benefit of authors and readers. One of the most prominent recent initiatives has been the formation of SPARC (in 1998) and SPARC Europe (in 2002). [2]

SPARC was founded in 1998 as a programme of the Association of Research Libraries. From the start the intention was to promote alternative publishing solutions and to advocate change in the scholarly communication market. This dual strand of publishing initiatives and advocacy has been highly successful and led to the formation (under the auspices of LIBER) of SPARC Europe.

SPARC's early success was with a group of journals launched to rival existing high price titles. A number of these titles now exceed their competitors in quality (as measured by impact factor) and popularity (as measured by number of submissions and papers published.) (For more details see Mary Case's paper listed in ref.2.) While this strategy continues, SPARC and SPARC Europe have increasingly looked to the introduction of institutional repositories and the open access journal model as a means of giving libraries and researchers their first chance to change fundamentally the way that scientific information is communicated.

In the rest of this paper I will investigate how, by looking closely at the functions performed by scholarly journals, we can determine how new technology and models can better serve the international research community.

New opportunities

Throughout history technological developments have resulted in new ways of imagining processes. Often, the technology is initially used in unimaginative ways, simply replicating the exiting models. (One thinks, for example, of the original motor cars which looked like traditional carriages without the horses!) Over time, better ways of using the technology are designed and new models are developed. We are at this stage with the internet and scholarly communications. To date, online versions of print journals have been produced, but almost all provide access only on the old subscription model, placing price barriers before readers. Over the past couple of years new thinking has developed and the question of whether it might be possible to totally re-engineer the scholarly communication process has been asked. Might there be new financial models that use new technology to better fulfil the functions of journals and better serve authors, readers and, ultimately, research?

Traditionally, journals have been seen to perform four functions: registration, certification, awareness, and archiving. [3] That is,

Registration – the author wishes to ensure that he is acknowledged as the person who carried out a specific piece of research and made a specific discovery.

Certification – through the process of peer-review it is determined that the author's claims are reasonable.

Awareness – the research is communicated to the author's peer group.

Archiving – the research is retained for posterity.

The current model integrates these four functions into a single package – 'the journal'. This made perfect sense in the print environment. However, in the new information environment it is sensible to ask whether the integration of these functions still provides optimal efficiency or if we can design a better system if we meet the functions in different ways. One option is to investigate the interaction between institutional repositories and open access journals.

Institutional repositories

The term 'institutional repositories' has been used to describe digital collections capturing and preserving the intellectual output of a single or

multi-university community.[4] Institutional repositories (hereafter 'IR') would have a number of features and functions:

Institutionally defined: content generated by an institutional community.

Scholarly content: they may contain a wide range of material that reflects the intellectual wealth of an institution – for example, preprints and working papers, published articles, enduring teaching materials, student theses, data-sets, etc.

Cumulative and perpetual: they would preserve ongoing access to material.

Interoperable and open access: they should be built to common international technical standards to ensure that the material can be searched and retrieved[5] and they should be available freely over the internet.

If researchers were to place the results of their research into their local IR, three of the functions of a traditional journal would be immediately met:

1. *Registration* – by depositing in the repository the researcher would make claim to their discovery.

2. *Awareness* – by constructing the repository to internationally agreed standards the institution would ensure that the researcher's work would be found by search engines and available to their peers.

3. *Archive* – the institution would be responsible for maintaining the long-term archive of all the work produced by members of that institution.

There are many benefits, at many levels, to IR. For the individual they provide a central archive of their work and increase the dissemination and impact of their research. The researcher's institutions benefit from increased visibility and prestige as the full range of the work supported is seen. In this way, the IR can act as an advertisement for the institution and can be used in attracting third-party funding sources, potential new faculty and students, etc. For society the IR would ensure long-term preservation of institutes' academic output (output that is currently rather precariously archived as few institutions have robust archiving policies). Finally, and most valuably, a network of IRs would allow all interested readers access to all of the world's primary research literature.

Peer-review and open access journals

The one function of the traditional journal that institutional repositories do not fulfil is certification or peer-review. Each institution will be able to make its own policies on how material is to be deposited in the repository, and some may insist that papers receive at least an initial review before being made widely available. However, this will not be a substitute for independent, international peer-review. Peer-review serves the reader as a mark of quality and it is used by authors to validate their research (which is of particular importance in their next grant proposal or attempt at promotion). Peer-review journals could sit comfortably with the network of IRs. Authors who wanted their work to be peer-reviewed could, after they had deposited it in their local IR, send it to their journal of choice. At this stage the work would be evaluated as in the current system and, if considered by the editor of the journal to be acceptable, the paper would be published in the journal and so receive the journal's quality stamp.

Obviously, with all the relevant material available for free on a network of IRs it becomes impossible for a journal to charge a subscriber to access a paper in the journal. The peer-review journals, therefore, would need to have no access restrictions on them – that is, they would be 'open access'.

Open access journals would give free and unrestricted access through the internet to all primary literature published within the journals. This literature is given to the world by scholars without expectation of payment and in the hope that it is distributed and read as widely as possible. Open access provides these authors with a major benefit. Making their work freely available over the internet immediately distributes it to the 650 million people worldwide who have internet access, not just readers at the few hundred institutions lucky enough to have a subscription to the journal. This increases the profile of the authors, their institutions, and their countries.[6]

Giving all interested readers access will accelerate research, enrich education, share learning among rich and poor nations, and, ultimately, enhance return on investment in research (much of which comes from the world's taxpayers). From being in a position where

institutions cannot supply all the information needs of the researcher, researchers will be able to access all of the relevant information they need to be effective.

Without subscription income publishers will have to look at new financial models to support their journals. There are costs associated with the peer-review process and with publication of a paper (even if it is only online), and these costs must be met somehow. A number of possible revenue sources for open access journals have been identified,[7] including direct grants from government, academies, and independent foundations, subvention by libraries and university departments, advertising and sponsorship, or a combination of these. However, one of the most stable sources of income may be that where authors pay a publication charge, so ensuring that the publisher would receive sufficient revenue to make the paper available to all with no access restrictions. Ultimately, it would be for the research funding bodies or the authors' institutions to cover the publication charge, but basically this model looks to a move from paying for access to material (through subscriptions) to paying for dissemination.

Theory into practice

The scenario described above – a network of institutional repositories with an over-layer of peer-reviewed journals, all open access and free to all – may sound utopian, but already many positive steps are being taken to realize this future.

Institutional repositories Three open source software packages exist for setting up and managing institutional repositories.[8] Almost 100 institutions worldwide have set up repositories using this software. In addition, there are at least two major national projects investigating how to set up national infrastructures for institutional repositories – SHERPA in the UK, and DARE in The Netherlands.[9,10]

Open access journals The number of open access journals publishing high quality, peer-reviewed research is growing. SPARC and SPARC Europe are in partnership with a number of these journal publishers,[11] in particular, BioMedCentral who have now published over 2000 papers in 80 open access journals. New open access initiatives are regularly being announced, including the recent decision of the Indian Academy of Sciences to make their 11 journals open access[12] and the Public Library of Science decision to launch two high-quality open access journals in biology and medicine.[13] In addition, a plan has been put forward to transform current subscription-based journals into open access journals and it is expected that a number of publishers will shortly announce their intention to follow this model.[14] SPARC and SPARC Europe also support the *Directory of Open Access Journals (DOAJ)* developed by Lund University in Sweden. Launched in the last few weeks, the *Directory* lists 340 peer-reviewed open access journals, with more titles being added.[15]

Next steps

It is my belief that there is growing international momentum in favour of institutional repositories and open access journals. Increasing numbers of libraries are taking on the role of hosts for IR, becoming responsible for maintaining the intellectual heritage of their institution. The success of growing numbers of open access journals is proving the feasibility of the new business models. As success is proved, more authors, university administrators, librarians, and funding bodies are becoming aware of the limitations of the current system and possibilities of the new models.

Over the next few years all players in the communication process can play a part in making change happen.

Publishers can:

look at their author agreements – can they be more flexible and allow authors the right to deposit their own material on their local IR? (See Project RoMEO at Loughborough for a comparison of publisher views on rights[16]).

consider moving their existing journals to open access, using the business plans produced by SPARC Europe and the OSI as models for transition.[7, 14]

make any new journal launches open access.

Librarians can:

establish institutional repositories.

help faculty archive their research papers (new and old) within the repository, digitising older papers if necessary.

help open access journals launched at their

institutions become known to other libraries, indexing services, potential funders, and potential readers.

ensure that scholars at their institutions know how to find open access journals and archives in their fields and set up tools to allow them to access them (particularly by cataloguing open access journals listed in the Lund *DOAJ*[15]).

as open access journals proliferate, and as their usage and impact grow, cancel over-priced journals that do not measure up.

familiarise themselves with the issues.[17]

support SPARC and SPARC Europe to multiply their effort.[2]

Conclusion

The scientific journal served the community well for many years (if not centuries!). However, we find ourselves in a significantly different environment from that in place when journals were created. Is this not the moment to re-examine the communication process, to analyse what it is that authors, readers, and society require of it, and to take advantage of the new opportunities while still retaining those parts of the current system (such as peer-review) that serve research and education? We have the opportunity to create a system that better serves authors (by giving them the wide dissemination they require) and readers (by removing access barriers to the information they need). This will enhance research and education worldwide and bring great benefits to society. Surely, this is the time to create change!

References

1.   A collection of papers on this topic can be found at: http://www.lib.utk.edu/~jon/crisis.html

2.   See the SPARC and SPARC Europe websites: http://www.arl.org/sparc and http://www.sparceurope.org A detailed history of the formation of SPARC has been given by Case, M.M., Igniting Change in Scholarly Communication: SPARC, Its Past, Present, and Future. *Advances in Librarianship*, Vol. 26, pp.1-27, 2002.

3.   Roosendaal, H.E., and Geurts, P.A. Th. M., Forces and functions in scientific communication: an analysis of their interplay. *CRISP 97*, 1998.

4.   Crow, R., *The Case for Institutional Repositories*: A SPARC Position Paper, 2002. http://www.arl.org/sparc/IR/ir.html

5.   For details of institutional repository technical specifications see the Open Archive Initiative: http://www.openarchives.org

6.   An excellent expansion of the benefits of open access is given in Peter Suber's 2003 paper 'Removing the Barriers to Research: An Introduction to Open Access for Librarians': http://www.earlham.edu/~peters/writing/acrl.htm

7.   See the Crow and Goldstein *Guides to business planning for open access journals*: http://www.soros.org/openaccess/oajguides/index.shtml

8.   Details of the various Institutional Repository software can be found at: Eprint – http://www.eprints.org/ DSpace - http://www.dspace.org/ CDSWare - http://cdsware.cern.ch/

9.   http://www.sherpa.ac.uk/

10. http://www.surf.nl/en/themas/index2.php?oid=7

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15. http://www.doaj.org

16. http://www.lboro.ac.uk/departments/ls/disresearch/romeo/index.html

17. See, for example, *Create Change* (www.createchange.org)

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