Economics of open access publishing

This article is based on a study undertaken at CERN Library. After a short introduction to the open access movement, an analysis of some CERN Library open access journals from a number of publishers is presented. Open access publishing models are then applied to some of the most important journal titles in particle physics. The results give a picture of the possible implications and the cost of open access in the current environment. Publishers' open access offerings, CERN authors' reactions to open access and the probable impact for CERN as a research institution are then examined.

MAGALY BÁSCONES DOMINGUEZ
Consultant

CERN (European Center for Nuclear Research, now known as the European Laboratory for Particle Physics) was founded in 1954. Today CERN is the biggest centre for the study of particle physics and is used by physicists the world over, representing 80 different nationalities. In 2004, the total budget of CERN was 1,325.2 million CHF. The budget of the Scientific Information Service (Library and Historical and Scientific Archive) was about 1.37 million CHF (of which 0.669 million CHF was used for the periodicals collection).

In its field of expertise, CERN stands alone in the world as an institution that generates a high volume of scientific literature. The physicists at CERN are forerunners in the advancement and push for new technologies. Due to their intellectual needs, they are also at the forefront of the need for rapid and efficient information dissemination. CERN contributes substantially to the growth of scientific literature discussing particle physics as well as other related sciences[1]. However, like other research libraries worldwide, CERN must pay to acquire this same scientific literature through periodical subscriptions. This explains why the open access movement is of interest to CERN.

Concepts of open access

When we talk about open access (OA) we must take into consideration two main concepts. Firstly, the objective of the open access movement which is 'free information availability on the public internet, permitting any users to read, download, copy, distribute, print, search, or link to the full texts of these articles, 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'[2]. Secondly, we must consider the nature of an open access publication. The author defines this as an individual work or a journal that meets the following two conditions: (i) the copyright holder(s) grant(s) to all users a free perpetual right of access and right of use[3]; and (ii) a complete version of the work and all supplemental materials is available in an electronic format in at least one publisher's or aggregator's web site and/or an online repository that is supported by a well-established organization that seeks to enable open access. The objectives of the open access movement are:

- to make scientific literature, published or pre-published, readily and freely available to the public through electronic means

[1] In 2000 CERN published 2,250 peer-reviewed papers (2000 was a highly productive year).

[2] *Budapest Open Access Initiative: Frequently Asked Questions*, http://www.earlham.edu/~peters/fos/boaifaq.htm #Openaccess (19.07.2005). Other definition is contained in *Bethesda Statement* http://www.earlham.edu/~peters/fos/bethesda.htm

[3] Right to use could include for example: copy, distribute, transmit and display the work publicly, in any digital medium for any responsible purpose, subject to proper attribution of authorship.

- to increase the impact of scientific research as well as increase the pace of scientific progress
- to redesign the market cluster of scientific publishing by proposing new systems of dissemination such as institutional repositories and open access publication models[4].

In the open access movement, libraries hope to find a solution to the 'serials crisis'. The cost of scientific periodicals is ever increasing and this clearly has an adverse effect upon library budgets. However, libraries are under pressure to maintain the quality standards of the services they provide as well as maintain a complete collection of works – despite restricted budgets.

There are various different aspects to the open access movement: political, technological, legal and economic. This article will explore mainly the economic aspects of proposed open access publishing models. Political actions have been undertaken to support open access. To show their endorsement as well as their determination to promote open access, many international organizations (scientific societies and institutions, universities, libraries) have signed numerous declarations in favour of open access. These include:

- Budapest Open Access Initiative (BOAI)[5]
- Bethesda Statement on Open Access Publishing[6]
- Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities[7].

Technical aspects of open access include free software and open-source publications. Legal aspects remain unclear; legal initiatives such as the Creative Commons propose revised and transformed legal concepts relating to a flexible copyright system. Nevertheless, copyright clarifications and reflections under the open access publishing models described below are neither necessary nor desirable.

The open access movement has evolved considerably during the past few years. Two major phases can be identified, described by the BOAI as two different strategies. Firstly, the publication of articles in an open access journal, and, secondly, the traditional publication of articles but with self-archiving by authors in an institutional document server. These two strategies are known in open access jargon as the 'gold' and 'green' strategies[8]. Table 1 (next page) presents the main features of these two strategies, the corresponding models and their description as well as several examples.

Document repositories

In the field of physics, one the most important document repositories is the arXiv (Cornell). This repository contains mainly physics preprints. However, it must be pointed out that articles contained in repositories are not considered formally published by the scientific community. Indeed, preprints do not offer the same quality guarantees as peer-reviewed articles published in journals. Hence, periodicals remain the favoured method of disseminating information for authors.

Some document repositories also include published documents[9]. This alternative is possible thanks to the endorsement and the support of the open access initiative by institutions such as the United Kingdom Research Councils and the National Institutes of Health of the United States. These organizations seek to set up the obligatory deposit of all published articles which are based on research financed with their own funds. In parallel, publishers are introducing new policies to allow authors to deposit their works on public or institutional servers one or two years after the initial date of publication. These policies do not coincide with the agenda of the open access movement

[4] CPB Netherlands Bureau for Economic Policy Analysis, *Tackling the journal crisis: when authors pay with money instead of copyrights*, working paper no 121, The Hague, March 2000.

[5] Budapest Open Access Initiative, http://www.soros.org/Openaccess/ (15.06.2005)

[6] Bethesda Statement on Open Access Publishing, http://www.earlham.edu/~peters/fos/bethesda.htm (15.06.2005)

[7] Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities, http://www.zim.mpg.de/Openaccess-berlin/berlindeclaration.html (15. 06.2005)

[8] Harnad Stevan, Keynote Lecture: Providing Open Access to peer-reviewed articles to maximize and measure their research impact, http://www.oai.unizh.ch/symposium/docs/Harnad.ppt (15.06.2005).

[9] These papers are still under copyright but copyright holder allows posting.

Main features			OA publication models	Descriptions	Examples
Not journal based (Green strategy)	Not necessarily peer reviewed	Free to authors and readers	E-print repository	Authors deposit preprints and/or postprints in OA repository	arXiv; Spires; CDS-CERN
Journal based (Gold strategy)	Peer-reviewed articles	Free to authors and readers	All free OA	No author or reader fee Online only	*Living Reviews of Solar Physics* (M. Planck Inst.) Former *JHEP*
			Partial OA	Some articles in an issue are OA	Many publishers use this for promoting a journal to a wider audience
			Per capita country[10]	OA made available to country based on per capita income	AIP, IOP, PNAS, OUP
		Not free to authors Free to readers	Paid OA	Manifestation of a 'new' publishing paradigm: Authors pay to publish Readers have free access to these works	Springer Open Choice IOP (*New Journal of Physics*) AIP (*Chaos, Rev. Sci. Ints., J. Math. Phys.*) PNAS OUP PLoS

Table 1. Open access models

AIP = American Institute of Physics; IOP = Institute of Physics; PNAS = Proceedings of the National Academy of Sciences of the USA; OUP = Oxford University Press; PLoS = Public Library of Sciences; JHEP = Journal of High Energy Physics

which would like to see articles made readily available to the public free of charge immediately.

Open access journals

In this study, four types of open access journal have been identified:

- completely free journals
- partially free journals – the partial availability of a publication mainly due to the decision of the publisher to grant free access to selected articles for marketing purposes
- free journals for developing countries
- journals based on payment by authors and/or their institutions in order to be published.

The common features of all these types of open access journal are:

- they offer peer-reviewed articles
- they are structured in the same way as traditional journals
- the printed version does not exist or is only available at a cost
- an open access journal could be available through the web site of a publisher or of an aggregator.

Examples are shown in Table 2 (next page).

Payment-based open access models

We analysed further the payment-based open access model. The key issue for publishers in this model is to ensure the coverage of costs. Open access models proposed by publishers are based upon either an author fee or the author's institution membership fee and/or library subscription fees. These three elements combined give rise to a large variety of models. In the case of some publishers, for example *PNAS* (*Proceedings of the National Academy of Sciences*), the publisher offers three different types of open access model to readers (see Table 3 on next page).

[10] Two major initiatives on the access to peer-reviewed journals to the developing countries are HINARI (Health InterNetwork Access to Research Initiative) and AGORA (Access to Global Online Research in Agriculture). These initiatives are held by United Nations agencies (the World Health Organization and the Food and Agriculture Organization) and major publishers such as Blackwell, Elsevier, Springer and others to provide free access to public and or not-for-profit institutions in developing countries. These initiatives were encouraged by publishers.

OA models	Main features	Examples	Description
Free journal	Peer-reviewed articles & Journal-based context	Former *JHEP* *Living Reviews of Solar Physics* PNAS (back-files) CERN *Courier* DOAJ Journals	No author, reader or subscription fee
Partially free		*Nature* *Journal of Physics A* (IOP)	Selected articles are available free within the subscription model
Per capita country income		AIP, IOP, PNAS	Journal made available to country based on per capita income. Mainly in developing countries
Author/Institution fees		Spinger Open Choice IOP (*New Journal of Physics*) AIP (*Chaos, Rev. Sci. Inst., J. Math. Phys.*) PNAS OUP PLoS	Authors pay to publish

Table 2. Types of open access journal
DOAJ = Directory of Open Access Journals

	Cost	Publishers	Description
Author-pays model	**Author fee** by article	IOP – *New Journal of Physics*	Author/institution pays fees to be published (573€ in 2004)
		AIP Author select (*Chaos, Rev. Sci. Inst., J. Math. Phys.*) On trial basis in 2005	Author/institution pays fees to be published (1,511€ in 2005)
Hybrid model	**Author fee** + subscription	Springer Open Choice	The institution/author pays author fees (2,393€ in 2004) The institution also pays a subscription fee which decreases with the number of OA articles published
	Author fee + membership in tier category	Proceedings of the National Academy of Sciences of the USA	Author fee is determined by the paid institutional membership fee based on licence tier category
	Author fee and/or membership	PLoS – *Medicine* BioMed Central	Author fee is determined by the institutional membership category
	Author fee + page charges + [membership or print subscription]	Oxford University Press (*Nucleic Acids Research*)	Membership = discount for author fee Print subscription = discount for author fee

Table 3. Open access publishing models

We can therefore distinguish two different types of payment-based open access models:

- *Simple model* The publisher's costs are covered by a single source, the author's payment, in order to be published. At this time, the cost of this model could vary between 573€ and 2,393€.
- *Hybrid model* Each publisher proposes their own model. The publisher's costs are covered by a complex combination of two (or more) elements, such as the payment by the author, subscription fees, the institution's affiliation, etc.

A simulation of open access costs for CERN

In our study we use different types of simulations to answer the following questions:

- How much would it cost CERN to publish according to an open access model?
- What would be the impact for CERN if some of the high energy physics journals become open access journals under the current models proposed by publishers?

Our approach was fairly simple. We compared the cost of open access publication with the cost of library subscription. A more detailed study would be needed to take other factors into consideration.

The author-pays model of the Institute of Physics (IOP)

The IOP offers an open access publishing model. This model is currently applied to *New Journal of Physics (NJP).* In our study we simulated that *Journal of High Energy Physics (JHEP)* also became an open access journal under the same model.

Data

For *NJP* the author/institution fee is 573€ per published article (in 2004)

The subscription fee of *JHEP* is 1,025€ (in 2004)
Total articles published in *JHEP* by CERN authors (1999–2003): 248

Total articles published in *JHEP* (1999–2003): 3,040

Calculations

The majority of articles published in the field of physics are by more than one author. Therefore, in order to calculate the probable cost that would be incurred by CERN, two possible scenarios were identified:

(i) In the first instance, costs were calculated on the basis of payment being shared by the different institutions to which the authors belong.
(ii) Secondly, costs were calculated where CERN is responsible for the entire payment.

The results shown in Table 4 are very clear. Publication costs for CERN under the IOP open access model would be at least nine times more expensive than the current subscription fee of *JHEP.*

The hybrid model: author fees and subscriptions – Springer

Springer proposes an open access publishing model: Springer Open Choice. In our study we simulated that the Springer journal *Hyperfine Interactions* becomes an open access journal under the same model.

Data

The Springer Open Choice model allows authors to publish their articles either under the traditional publication model or under the open access model. The open access publication fee is 2,393€. However, if the author does not wish to publish under the open access model, he can always publish under the traditional publication model. If the author decides to publish the work in the traditional way, the readers must subscribe to the journal. The subscription fee is calculated once a year (usually mid-year) and the price for the next year's subscriptions is calculated. At that time, Springer calculates the number of articles published under the traditional model in the previous 12 months. If that number is less than the twelve-month period before that, then subscription prices will decrease accordingly. If it has increased, then prices will increase accordingly[11].

- *Hyperfine Interactions* (2004) subscription fee: 2,503€
- Total articles published by CERN authors (2000–2003): 41

Year	**Total articles published in *JHEP* by CERN authors**	**CERN estimated publication cost**	
		Fee is shared with co-author institutions (Author fee per article 573€)	Fee is not shared with co-author institutions (Author fee per article 573€)
2003	61	14,058€	34,953€
2002	50	15,489€	28,650€
2001	64	16,322€	36,672€
2000	45	14,692€	25,785€
1999	28	9,849€	16,044€

Table 4. NJP model applied to JHEP

[11] Springer Open Choice, http://www.springeronline.com/sgw/cda/frontpage/0,11855,1-40359-0-0-0,00.html (19.07.2005)

	Total published articles	CERN authors' articles	CERN estimated publication costs (author fee per article 2,393€)	Estimated total expenditure for CERN
2003	129	5	11,965€	Publication costs + subscription fee ~2,503€ (depending on number of articles published under the traditional model in the previous 12 months)
2002	213	0	—	
2001	330	14	33,502€	
2000	255	22	52,646€	

Table 5. Springer Open Choice model applied to 'Hyperfine Interactions'

Calculations

By using the information that was readily available for this study, this model only allows the calculation of the cost of publishing an article. As seen before, the total cost incurred by CERN also includes the subscription fee to the printed version of the periodical, which varies according to the number of articles published.

Table 5 shows that the publication cost for CERN under Springer Open Choice model would be at least five times more expensive than the current subscription fee of *Hyperfine Interactions.*

The hybrid model: author fees and/or membership – PLoS

Data

The publishing fee paid by the author varies according to the type of membership his institution has with the Public Library of Science (PLoS). The membership fee is recalculated each year. Hence, there is a similarity between the subscription fee and the affiliation fee.

Calculations

Table 6 shows that the PLoS hybrid model represents a cost for CERN (which is not a PLoS member) of at least 11,960€ for the publication of 10 articles.

Having tested these models, the following key conclusions can be drawn:

- although the models tested are diverse, the calculations show that none of them is economically viable for CERN
- yearly forecasts of costs are difficult to ascertain due to the complexity of the calculations involved
- in general, the open access models available would be more expensive for CERN than the cost of periodical subscriptions.

The economic consequences of the application of these types of open access model are made clear in Table 7 (next page), which shows the major particle physics journals. This study has analysed the majority of publishers in the field of particle physics, notably IOP, Springer and AIP (see Table 1: AIP offers an open access model based on author payments of 1,511€ per article.) It should be noted that Elsevier does not yet offer open access publication. As can be seen in Table 7 (next page), the estimated expenses which would be incurred by CERN through the yearly open access publication of its authors' work is much greater than the cost of the current subscription fees.

Hence, the open access models examined in this study financially penalize research institutions who publish large numbers of articles. It could be

Institutional membership level	Annual institutional membership fee	Author fee per article	Cost for 10 articles	Estimated total expenditure for CERN
No member	0€	1,196€	11,960€	11,960€
Active member	1,595€	1,077€	10,770€	12,365€
Participating member	3,989€	957€	9,570€	13,559€
Promoting member	7,979€	838€	8,380€	16,359€
Sponsoring member	19,948€	718€	7,180€	27,128€
Sustaining member	39,896€	598€	5,980€	45,876€
Championing member	79,778€	299€	2,990€	82,768€

Table 6. PLoS model applied to CERN

Titles and impact factors	Publishers	Total articles published	Total articles published by CERN authors	Estimated cost for CERN	Subscription fee 2005
European Physical Journal C (6.162)	Springer	291	54	129,222€	3,954€
JHEP (6.854)	IOP	809	61	34,953€	990€
Journal of Physics G (1.399)	IOP	286	17	9,741€	1,611€
Nuclear Physics B (5.409)	Elsevier	632	111	—	13,731€
Physics Letters B (4.298)	Elsevier	1,097	76	—	9,299€
Physical Review D (4.358)	AIP	1,975	43	64,973€	3,810€ (tiers 1)

Table 7. CERN publishing in high energy physics journals in 2003

hypothesized that these models would benefit research institutions who do not publish or publish very few articles, such as small research institutions or universities, as well as the military and not-for-profit organizations.

The authors' viewpoint

Authors play a fundamental role and without their support open access publishing is simply not feasible. We interviewed a number of CERN authors who, in 2002, published in *NJP*. Of a total of 15 authors, 13 were successfully contacted and 9 agreed to be interviewed. The commentaries and opinions of those authors give us a snapshot of CERN authors' opinions on a specific open access publishing model as well as on the applicability of the open access publishing model in the particle physics community.

The authors interviewed were very different from one another although they all worked in theoretical physics or in experimental physics.

Some authors had many works published; others were at the beginning of their professional life. Some had experience in editorial activities as a referee or member of an editorial board, others not.

During an informal but structured interview, the authors spoke freely of their experience of publishing in an open access journal. From their experiences of being published in the *NJP*, we have extrapolated the following key points:

- the majority of them received an invitation to publish their work in these journals
- only one author paid to be published
- some of the authors were not contacted concerning payment
- others refused to pay
- one was exonerated from payment because of being actively involved in the publication process as referee.

Most authors were unsure of exactly what was meant by open access publication. Nevertheless, they highlighted the positive and negative aspects of the open access system.

Positive aspects

- All the authors agreed that there is a need to increase the accessibility and the free availability of scientific information.
- One researcher recalls that open access already exists through the use of document servers such as arXiv and CDS (CERN Document Server). In order to access information for their everyday work, physicists use electronic archives and/or e-mails. The particle physics community is tightly knit which allows easy and rapid communication amongst its members. The use of periodicals is extremely limited in the day-to-day work of physicists, unless they require them to check old references.

Negative aspects

The negative aspects highlighted by the majority of the authors interviewed related to the fact that authors had to pay to have their work published. (Only one author approved of the idea of paying to get their work published.) They argued as follows:

- Authors should not pay anything to the publisher since they do the majority of the work. It

is illogical for the authors, after having completed their research, written their articles and even in some cases worked as referees, to be required to pay to be published.

- Most authors already face problems subsidizing their research as it is extremely difficult to find funding. For some authors, the problem is not having to pay to be published, but rather what funds to use to pay to be published.
- The repartition of CERN's internal budget is also a problem for certain authors interviewed, as this would be distributed at the level of research groups.
- For some of the authors interviewed, the open access models amount to a return to the past, more precisely to the 1970s, where the journal *Physical Review* demanded that authors pay in order to have their work published.
- In addition, some authors interviewed felt that the quality of the journal could suffer if papers are accepted just to raise income. For others, this is not a problem as they believe that the editors would not publish work of an inferior quality, in order to preserve their prestige and credibility amongst their readers.

Certain other points (not linked specifically to open access) worth noting were raised during these interviews:

- Authors need to publish their work. The need to publish their work in a journal is strongly linked to the importance of peer review. Most authors affirmed that they believe that peer review is the only reason that justifies the existence of journals. Nonetheless, many authors equally believe that peer review is not an unconditional guarantee of the quality of an article. Indeed, some authors believe that the quality of an article actually depends on the editorial committee that selects the referees. This is especially important as some referees can lack the objectivity required by their assignment.
- Up and coming physicists require the recognition of the scientific community at large. This can be obtained through the publication of articles in respected scientific journals. In some cases, authors find it preferable not to publish at all rather than to publish in journals with a poor reputation. Publishing numerous articles in obscure journals can tarnish a physicist's reputation.

Conclusion

Scientific journals play an important role in the functioning of the system of scientific research, however, the climate of scientific publishing has changed in the past decades. The 'publish or perish' culture led to an increase in demand for journal titles but library budgets for scientific journals have not increased accordingly. More recently, new information and communication technologies have changed the scene. They enlarge the set of business strategies available to publishers[12].

For CERN, open access publishing models are not entirely satisfactory and appear not to be economically viable. The probable costs incurred by the CERN authors and their lack of motivation to be published in such publications – which may well be reflected in other large research-orientated organizations – may create a problem for the development of open access models.

For physicists, the most important feature of open access is the free availability of scientific knowledge which is a key to scientific communication. However, many physicists already believe that such communication already exists within their small community. However, examples from CERN are not necessarily applicable in a universal way.

Freeing libraries from the economic pressure of journal subscription costs is not an easy task and is unlikely to be a direct consequence of the expansion of the open access model. And, if open access develops substantially in the years to come, it will most certainly not be to the detriment of the publishers.

We are still looking for a feasible open access model; a model that will work for all stakeholders – publishers, research institutes, authors and libraries.

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http://www.oup.co.uk/

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■ **Magaly Báscones Dominguez**
Consultant

E-mail: mbascones2@yahoo.com.ar

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