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The Next Information Revolution - How Open Access Repositories and Journals will Transform Scholarly Communications

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INTRODUCTION

The birth of modern scholarly communications can be dated to the second half of the seventeenth century with the launch of the *Journal des Savants* in 1665 and the *Philosophical Transactions of the Royal Society* in 1666. At this time scientists (although they would not have used the term to describe themselves!) were driven by two motives to publish - they wanted to communicate their discoveries and share knowledge, but they also wanted to lay intellectual claim to their discoveries and insights, so registering intellectual priority. In the 300 years that followed authors continued to feel the force of these motives. As researchers increasingly had to compete for research grants and university positions their publication records became the main features of their CVs. Journals, therefore, had a ready supply of 'raw material'. Journals also easily found readers. Researchers need to keep up with the latest results and the scholarly literature became a research tool as new discoveries were built upon the work of others described within journals. Quality was assured through the system of independent peer-review and libraries ensured the continuing availability of historical research by maintaining archives. The number of researchers, the amount of research published, and the number of journals has grown steadily since 1665, until in the second half of the twentieth century the system began to show signs of sever strain. Libraries could no longer afford to purchase all the journals that all the researchers at the institution required. This led to declining subscriptions followed by increased prices as publishers tried to maintain their profit margins. Prices increased more rapidly than library budgets; leading to more cancellations, further price increases, more cancellations, and triggering a vicious cycle of reduced access to research. This is the well documented 'serials crises'. **[1]**

The introduction of the Internet in the 1990s has brought a number of changes to the way that the literature is accessed and used. Firstly, in many cases it has accelerated the transfer of knowledge. In some subject areas electronic pre-prints make results available months earlier than they would have been in the old, print-only system. Even in subject areas where pre-prints are not the norm, online publication makes papers available to all subscribers at the same time as it eliminates postal delays. More fundamentally, reading patterns have changed as readers can now access the literature from their desks, rather

than having to go to the library. This is probably also promoting a shift towards searching for information (through online abstracting services) rather than browsing (through journal tables of content). The Internet has also allowed libraries to come together to purchase information as consortia and for publishers to offer their entire corpus of journals for sale as bundles. In this way, the average researcher now has access to more of the literature than they did ten years ago. While this is obviously a good situation it is not destined to last for long. The rate of increase in the costs of access to these electronic bundles continues to be higher than the rate of increase in library budgets. Therefore, we will see the same pattern as has been observed over the past thirty years - the number of people with electronic access will slowly decline as the price of access increases. The rise of the Internet and new digital publishing technology gives us the opportunity to examine carefully what it is that we require of a scholarly communications system. In particular, we can begin to think of new tools and business models that better provide the international dissemination and impact that authors require, together with quality control and access needed by readers. The combination of institutional repositories and open access journals is increasing, giving libraries and researchers their first chance to change fundamentally the way that scientific information is communicated. They hold out the promise of providing a fairer, more equitable, more efficient system of scholarly communication, and one that can better serve the international research community.

THE SITUATION TODAY

Many thousands of words have been written on the 'serials crisis' and its cause. Basically, it represents a gap between the proportion of the literature that libraries can access and the information that researchers need to be effective. This gap has widened as over the last few decades the annual rise in average subscription price for science, technical, and medical (STM) journals has outstripped the increase in library budgets around the world. For example, the Association of Research Libraries (ARL) report that the average cost of STM journals rose by 227% between 1986 and 2002, while the consumer price index rose by 64%. **[2]** During this period, spending on journals by ARL libraries managed to keep pace with the price rises, but only by transferring an ever-increasing proportion of the library budget to journals. Not all institutions worldwide, especially those institutions that are less well funded than the ARL members, have been able to keep up with price rises.

Following the introduction of the Internet most leading peer-reviewed journals are now available online. Libraries have over the past few years taken advantage of consortia and bundle deals to access more material than they had subscribed to in print. In online publishing, there are few additional costs in allowing extra libraries to subscribe to online journals (once the initial costs of publishing online have been covered). Therefore, a library can be offered online access to all of a publisher's titles, rather than print access

to a proportion of the titles. Alternatively, libraries can band together in consortia to negotiate a deal whereby all members of the consortia gain access to all journals in the publisher's portfolio. Invariably, these deals are priced by the publisher at a rate above what the library (or consortia) currently spends with that publisher.

There are undoubted benefits to institutions in taking up these deals as they are able to greatly extend the amount of material they can offer to their researchers. However, to find the extra money for the bundles the library often has to cut back in other areas. Further, the annual rate of increase in price for the bundles is often greatly in excess of any increase in library budget. This is especially true currently when many libraries worldwide are actually facing budget cuts. To maintain the bundles, libraries must transfer additional funds from the monograph acquisitions budget or cancel journals that are not part of the bundles (for example, high quality journals from society publishers). So, having initially gained access to addition titles, we now face a new 'serials crises' where the librarian does not even have the freedom to cancel under-used journals that are part of the bundle. Peter Suber identified a further crisis - the 'permission crisis' -, whereby legal and technological barriers limit how libraries may use the journals for which they have paid (Suber, 2003). These barriers are made up of copyright law, licensing agreements, and digital tights management that block access.

The information gap described above has resulted in widespread dissatisfaction with the current scholarly communication model at a number of levels. Authors want to put their work before their peers and before society as a whole, and they do this without any expectation of direct financial reward, e.g. from royalties. In fact, they often have to make a financial contribution to the costs of publication in the form of page charges, figure reproduction charges, reprint costs, etc., as well as giving away the copyright of their text, so limiting their further use of their own work. In return for donating their papers (together with a financial contribution and surrender of copyright), the current system places barriers between authors' work and their potential readers, so resulting in reduced dissemination and impact of their work. Readers are dissatisfied, as they cannot get access to all the research that they need. The research literature is the most potent research tool available - it educates, provokes, and inspires researchers. The current system denies access to the complete body of the literature, so making the tool much less powerful and reducing the effectiveness of researchers. Librarians are dissatisfied as they are not able to meet the research needs of their users (both researchers and students). Even the wealthiest institutions cannot purchase access to all the information that its researchers require to be effective. A recent UK report of the Research Support Libraries Group (RSLG) accepted that

"*...providing all of the information required by UK researchers is beyond the capability of any single library; and indeed that the aggregated efforts of all UK research libraries are failing to secure a national collection in keeping with the researchers' current and emerging needs and demands.*" (Final Report, 2003).

Finally, Society as a whole loses if we continue with sub-optimal communications channels that restrict the free-flow of information between the world's scholars and the public.

NEW OPPORTUNITIES

As a result of the problems described above, many have looked at the continued development of the Internet and new electronic publishing tools and have asked whether it might be possible to totally reengineer the scholarly communication process. Rather than only producing online versions of print journals accessed using traditional subscription-based models, 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? The most profitable approach to finding ways of using new technology and business models to provide solutions to the serials crisis is to look carefully at what it is that journals actually do. Traditionally, journals have been seen to perform four functions: Registration, Certification, Awareness, and Archiving (Roosendaal & Geurts, 1998). That is,

- *Registration* - the author wishes to ensure that he/she 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 traditional journal integrated all these functions into the print issue, distributed through subscriptions. This made perfect sense in the print environment where the production of extra copies incurred extra costs, which were recovered by charging subscriptions. In the new environment dominated by the Internet and digital publishing technologies it is perhaps no longer the case that integrating these functions is the most efficient solution.

In December 2001 a meeting was convened in Budapest to address these issues, to scrutinise potential new models, and to investigate the best ways in which the new technology could be used. As a result of this meeting the Budapest Open Access Initiative (BOAI) was published in February 2002. The BOAI identified two parallel and complementary strategies that could be used to move towards a fairer, more equitable, and more efficient communications system. These were self-archiving and open-access journals. Self-Archiving refers to the right of scholars to deposit their refereed journal

articles in searchable and free electronic archives**.** Open Access Journals do not charge for access to the papers, but make the papers available to all electronically and look to other financial models to cover the costs of peer-review and publishing. They do not invoke copyright or exclusive licenses to restrict access to the papers published within them, rather they encourage the dissemination of research limited only by the reach and extent of the Internet. These complementary approaches will now be investigated in more detail to show how by acting together they can fulfil the functions required of a 'journal'.

SELF-ARCHIVING IN INSTITUTIONAL REPOSITORIES

The terms 'institutional repositories' and 'open archives' have been used to describe digital collections capturing and preserving the intellectual output of a single or multi-university community (Crow, 2002). They may contain a wide range of materials that reflect the intellectual wealth of an institution - for example, pre-prints and working papers, published articles, enduring teaching materials, student theses, data-sets, etc. The repositories would be cumulative and perpetual, ensuring ongoing access to material within them. By building the archives to common international technical standards - specifically, to the Open Archive Initiative (OAI) standards - the material deposited within them will be fully searchable and retrievable, with search engines treating the separate archives as one. Readers will not need to know which archives exist or where they are located in order to find and make use of their contents. To maximise the use and impact of the repositories the material within them should be freely available over the Internet.

While an institutional repository can make available a wide range of material (as described above), this paper is concerned only with the peer-reviewed research literature. If researchers were to place the results of their research into their local institutional repository, i.e., to self-archive their papers, 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 OAI standards the institution would ensure that the researcher's work would be found by search engines and available to their peers. New alerting services could be developed that would inform readers of new papers deposited in any repository that matched their research interests (in the same way that journal table of contents can be received).
3. *Archiving* - the institution would be responsible for maintaining the long-term archive of all the work produced by members of that institution. This would place the onus of archiving back onto the library community where it has rested for

> centuries, rather than on the publisher community where it has migrated following the transfer from print to online. In many cases the research library will be best placed to maintain over many decades an archive of its own research.

As well as fulfilling these three functions of the traditional journal, there are many benefits, at many levels, to institutional repositories.

For the individual:

- they provide a central archive of the researcher's work
- by being free and open they increase the dissemination and impact of the individual's research
- they act as a full CV for the researcher

For the institution:

- they increase the institution's visibility and prestige by bringing together the full range and extent of that institution's research interests
- they act as an advertisement for the institution to funding sources, potential new researchers and students, etc.

For society:

- they provide access to the world's research
- they ensure long-term preservation of institutes' academic output
- they can accommodate increased volume of research output (no page limits, can accept large data-sets, 'null-results', etc.)

PEER-REVIEW AND OPEN ACCESS JOURNALS

The one function of the traditional journal that self-archiving in 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 (helping them to decide which papers they wish to read), while it is used by authors to validate their research (which is of particularly importance in their next grant proposal or attempt at promotion). Peer-review journals could sit comfortably with the network of institutional repositories. Authors, who wanted their work to be peer-reviewed, could, after they had deposited it in their local repository, 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. The authors could place a peer-reviewed 'post-print' onto their local institutional repository ensuring that both versions were archived.

Obviously, with all the relevant material available for free on a network of institutional repositories it becomes impossible for a journal to charge a subscriber to access a paper in the journal. The peer-reviewed 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 journal. Scholars give this literature to the world without expectation of payment and in the hope that it is distributed and read as widely as possible. Making it freely available over the Internet immediately distributes it to the 650 million people worldwide who have Internet access. 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 need of researchers, researchers will be able to access all of the relevant information they need to be effective. Open access also provides major benefits for authors. Rather than their paper being seen by readers at the few hundred institutes at institutions lucky enough to have a subscription to the journal, the paper can now be seen by all interested readers. This increases the profile of the authors, their institutions, and their countries.(Suber, 2003).

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 (Crow & Goldstein, 2003), but one of the most stable for the science, technical, and medical fields 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 funding body or the institution to cover the publication charge, but basically, this model looks to a move for paying for access to material (through subscriptions) to paying for dissemination.

PRACTICAL DEVELOPMENTS

The scenario above gives a vision for a fair and efficient mechanism for scholarly communications. All research material is made freely available in a world-wide network of fully searchable repositories. A sub-section of the material in the repositories - peer reviewed papers - receives a certification 'quality stamp' from journals. This process is

financed by the authors' institutions and funding bodies, rather than through the readers' libraries, so allowing free access to all interested readers to all peer-reviewed papers via the Internet. This vision may sound utopian, but already many steps are being taken around the world to realise this future, and the pace of change appears to be increasing.

Institutional Repositories

At least four open source software packages exist for setting up and implementing institutional repositories **[3]** and well over 100 institutions worldwide have used these packages to set up repositories. In addition, a number of national initiatives have been set up to provide infrastructure support for repositories - these include SHERPA in the UK, DARE in The Netherlands, and the recent announcement of the Australian Government to fund more than $12 million to promote institutional repositories in Australia.

As the amount of content in the growing number of repositories continues to increase, new services are being developed to make use of this content. To date, the most active area of service provider development has been the construction of search engines that can search over a number of repositories simultaneously, so ensuring that the reader can find material irrespective of where it have been deposited. **[4]** One of these search engines, OAIster, now searches through almost 2,000,000 electronic items in over 200 repositories.

Open Access Journals

The number of open access journal publishing high quality, peer reviewed research is growing. SPARC and SPARC Europe are in partnership with a number of these journals,[15] in particular, BioMedCentral who have now published over 4000 open access papers in 100 journals. Lund University have compiled the Directory of Open Access Journals (DOAJ) listing fully peer-reviewed journals that place no financial barriers between the papers published online and readers. The DOAJ was launched in May 2003 with 375 titles, a figure that had quickly risen to over 570 six months later. One feature of the DOAJ is that records for each journal listed can be easily download by librarians and entered into their catalogues, thereby allowing readers to learn about the journals. New open access initiatives are regularly being announced. In October 2003 the first issue of PLOS Biology was launched. Produced by the Public Library of Science (PLOS), *PLoS Biology* is the first in a proposed stable of journal titles. It is aiming to publish the highest possible quality papers - rivalling such established titles as *Science* and *Nature*. The first issue generated massive international publicity, with reports and editorials in many of the world's leading newspapers. Like the BioMedCentral titles, *PLoS Biology* is mainly financed through author payments. The Public Library of Science plans to launch a *PLoS Medicine* early in 2004.

In addition, a plan has been put forward to transform current subscription-based journals into open access journals (Prosser, 2003). Under this plan, authors are given a choice as to whether or not they are willing and able to pay a publication charge. If they are (and,

of course, the paper is judged acceptable for publication following peer-review) the paper is made open access on publication. If they are unwilling or unable to pay, the paper is only made available to subscribers. Over time, the proportion of authors willing to pay should increase and the publisher can begin to reduce the subscription price. Eventually, the entire journal will be open access. This model has proved to be attractive to a number of publishers, especially smaller and society publishers who believe in the moral case for open access but who did not see a way of converting their journals. The model gives authors who pay the benefits of open access (i.e., wider dissemination, higher citation, greater kudos, etc.), while allowing those authors who do not pay the opportunity to still publish in their journal of choice. As the benefits of open access become clear (and in this hybrid model they can be accurately measured) authors will place pressure on their funding bodies to provide grants for publication.

While not eliminating financial risk for the journal owner, this model does reduce the risk by providing a smooth transition period as the decline in subscription revenue is matched to the increase in publication revenue. It is probably for this reason that a number of 'traditional' publishers such as Oxford University Press, the Company of Biologists, and the American Physiological Society are experimenting with variations of this model.

Support from Funding Bodies

The year 2003 has seen increasing support for open access (in the form of both self-archiving and open access journals) from the funding bodies that pay for research. In April 2003, a meeting organised by the Howard Hughes Medical Institute resulted in the Bethesda Statement. This was followed in the summer by a statement of strong support for open access by the Wellcome Trust in the UK. In October, all the major German funding bodies signed the Berlin Declaration supporting open access. The Berlin Declaration has also been adopted by, amongst others, the CNRS and INSERM in France, by the FWF Der Wissenschaftsfonds in Austria, and the Fonds voor Wetenschappelijk Onderzoek in Flanders. This support from the funding bodies has come about as they realise that, to quote the Berlin Declaration, "*Our mission of disseminating knowledge is only half complete if the information is not made widely and readily available to society.*" They increasingly believe that it is in their interests and it is their responsibility to support the wider dissemination through open access of the research results that they have funded

The Power of Open Access

As open access is a relatively new concept, it is difficult to compare directly open access publication (either through self-archiving or in peer-reviewed journals) with closed, subscription-based access. However, initial evidence is accumulating that supports that intuitively obvious assertion that open access will give greater dissemination and impact. Recent figures from the *Astrophysical Journal* show that for 72% of papers published free versions of the papers are available (mainly through ArXiv). Citation analysis shows

that these 72% of papers are, on average, cited twice as often as the remaining 28% where there are no free versions available. At this stage it is difficult to show clear cause and effect, but it is an intriguing indication of the increase in impact of authors' work if they self-archive.

The differences in downloads between closed, subscription-based journals and open access journals is even more dramatic. Working from Elsevier's half-year results, Peter Suber calculated that the average number of downloads for articles in ScienceDirect over the past year was 28. Over the same period the average number of downloads for articles in BioMedCentral was 2,500. This would suggest that publication in an open access journal gives, on average, 89 times as much usage as publication in a subscription-based access! **[5]** There are a number of reasons why this may not be an entirely accurate comparison, but Elsevier has refused to give the average downloads for biomedical papers published over the past year and so a direct comparison cannot be made. But even if 89 times is an over-estimate, it is clear that the evidence is beginning to show that open access does give greater dissemination, usage, and impact and as authors become more aware of this, they are increasingly going to want to publish in open access journals and to deposit their papers in their local institutional repositories.

NEXT STEPS

It's 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 host for institutional repositories, becoming responsible for maintaining the intellectual heritage of their institution. The libraries are also increasingly resisting the old models of subscriptions and big deals. Growing numbers of open access journals are attracting high profile editors and quality papers from excellent authors. More and more readers view these papers, increasing the impact and visibility of the journals. In addition, the continued success of these open access journals is proving the feasibility of the new business models.

As issues surrounding institutional repositories and open access journals become more widely discussed there is increasing awareness amongst authors of their need to retain their publishing rights (e.g., does assigning copyright mean that they cannot put a copy of their own paper on their departmental website?). There is also increasing awareness of Editors and Editorial Board members of their power and responsibilities to engage their publishers in discussions regarding fairer publishing practices. As described above, the past year in particular has seen a burgeoning of interest internationally in publishing issues amongst funding bodies and at the political level. As success is proved, more authors, readers, university administrators, librarians, and funding bodies are becoming aware of the limitations of the current system and the possibilities of the new models.

More importantly, they wish to act positive action to bring about a change in the system as quickly as possible.

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

In particular, authors can:

- deposit their work in institutional repositories
- support open access journals by submitting papers to them and refereeing, reading, and citing articles in them
- launch new open access journals if appropriate
- discuss publication rights, open access, and reasonable prices with the publishers of the journals they use regularly (especially if they are editors or board members)
- discuss with funding bodies and university administrators funding and promotion criteria to ensure that researchers are not penalized for using repositories or publishing in open access journals (especially those that are online only)
- lobby funding bodies for specific publication funds to take advantage of the benefits of publishing in open access journals.

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.
- make sure 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 (e.g., by including the journals listed in the DOAJ in their catalogues).
- as open access journals proliferate, and as their usage and impact grow, cancel over-priced journals that do not measure up.
- engage with University administrators and funding bodies to raise the issue of open access
- familiarize themselves with the issues **[6]**
- support SPARC Europe to multiply their effort

CONCLUSION

The text of the Budapest Open Access Initiative opened with the statement "*An old tradition and a new technology have converged to make possible an unprecedented public good*." We can see how by harnessing the power of the Internet we can construct a system of scholarly communication that better serves authors (by given them the wide dissemination they require) and readers (by removing access barriers to the information they need). This in turn will enhance research and education worldwide and bring great benefits to society.

Obviously, any attempt to change such a well-embedded system with large degrees of inertia will be difficult. However, the advantages of the new model are immense. By working together we have already made many great strides towards the new system and by continuing to work together we can achieve it. That is the aim of SPARC Europe and of the many thousands of librarians, authors, readers, funders, publishers, etc. who see open access as the future of scholarly communications.

NOTES

1. A collection of papers on this topic can be found at http://www.lib.utk.edu/~jon/crisis.html
2. See the ARL Statistics at http://www.arl.org/stats/arlstat/graphs/2002/2002t2.html
3. Details of the various Institutional Repository software can be found at: GNU Eprints, DSpace, CDSWare, and Arno.
4. See the page with registered service providers. http://www.openarchives.org/service/listproviders.html
5. Open Access News, Friday September, 5. http://www.earlham.edu/~peters/fos/a106276332667919229
6. See, for example, Create Change

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American Physiological Society. http://www.the-aps.org/publications/pg/interest.htm

ArXiv.org e-Print archive. http://arxiv.org/

ARL - Association of Research Libraries. http://www.arl.org/

Arno. http://www.uba.uva.nl/arno

Australian initiative
http://www.dest.gov.au/Ministers/Media/McGauran/2003/10/mcg002221003.asp

Berlin Declaration. http://www.zim.mpg.de/openaccess-berlin/berlindeclaration.html

Bethesda Statement. http://www.earlham.edu/~peters/fos/bethesda.htm

BOAI - Budapest Open Access Initiative. http://www.soros.org/openaccess

CDSWare. http://cdsware.cern.ch/

Company of Biologists. http://www.biologists.com/openaccess.html

Create Change. http://www.createchange.org/

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

DOAJ - Directory of Open Access Journals. http://www.doaj.org

Dspace. http://www.dspace.org/

Eprints. http://software.eprints.org/

OAI - Open Archive Initiative. http://www.openarchives.org

OAIster. http://oaister.umdl.umich.edu/o/oaister/

Oxford University Press. http://www.oup.co.uk/

PloS - Public Library of Science. http://www.plos.org

RSLG - Research Support Libraries Group. http://www.rslg.ac.uk/

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

SPARC Europe. http://www.sparceurope.org

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

Wellcome Trust. http://www.wellcome.ac.uk/en/1/awtvispolpub.html