ALTERNATIVES PUBLISHING : Overview of Open Archives Initiatives (*)

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Introduction : Scientific (scholarly) Communication

Since " Open Archives " can in principle be discussed in different contexts, let us start by stating that we will limit ourselves to the context of scholarly communication. What do we mean by that? As a pragmatic definition, scientific communication (or scholarly communication) is the set of processes through which the outcome of (academic) research is distributed and archived for the benefit of present and future researchers and scholars. Its essential ingredients and aims are the publication of (new) scientific information and its quality control (QC) (e.g.: peer review).

If for any reason we want to introduce changes (and hopefully improvements) to the mechanisms of scholarly communication, we should remain conscious of the primary stakeholders: which parties have an interest in its efficient performance? The answer should be:

- the readers (who need qualified information and easy access)the authors (anxious for a broad distribution of their work and academic recognition for it)the institutions (who measure scientific out-put for staff evaluation)the global community and its requirement for more and better scientifically validated infor-mation.

Publishers can be considered as secondary stakeholders, since they can pursue their commercial aims also with other publications. Learned society publishers are a special case, since they in general combine commercial goals with a true commitment towards the scientific community they serve.

What are the problems with the present system? They reside mainly in the fact that each of the stakeholders is confronted with some conflicting needs. The authors want at the same time academic recognition, i.e. prestigious journals, and wide and fast distribution of their writing, i.e. cheap journals. In the extreme example of physics, e.g., this has led to the full separation between dissemination (through the arXiv) and publication (in the journals). Also the readers have conflicting needs: they ask for qualified information, which requires costly peer review, but they would also like to have fast, easy and free access. Even the publishers have enormous problems to reconcile the need for high share-holder return (meaning high prices and low services) with their commitment towards the academic community (good services for reasonable prices). There is an inherent conflict between the highly appreciated peer review and the time delay it causes for the dissemination of new science.

The advent of the Internet raised widespread hopes for the development of new mechanisms that eventually might solve most of these problems.

An alternative system: the prehistory of the preprint server

In the exact sciences, and especially in the field of physics, there was a longstanding tradition to communicate search results through the mailing of *preprints*, which happened simultaneously with the submission of a paper to a journal. The Internet led to electronic preprints, either through e-mail or through the posting of a paper on an institutional *website*. In 1991, Paul Ginsparg at the Los Alamos National Laboratory created with " arXiv " a central e-print *archive* [1] for physics and mathematics where, through an automated submission process, authors can self-archive their as yet unrefereed papers. Those contributions mostly reappear later in standard journals. Access to the archive is free for search and retrieval and this fast dissemination of research results has greatly contributed to the development of modern physics.
Since the arrival of the arXiv, practically all scientific communication in high energy physics

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occurs through this channel, and the practice of peer-reviewed journal publication continues mainly for archival purposes and for the benefit of the author's curriculum vitae. At present, the ArXiv contains some 263.000 articles (1/2/2004) with 3 million accesses per month. The system has been transferred to Cornell University in December 2001, and an endorsement system has been introduced since January 2004 in order to slightly monitor the free self-archiving.

Figure 1 : Starting page for the arXiv

The success of the Los Alamos arXiv has led to several analogous initiatives. The CERN Document Server (DCS) [2], also in physics, contains different types of documents, e.g.: 550.000 bibliographic records, 220.000 full texts of research papers. Users have to register, but registration is free. Elsevier took the initiative for a free Chemistry preprint server (CPS) at ChemWeb, again with free registration. Unfortunately, this never turned into a large collection, and it has recently been discontinued. In economics there is RePEC [3] and in the cognitive sciences (psychology, neuroscience, linguistics,…), Stevan HARNAD from the University of Southampton, UK, started Cogprints [4].

Apart from these preprint servers, which physically contain the electronic full text versions of the papers, there appeared also some subject portals pointing towards various websites. A typical example, which is interesting in order to understand the importance of OAI, is MathNet [5] and its subset MPRESS. MathNet is a global electronic information and communication system for mathematics providing, e.g.:

- results of mathematical research and development,
- teaching material,
- information about working mathematicians and mathematical institutions.

MPRESS is an *index* of mathematical preprints from 110 different sources (i.e. websites from mathematical departments). This means that the researcher, who is looking for new publications in his field, does not have to search the 110 departmental websites but will be immediately directed by MPRESS to the relevant papers.
The obvious question is then: " Is this scalable to thousands of websites and to all different subject fields? " and since the index information has to be collected in some way or another: " Can it be automated? " This is precisely where OAI plays a role!

The Open Archives Initiative (OAI)

The Open Archives Initiative tackles the technical aspects of the e-print dissemination. Its purpose is to establish interoperability between e-print servers. A protocol has been written to collect through queries the metadata representing each document. It is the Metadata Harvesting protocol of the Open Archives Initiative (OAIMHP). It contains specifications for the XML-based exchange of metadata between ar-

chives (‘ data providers ’) and harvesters (‘ service providers ’). It is potentially useful for creating metadata databases for a large set of archives, but also for SDI, alerting services, linking, etc…
The current version is OAIMHP 2.0, dated April 2003. It may be freely downloaded from the OAI website [6], but free software for the construction of a preprint database that conforms to the protocol is also available from eprints.org [7], Dspace (MIT) [8], CDSware (CERN) [9], i-Tor [10], OAICat (OCLC) [11] or MyCoRe (Germany)[12]. In the meantime, the first harvesters have become available (ARC [13], OAIster [14], CiteBase [15], and harvester software at OAICat [16],…)

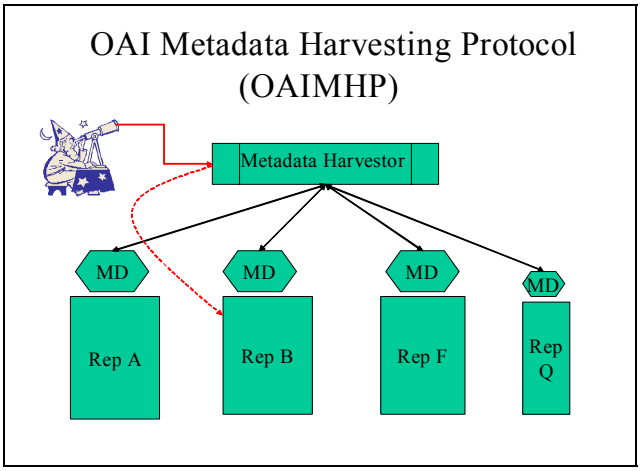

Figure 2: Principle of the OAIMHP

There has been a growing international interest for the application of OAI in preprint repositories. Recent efforts of the OAI working group have been directed towards OAI-rights. This was launched in September 2003. Means of expressing rights about metadata and resources in the OAI framework are being investigated and developed in collaboration with the RoMEO project (Rights MEtadata for Open archiving) initiated by the Joint Information Systems Committee (UK).

Figure 3: OAI Website

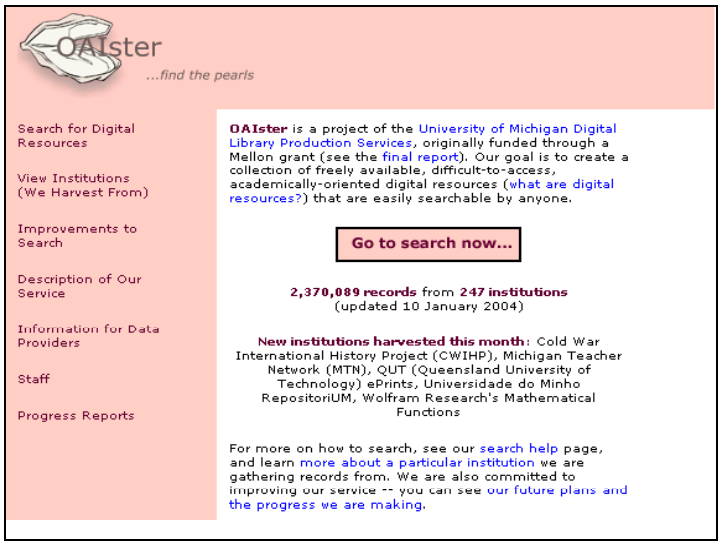

Figure 4: The OAIster harvester

The principle of Open Access [17].

The principle of Open Access is to promote: *Free web based access to scientific publications.* It is an alternative to the traditional subscription-based publishing model, made possible by the new digital technologies and networked communications. Of course, Open Access refers only to works that are created with no expectation of direct monetary return and made available at no cost to the reader on the public Internet for purposes of education and research. It should permit users to read, download, copy, distribute, print, search, or link to the full texts of works, crawl them for indexing, pass them as data to software, or use them for any other lawful purpose without financial, legal or technical barriers other than those inseparable from gaining access to the Internet itself.

Many arguments can be forwarded in defence of Open Access. Society always benefits from the open exchange of ideas and access to information is essential in a democratic society. Access to copyrighted materials inspires creativity and facilitates the development of new knowledge, since intellectual property is the lifeblood of progress in the sciences and the arts. New knowledge is developed from existing information and authors build on the intellectual products of others to create new works. Thus Open Access accelerates research output, enriches education, shares learning equally among rich and poor nations and enhances return on taxpayer investment in research.

The Open Access idea has to date a rather short history. In 1995, Steven HARNAD, professor in psychology at the University of Southampton, UK, launched his ‘ subversive proposal ’ [18], a crusade for freeing the refereed research literature by author self-archiving. " Authors should claim the right to publish their articles on the Internet. Self-archiving is possible *now!* "

The Entomological Society of America (ESA) made the bet to offer authors the option to pay for the facility to offer open access to their papers, and this was taken up with a 59% success rate.

In 2001, the Public Library of Science (POS) [19] is launched as an appeal to all biomedical journals for making their content freely available online not later than 6 months after publication and this was accompanied by a threat to boycott the non-cooperative journals. 30.000 scientists from 170 countries signed their support for the initiative. A public debate on the subject took place on Nature’s website.

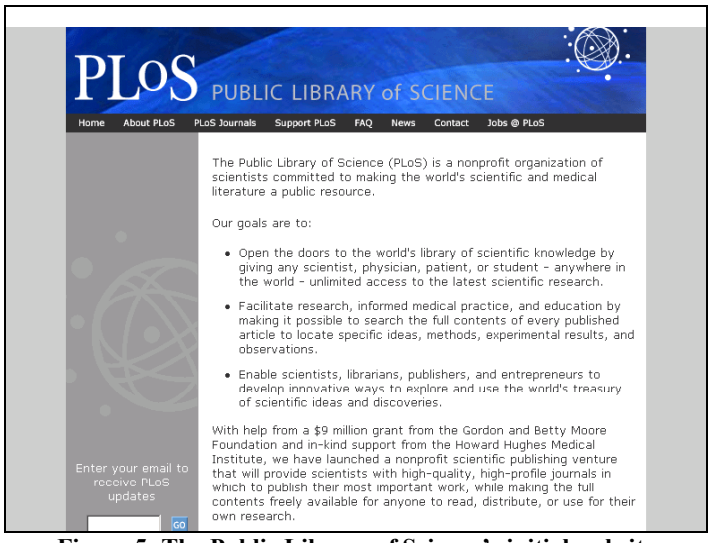

Figure 5: The Public Library of Science's initial website

In 2002, the Budapest Open Access Initiative (BOAI) [20], convened by the Open Society Institute (OSI), clearly encouraged the search for a replacement of the present unsustainable model of scientific communication. It was " at once a statement of principle, a statement of strategy, and a statement of commitment. "

In October 2003, an important group of European research organizations (MPG, DFG, CNRS, AcEur, OSI,…) met in Berlin and published the so-called Berlin Declaration [21]. We quote from this declaration:

Our organizations are interested in the further promotion of the new open access paradigm to gain the most benefit for science and society. Therefore, we intend to make progress by

- *encouraging our researchers/grant recipients to publish their work according to the principles of the open access paradigm.*
- *encouraging the holders of cultural heritage to support open access by providing their resources on the Internet.*
- *developing means and ways to evaluate open access contributions and online-journals in order to maintain the standards of quality assurance and good scientific practice.*
- *advocating that open access publication be recognized in promotion and tenure evaluation. (...)*

Since then, several other organisations, including the Flemish FWO and the Walloon FNRS, have also signed their agreement with this declaration.

At least one funding agency (the Danish Research Centre for Organic Farming) has decided that all (written) products from its funded research must be entered into an e-print archive [22]. The arguments for this decision were :

a) that all publicly funded research should be publicly accessible,
b) that increased accessibility is expected to increase the communication and impact of the research, and
c) that it provides increased possibilities for coordination, evaluation, and management of the research projects that are funded by the programme.

Quite recently, in July 2004, the US House of Representatives Appropriation Committee recommended that the NIH (National Institute of Health, which is the most important US funding agency for medical research) provide free public access to all papers coming from NIH-funded research. Almost simultaneously, the Science and Technology Committee of the UK House of Commons published its report on Scientific Publications [23]. This report is the outcome of a series of hearing sessions, where publishers, librarians and scientists were asked to give oral or written evidence. The report offers a balanced look at the publication market, it strongly concludes that " the current model for scientific publishing is unsatisfactory " and it recommends through 82 conclusions the Open Access approach, either through repositories or through open access journals.

Open Access was also on the agenda of the ' World Summit on the Information Society ', organized in December 2003 by the United Nations.

The OECD Ministerial Committee for Scientific and Technological Policy met in Paris on January 30, 2004 and published a *' Declaration on Access to Research Data from Public Funding '* stating a commitment towards openness, transparency, legal conformity and formal responsibility (recognition of authorship!), interoperability, efficiency,… They invite the OECD to develop a set of guidelines based on commonly agreed principles to facilitate optimal cost-effective access to digital research data from public funding. The interpretation of this statement, however, is unclear since one might argue that a scientific publication is different from a collection of research data.

SPARC and the serials crisis

During the past decades, a general dissatisfaction has been growing with the current scholarly communication model, which is expensive and slow. Even the wealthiest institution can no longer purchase the access to all the information that all of its researchers require. One may point to various reasons for this cost explosion, such as the exponential increase in research output, but the obsession in academic circles with the Science Citation Index (SCI) *impact factor* of the journals certainly also played an important role. The SCI brought a quality hierarchy among the journals, allowing for uncontrolled price increases for the top ranked journals, since no respectable research institute could afford to cancel the subscription to such journals. The average subscription price of scientific journals grew with more than 200% over a 15 year period, well above the increase of the consumer price index (see Figure 6). Studies at the University of Wisconsin in 1997 [24], where the average journal price not only per page but also per thousand characters was calculated, clearly showed an enormous discrepancy between the higher rates imposed by the commercial publishers than the more reasonable ones practiced by most society journals.

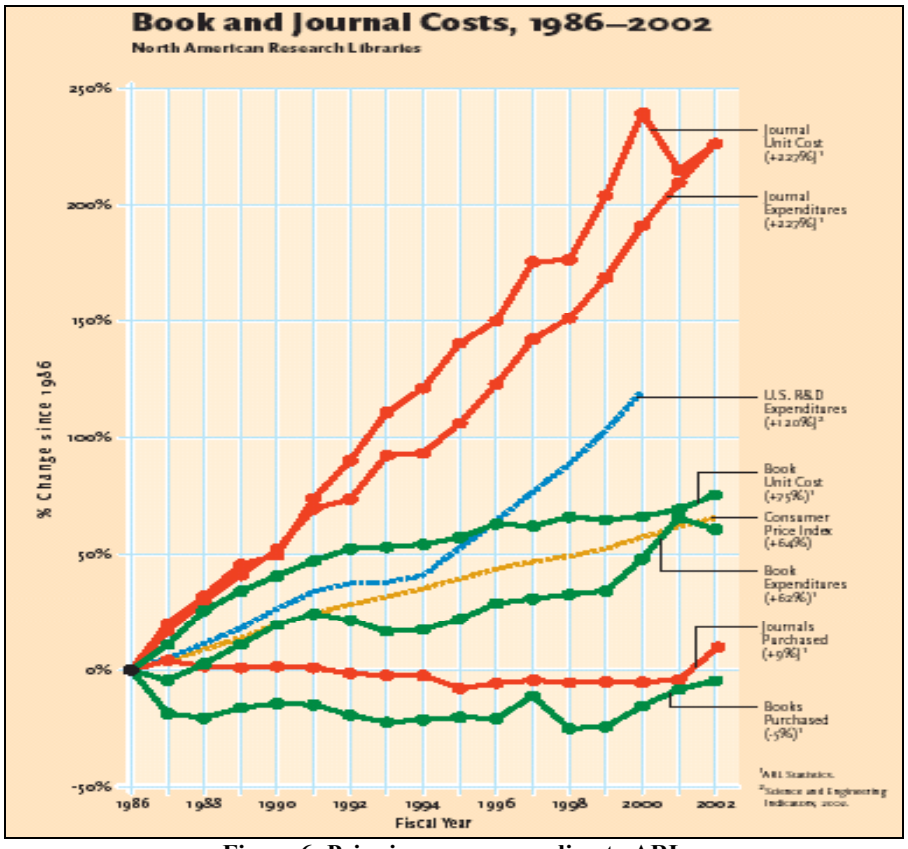

Figure 6: Price increases according to ARL

Site licenses and consortia deals with publishers have helped, but mainly in the richest countries. Moreover, many commercial publishers charge extra for online access, causing more pressure on library budgets. The introduction by the large publishers of 'package deals' often leads to cancellations of the products of smaller publishers, and this may in its turn lead to an unnatural distortion of the impact parameter system.

In the past, the standard library strategies for coping with this problem has consisted of journal cancellations and reduced book acquisitions, improved document delivery, cooperative collection development, consortial purchasing and national site licensing, but all this now proved to be insufficient and the underlying problem persists. Furthermore, the scientific community is becoming more and more aware of the fact that the intrinsic value of the journals (content and quality control) is a free gift from the academia and that the added value from the publishers is not large enough to justify the high prices. With respect to the technology of publishing, the academic community has certainly a sufficient mastering of the tools necessary for electronic publishing and distribution; this is a new fact in contrast to the situation for paper publications. Nevertheless, just as it is very hard to stop a moving train, it is also very difficult to change the habits of the scientific community and the way in which they publish. Researchers, both individually and as a group, are evaluated on the basis of their output and impact parameter ranking is still very important here!

Considerations as described above have led in 1998 to the launching in the U.S. of the *Scholarly Publishing and Academic Resources Coalition* (SPARC) [25], under the umbrella of the Association of Research Libraries (ARL). SPARC is ' an alliance of universities, research libraries, and organizations ' that seeks to serve ' as a catalyst for action ', helping to create systems that expand information dissemination and use in a networked digital environment. Its aim is to correct market dysfunctions and inefficiencies in the scholarly publishing system, which have driven up the cost of scholarly journals and needlessly restricted access to the world's research literature. It is based on a membership structure which includes a yearly fee plus the moral obligation to subscribe to SPARC partner products.

Figure 7

SPARC's general action plan is to incubate alternatives and to demonstrate better and more cost-effective scholarly communications systems. They try to realize this plan by promoting and aiding scholar-led publishing initiatives, by bringing new players into the present system, by introducing new economic models, and by initiating partnerships between the library and the research community. A typical example can be found in their awareness raising programme directed at the members of the editorial boards of the top expensive journals. During the first years of its existence, SPARC spent quite some effort in helping the start-up of alternative journals to replace unreasonably expensive commercial ones, often with the assistance of the editorial board members who came over to run the new journal. Examples (with price information from 2001) can be found in Figure 8.

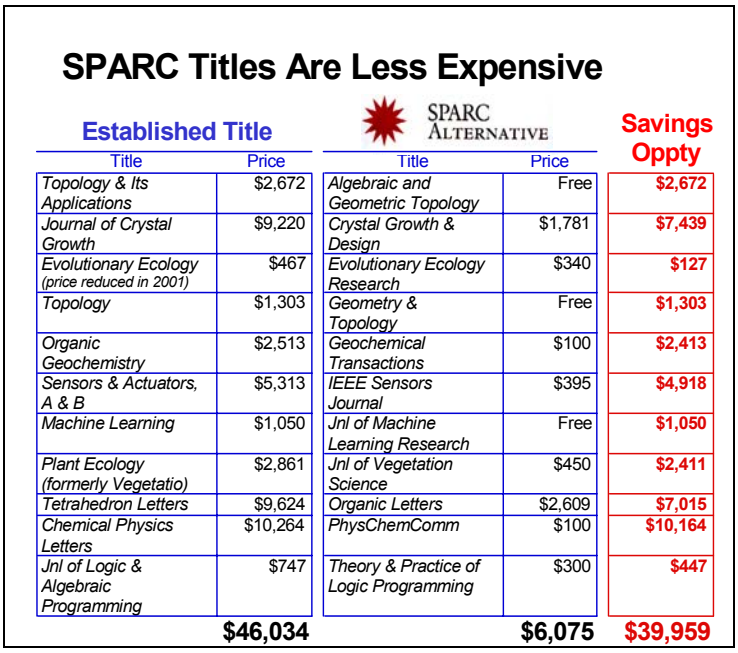

Figure 8: SPARC alternative titles

In recent years, SPARC's activity has shifted more toward supporting the Open Access journals and promoting networked institutional repositories. Its coverage has also expanded in the direction of the Humanities, were initially it was mostly focused on the STM (Science, Technology and Medicine) journals.

In 2002, SPARC Europe was launched under the umbrella of LIBER, the European Research Library Association, following the success of SPARC in the US. Today it has already grown into an alliance of over 100 academic and research libraries and library organizations from 14 European Countries.

Subject oriented (disciplinary) vs. institutional repositories

We have already described the rise of some disciplinary repositories like arXiv, CogPrints or RePec. The question can be asked, however, whether further development of such subject oriented repositories is really the best strategy for the future. Who will take responsibility (both organizational and financial) to reach full coverage of all subjects? Further progress in that direction is certainly very slow, and nowhere has one been able to repeat the success of the physics arXiv.

Fortunately, the mechanism of the OAI Protocol provides us with an alternative solution. If each university or research institute worldwide would be willing to set up its own cross-disciplinary archive for all the scientific output of its own researchers, using one of the available OAI-compliant softwares for the handling of the metadata, we would be offered in such an all encompassing network of repositories a strong instrument for handling the scholarly communication.

In a " White paper on Institutional Repositories " [26], published by SPARC, several arguments are summed up in favour the institutional repositories:

- For the individual researcher, they may provide a central archive of his work, on the basis of which it may be easy to maintain an always updated publication list. Furthermore, through the mechanism of the international harvesters the presence of a publication in the repository will ensure immediate and worldwide dissemination of his work and it will positively influence the impact of his research.
- For the institute itself, these repositories should increase its visibility and prestige in the research community. In this way it can act as an advertisement to funding sources, or it may attract new staff members and students.

- For the society, the network of repositories will provide full access to the world's research. If the repositories are maintained in a professional way, e.g. by the library, it may also ensure some long-term preservation of the academic output.

How should such repositories be organized? In principle they may contain all kind of scholarly content: preprints and working papers, published articles, enduring teaching materials, student theses, data-sets, etc. - with low submission barriers. Only a minimal monitoring of academic standards should be necessary, since the inclusion in a repository does not yet give a paper the status of a peer-reviewed publication (see below!). It should be cumulative and perpetual, preserving an ongoing access to all material. It is obvious that it should be open access [27]: free, online, global.

Whereas these ideas may initially have seemed somewhat utopist, we now see that they are slowly starting to become realized. Large and prestigious universities (like MIT, the University of California and the Australia National University) and research organizations (like the German Max Planck Gesellschaft) have given the example. In some countries we see a national project with central funding (like SHERPA and FAIR in the UK, or the DARE project in the Netherlands).

The hardest part in the organization of such a repository is not the technical aspect, but it resides in convincing the researchers to yield their contributions for inclusion in the repository. Too many of them are still excessively afraid of recriminations by the publishers. It should help that most of the academic publishers (including Elsevier, holder of the largest set of journal titles) have officially declared to accept the simultaneous publication of a preprint of their papers in an institutional archive [28]. An overview of the copyright policy of the main publishers with respect to such archiving can be found at the website of the ROMEO-project [29], or at its successor the Sherpa project. 93 publishers are listed, 61 % of whom formally support self-archiving of either preprint, postprint or both. This percentage must be even higher in terms of journal titles, since some of the publishers with the largest number of titles (such as Elsevier) are accepting such archiving.

The support for such archives is, of course, a far way off the traditional activities of libraries. Nevertheless, it may be considered as the local contribution towards a new " distributed collective collection development " from all research institutes worldwide, and collection development is certainly one of the core activities of a library!

From dissemination to publication?

Up to now, we have only discussed the process of scholarly communication, which is the way in which researchers bring their findings to the attention of their colleagues and of the public at large. A scientific publication, however, is much more than a scientific writing made public. The traditional journal publications integrate the following functionalities [30] :

- *Registration* (establishing intellectual property rights)
- *Certification* (certifying the quality/validity of the research)
- *Awareness* (assuring the dissemination of the results)
- *Archiving* (preserving the research output for future use)

As a derived functionality, one should also recognize the " *rewarding* " of the author, which is a combined result from the certification and awareness.

The first and most important result of an Open Access paper is certainly its broad accessibility and dissemination, which means " *awareness* " [31]. " *Registration* " becomes possible through an eventual electronic legal deposit of the institutional archives and " *Archiving* " should be guaranteed if the archive servers are maintained by a stable organisation [32]. Self-archiving by the author in an institutional archive, however, does not contain any real form of quality control, and we have to look for other mechanisms to arrive at the " *certification* " of the publications. Many experiments are on their way that try to combine all functionalities, including this " *certification* ", and we will briefly discuss them below, but until we find a good solution, Open Access publishing will remain (only a) long-term goal!

The last decade showed a growing importance of peer review and of the impact factors derived from the number of citations. These impact factors are supposed to be related to the severity of

the peer review performed by the journal's referees. Why is this form of quality control necessary? Among the many arguments, we mention:

- Peer review is part of the process through which our global validated knowledge database is constructed.
- It is important for the academic recognition of the authors, and therefore for the ultimate success of any system of scientific communication.
- It is a guarantee of quality for the reader, who is confused by information overkill. Especially experts in the medical sector are horrified by the potential disastrous effects from unqualified medical publications.
- Peer review and the qualification degrees from the derived impact factors deliver a research evaluation method for academic authorities and funding agencies.
- Peer review improves the quality of the publications, not only because the referees may suggest changes to the text, but also because an author is more careful about the way in which he writes, if he knows that his text will be critically reviewed before being accepted.

Nevertheless, the organization of peer review is one of the main cost elements of the scientific journals. It is minimally estimated between 300 and 500 € per article.

Model 0:

The most simple approach towards a system of Open Access publications with quality control, and the one advocated strongly by S.HARNAD, is to archive in the institutional repositories and simultaneously to continue publishing in the traditional journals, at least in those that allow the self-archiving. In this way, the cost of the peer review process remains covered by those libraries that still want to subscribe to those journals.

Although one may question the long-term sustainability of such a business model, this zeroth-order approach is indeed for the moment the most realistic one, since the present day capacity of the other models, described below, remains rather limited.
In contrast to what is practiced in this " model 0 ", a strong argument is nowadays being heard for charging the cost of the quality control to the author(s) (or his/their institute):

- It is the author who receives the intellectual reward for the refereed publication; the author wants to be read, and he is prepared to pay for it.
- Covering the bill should make the author more aware of the publication cost.
- The dissemination of scholarly work should be considered as an essential part of the process of publicly funded research. To quote Harold VARMUS: *" If you do research and don't publish it, you might as well not have done it ".*

How can this be organized? Existing editorial boards may take care, just like some have (with the help of SPARC) switched to alternative journals in the past. Learned societies (the ' roots ' of the journals!) could and should also take their responsibility for the organization of peer review: they should consider themselves the most appropriate bodies for expert international judgement on the value of scientific papers.

Model 1: Open Access journals

One of the first organizations to experiment with full open access was the Entomological Society of America, when it started offering its authors the option to pay for giving free access to their papers. This option got accepted with a 59% success rate.

Many more players have since entered the field, with BioMed Central [33] as the champion with the largest collection (more than 100) of peer reviewed journals, freely accessible. The author pays $ 500 per paper, but there is also a system of institutional membership. The most prestigious Open Access publisher is certainly Public Library of Science (PLoS). This non-profit organization of scientists and physicians is committed to making the world's scientific and medical literature a public resource. They are launching two new journals, aiming at the highest level of quality, comparable to *Nature* and *Science*. *PLoS Biology* [34] started in October 2003, and the first issue of *PLoS Medicine* is announced for the Autumn 2004. Publication charges, however, costs $ 1500 per article.

Figure 9: Website of Open Access publisher BioMed Central

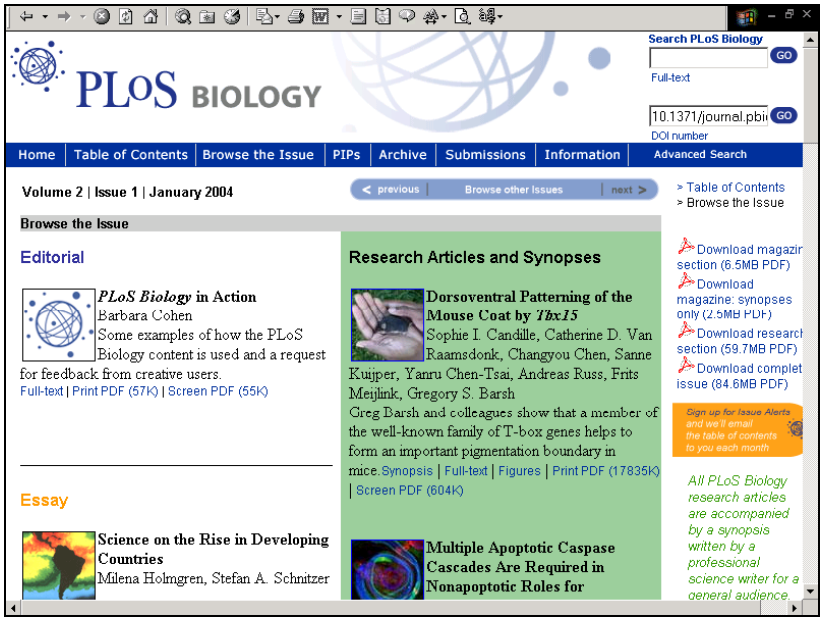

Figure 10: Recent issue of the Open Access journal PloS Biology

Many more high quality Open Access journals have started in the meantime. Even the Indian Academy of Sciences has made their 11 journals available free online and many more will follow. A Directory of peer reviewed Open Access Journals (DOAJ) [35] is maintained by the university of Lund, with a grant of the Open Society Institute. It already lists more than 1100 titles, and it also offers a search engine through which more than 300 of these titles can be searched on the article level.

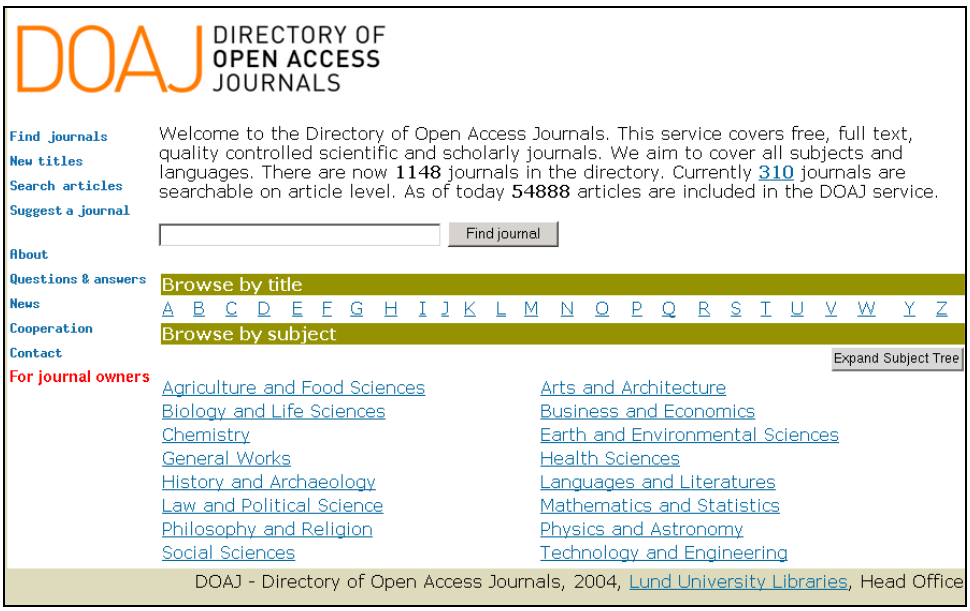

Figure 11

Model 2 : Overlay journals

A somewhat different concept is the so-called " Overlay journal ". In contrast to the Open Access journals from " Model 1 ", an overlay journal does not present on its website a collection of full text papers, but it offers instead a list of links to articles for which it has performed the peer review process. The articles themselves can remain on the institutional archives. In this way, this journal sits above a group of repositories to form a virtual 'overlay' journal. Its main activity is to give a stamp of quality to the research presented in the repositories.

The organization of an overlay journal is relatively cheap: no editing is necessary, no printing, no full text serving. It is sufficient to take care of the peer review, post the results (quality stamps) and link to the full text on the remote repositories, which obviously should be open access. In principle, this model should be ideally suited for learned societies who want to enter the field of high quality Open Access publication with minimal costs involved.

Up to now, only a few examples of this model exist: *Geometry and Topology* [36] and *Advances in Theoretical and Mathematical Physics* [37]. It is hoped, however, that more initiatives in this direction will be launched in the near future, and that their products will receive high qualifications also with respect to impact factors. Of course, it would be very helpful for this evolution if the Open Archives OAIMHP protocol could be extended to include in a well-protected way the metadata referring to the quality control.

Although this is not essential to the Open Access movement, the classical peer review can be improved in different ways, especially by making use of new web-based methods, and several experiments are already underway in this direction. The *British Medical Journal (BMJ)* [38] has applied a system of " open peer review ", in which the reviewer has to sign his report, making him in principle more responsible for the work he is doing. The *Journal of Interactive Media in Education (JIME)* [39] goes one step further by transforming the peer review into a fully interactive process among reviewers and author, where even the wider research community can have an input in the final phase of the process. In a similar way, all readers can contribute to the ranking of a paper through the services of CiteSeer [40].

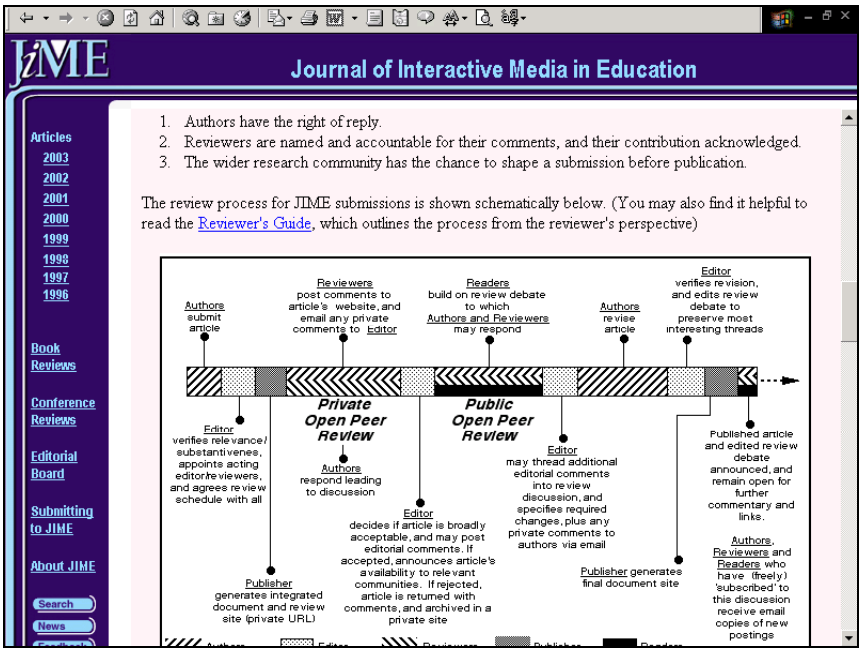

Figure 12: The interactive peer review system of JIME

To conclude, peer reviewed Open Access journals may offer the ideal solution for the requirements of both authors and readers. To the authors it offers a combination of maximal and rapid dissemination, allowing at the same time the publication in a prestigious journal. To the readers it gives full access to the publications, with the quality guarantees that up to now are offered only by the existing peer review system of the printed journals.

Concluding remarks

How should libraries proceed?

One might wonder if our advice is now that it should be the duty of academic libraries to start boycotting high-price printed journals, however widely used; so that we can reallocate our resources to support the new generation of alternative journals.

Certainly not! The first duty of the library remains to serve the academic community by providing all necessary information (now and in the future). For the moment, it remains the task of the library to provide access to all important scientific sources. However, with a view towards the future, we must work *now* towards instruments that *tomorrow* can be used in an affordable and efficient way. In the meantime, we should maintain a critical attitude towards what publishers are offering us (cfr. the more and more criticised " Big Deals ", and reactions to it from some important U.S. universities! [41]).

How should sientists proceed?

Scientists, especially the youngest, should not jeopardize their future. They must publish in high quality journals, but at the same time they should post their publications in an Open Access archive. In order to be able to do so, they should select a journal that allows them to archive in an institutional repository, and here the list published by the Romeo project may be quite helpful!
Senior scientists may consider refusing to referee for journals that are considered to be too expensive; editorial boards should use their influence and eventually threaten to resign… (cfr. the SPARC examples.) When more peer-reviewed open access journals become available, top researchers should feel responsible for helping them achieve good impact ratings through publishing their important contributions in such journals, and through performing editorial tasks.

What is the role of universities, funding agencies, etc.?
Out of concern for an optimization of the process of scientific communication, universities should set up Open Access *Repositories* of their own

publications, and encourage their researchers to deposit their scientific output in them.

Scientific assessment committees and funding agencies should *accept and appreciate* OA publications and encourage new models, out of concern for an optimal spending of the research money.

A process of *awareness raising* among the academic staff should be organized; scientists should be encouraged to contribute towards strengthening the new models, e.g., by helping with refereeing papers for the OA journals. In order to facilitate such awareness raising, SPARC has published a leaflet *Create Change* [42], offering librarians and scientists many tips and tools to help them cope with this problem through their website or their brochure.

Final remark

Modern Information and Communication Technology (ICT) offers great opportunities to improve the process of scientific communication and to solve the journal crisis, but first the threshold of inertia must be overcome. We should not be afraid of some temporary chaos, since it may lead us to an improved state (just like steel becomes hard and strong through the chaotic process of heating and beating).

Existing experiments prove that alternatives are possible and affordable, and that they are gaining worldwide credibility. Nevertheless, there is still a long way to go, on two fronts:

- the development of a new system, especially for the integration of quality control with the institutional repositories,
- awareness raising in the academic world, to overcome the inertia with the present system.

In the meantime, libraries should continue to give researchers access to the relevant scientific information, but with a critical attitude towards what is offered. All involved stakeholders (universities, learned societies and commercial publishers) are invited to join the concerned libraries in their search for a fair-priced system for scientific communication, which is as open as possible.

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