Who pays the Ferryman? About new models for scientific communication.

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Abstract
Due to a number of problems the traditional scientific journal no longer fulfils a role in the communication among scientists. Several initiatives have been started, using modern information technology, to realise other ways of scientific publishing, which are more in tune with the demands of the academic community.

Two Dutch universities (Utrecht and Delft) and two German universities (Oldenburg and Hamburg) have taken the initiative to set up an infrastructure for academic e-publishing in Europe and to establish a network of content providers making use of this infrastructure. This project, called FIGARO, is a European extension of the Dutch Roquade project together with the German GAP project and is financially supported by the European Commission.

The FIGARO project has a number of remarkable aspects.
Firstly, it offers a variety of possibilities, which together constitute an expeditious way for gradually changing the publication behaviour of scientists. It aims at creating an infrastructure that conglomerates the swiftness of publication, which hitherto could only be realised by grey publishing, with quality judgement but without the serious delay of the traditional review procedures.
FIGARO offers a wide number of facilities to a broad audience, based on a common organisational and technical infrastructure.
Secondly, it creates a business model, which distinguishes between service providers (especially for the e-publishing infrastructure) at one side and a network of front offices (content providers and intermediates for content providers) at the other side. This business model not only guarantees continuous feed back from the users, but it also allows content providers to stick to their own brand and brand name, instead of urging them to conform to a publisher's brand. In short, FIGARO is not a publisher in the traditional sense, but it enables scientists and organisations of scientists to become publishers themselves.

1. The breakdown of scientific communication

In order to make clear the historic perspective of academic publishing, we must go back more than 330 years. In 1665 the first issue of *Journal des Sçavans*, the first scientific magazine is published. A year later it is followed by a second journal, *Philosophical Transactions*. Both appear not in Latin but in the vernacular language, a quite unusual phenomenon during those

days. The reasons to start these endeavours were the need to record research results, making known that it was *their* result and to communicate with their peers about these results (Guédon, 2001).

A major factor in the start of scientific journals was the rising number of researchers. Similarly important was the influence of Francis Bacon who had been successfully advocating the use of systematic and empirical scientific inquiry and who had emphasised the significance of exploring written sources. In order to stimulate the process of building on each other's findings as well as to avoid duplication of efforts scientists needed to be informed on the results achieved and collected by their colleagues.

Of course there were books, but as a carrier for scientific information they had some disadvantages. Their main drawback — an aspect related to their volume — was their sluggishness due to precious time lost in producing them. Books also featured a definite character. Therefore, they tended to be less suitable for discourses on detailed investigations, especially if the facility of additions, comments and reply was useful.

As such, the need for communication among scholars has always been the very raison d'être of the scientific magazine. Then, editors were appointed to judge the quality of the contributions and their results. Due to differences in evaluations, a hierarchy was gradually emerging as some editors proved to be more critical since they had decided to introduce stricter selection conditions. Thus, a number of journals were acquiring a comparatively better reputation.

Consequently, scientists started deriving their stature from the reputation of the journal to which they contributed. Readers were becoming increasingly aware of the difference in quality and this difference even led to the ascension of a ranking system. Finally, the ranking system resulted in playing a significant role in the evaluation of scientific papers and articles, a role that is now firmly established.

As a result, scientific journals have become a distinct factor in evaluating academic research programs and sometimes even are the base for the funding of research groups. People who favour the current scientific journal often consider this factor as the main argument for continuing its existence. But do we really have any reason to be satisfied with its present form?

'Publish or perish' is an adage that we are all familiar with. It is mirrored by the growth in the number of scientific papers. As a consequence of this growth, the existing publishing system is troubled by considerable problems.

One of the main problems is that the system is sluggish: it takes at least six months, sometimes up to a year and a half, before a submitted paper actually appears in print.

In addition to this, the system is becoming unaffordable because of vast price increases, which are often higher than the general price index. These rises lead to the cancelling of subscriptions, which in turn cause new increases, eventually evolving in almost monopoly-like situations held by the publishers.

Furthermore, we must be aware of the fact that, in addition to these price increases, universities have to pay for these publications more than once, since they also pay:

- the salary of university staff members who write the articles and papers;
- the salary of the reviewer who, at the request of the publisher, judges whether the articles are suitable for publication;
- the publication's purchase price;
- the re-use of the publication in course-packs;
- the archiving of the publications.

To get an impression of the price increases we can look at the following samples, presented by Mary M. Case (Case, 2001).

SAMPLE OF JOURNAL PRICES

	1995	2001	% Change
Brain Research	$10,181	$17,444	71.3%
Biochim. Biophys. Acta	$7,555	$12,127	60.5%
Chem. Phys. Letters	$5,279	$9,637	82.6%
Tetrahedron Letters	$5,119	$9,036	76.5%
Eur. Jrnl. of Pharmacology	$4,576	$7,889	72.4%
Gene	$3,924	$7,443	89.7%
Inorganica Chim. Acta	$3,611	$6,726	86.3%
Intl. Jrnl. of Pharmaceutics	$3,006	$5,965	98.4%
Neuroscience	$3,487	$6,270	79.8%
Theoretical Computer Science	$2,774	$4,608	66.1%
Jrnl. of Exp. Marine Bio. & Eco.	$1,947	$3,501	79.8%

The effect of these price rises can be seen from the following graph, which is compiled by SCONUL and Loughborough University. The number of journal subscriptions is decreasing, but also less books are bought, because budgets for monographs are reduced to keep up the journal subscriptions as much as possible.

THE EFFECT OF JOURNAL PRICES ON UK ACADEMIC LIBRARIES
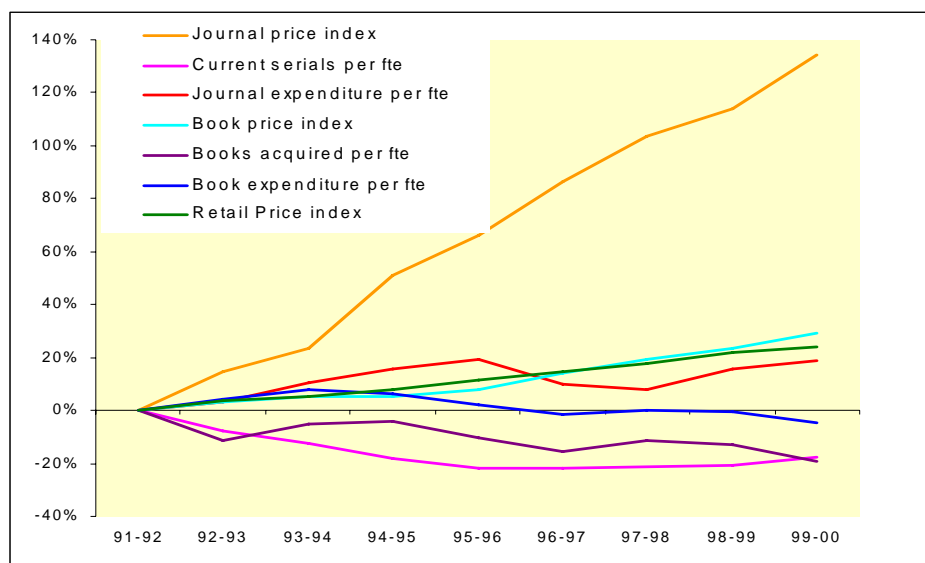
These figures become even more painful, when we look at the next overview, provided by SPARC. It is a list of new journals started by editorial boards that used to work for a

commercial publisher. No longer satisfied with this publisher's policy, they started a new journal with a slightly different title. The price consequences are quite surprising.

Title	Price	Title	Price	
Topology & Its Applications	$2,672	Algebraic and Geometric Topology	Free	$2,672
Journal of Crystal Growth	$9,220	Crystal Growth & Design	$1,781	$7,439
Evolutionary Ecology (price reduced in 2001)	$467	Evolutionary Ecology Research	$340	$127
Topology	$1,303	Geometry & Topology	Free	$1,303
Organic Geochemistry	$2,513	Geochemical Transactions	$100	$2,413
Sensors & Actuators, A & B	$5,313	IEEE Sensors Journal	$395	$4,918
Machine Learning	$1,050	Jnl of Machine Learning Research	Free	$1,050
Plant Ecology (formerly Vegetatio)	$2,861	Jnl of Vegetation Science	$450	$2,411
Tetrahedron Letters	$9,624	Organic Letters	$2,609	$7,015
Chemical Physics Letters	$10,264	PhysChemComm	$100	$10,164
Jnl of Logic & Algebraic Programming	$747	Theory & Practice of Logic Programming	$300	$447
	$46,034		**$6,075**	**$39,959**

2. New initiatives in scholarly publishing

The conclusion of this analysis is that the system is in urgent need of innovation. But this innovation appears to be rather complicated.
Firstly, the traditional commercial publisher is not anxious to stimulate innovations that could seriously change the established process of scientific communication. His main reason for being in the publishing business is making a profit. Innovations are uncertain and thus pose a threat to the stability of his business and profit.

Also many scientists seem to be a little squeamish when it comes to publishing their results. Naturally, this is partly understandable, because of the crucial role traditional journals play in quality assessment procedures. To a large extent, scientists derive their reputation from the journal's reputation.

While traditional publishers are reluctant to innovate the system of academic publishing, the academic community itself is undertaking projects that may lead to this innovation. They can afford to do so, because with the help of information technology, the distribution of their publications is a less hazardous activity than it was in the world of print publications.

In my opinion, it is a good thing that different lines and strategies are pursued by different organisations. It is impossible to predict what the future of academic publishing will look like and it is rather shortsighted to declare a standard for what the future should look like. We should facilitate the rising of a new order in scientific information processes and in this phase this implies that one should not be afraid of a certain degree of chaos.

At this moment, a number of trends can be observed in the innovation of academic publishing.

The first one is what I call a gradual revolution.

It starts with print journals, which are extended with the online publication of the electronic full text. The next step is formed by e-only journals: new electronic journals or journals that used to be print only journals.

Similar to many scientists, most editors who are interested in setting-up an electronic journal also want to start in a more or less traditional way, mainly involving text and pictures. The concept of volumes and issues – typical of the paper journal – is maintained during the start-up phase and, as in the case of traditional paper journals, peer review takes place before publication.

But gradually, a broad range of additions, modifications and alternatives is possible:
- the concept of separate issues will eventually become obsolete; articles are published as soon as they are ready for publication;
- research data can be appended;
- multimedia can be used to enrich the publication.

These "journals" then evolve into publication sites. Subsequently, the traditional process of peer reviewing may be transformed into several new types preserving the traditional advantages as much as possible. In this variant it is possible to achieve speed in publication without omitting the time-consuming peer review process, by delaying peer reviews until after publication. This variant also offers the possibility of experimenting with different forms of quality assessment, e.g. an open and public (not anonymous) peer-review discussion.

When additional services are developed (communication and discussion facilities, news, agenda, printing on demand) it evolves into a portal for the discipline involved which in turn will be an extremely useful instrument for the group of researchers to form a virtual community.

The second trend is based on the increasing importance of so-called archives.

A lot of individual academics present the full text of their publications on their personal homepages; these could be considered personal archives (Harnad, 2001). But there are also an increasing number of universities or research institutes that collect, preserve and provide access to the scientific output of their institute in so-called institutional repositories (SPARC, 2002). If every academic institution were to organise the scientific information it produces, this would result in a worldwide network of servers making full-text scientific information accessible on-line to everyone.

These archives may contain pre-print (contributions that are not peer reviewed or published elsewhere) as well as re-prints (documents that are already published through another medium). There are two functions that are particularly useful from the authors' point of view in this respect:
- Long-term preservation, including guarantees for permanent accessibility, readability, integrity and authenticity (with respect to the transition from one medium and/or format to another).
- Broadening of the readership by making the publications traceable via various Internet channels.

When these archives are interoperable by making use of the metadata protocol of the Open Archive Initiative (Lagoze & Van de Sompel, 2001; see also http://www.openarchives.org), these repositories can be easily aggregated by subject within various knowledge domains. When the archives contain non peer reviewed contributions, they can be reviewed after the publication; this review process can, for instance, be organised by research communities. Additional services may be added and, like is the case in the gradual revolution scenario depicted above, this implies an evolution towards virtual communities.

So these two trends may converge in the long run. An additional step to be taken may be the development of new instruments to measure the impact of the publications in the academic community, to replace the citation indices and traditional impact factors which heavily rely on the quality measures of the publication medium. Eventually, these trends thus may evolve into "a global mapping of science".

From these trends it can be seen that the traditional roles (like the publisher, subscription agent, bookseller, library) in the information chain are changing. In fact, it becomes clear that the borderlines between these roles are not given by God or nature, but that there is a continuum from producer to consumer of information. The borderlines within this continuum are determined by historical factors and technical possibilities. In innovative publishing models other borderlines can be observed. The traditional role of a publisher may well be performed by different parties, for instance peer review and distribution may be organised by different parties.

The FIGARO project is an example of a new initiative that changes the traditional roles.

3.   The FIGARO project: its philosophy

Two Dutch universities (Utrecht and Delft) and two German universities (Oldenburg and Hamburg) have taken the initiative to set up an infrastructure for academic e-publishing in Europe and to establish a network of content providers making use of this infrastructure. This project, called FIGARO, is a European extension of the Dutch Roquade project (http://www.roquade.nl) (Grygierczyk & Savenije, 2001) together with the German GAP project (German Academic Publishers, http://www.dl-forum.de/Foerderung/Projekte/germanacademic/, Gradmann, 2002) and is financially supported by the European Commission (1,4 million euro).
The name FIGARO is an acronym for the Federated Initiative of GAP and Roquade.

FIGARO wishes to enable competition with the few dominating commercial players in academic publishing and to diminish their monopoly-like position, but do so without threatening the role of small and medium-sized enterprises (SME's) as working partners. To accomplish this, FIGARO brings together non-profit academic publishing institutions and partner-SME's.

The mission of FIGARO reads as follows (see http://www.figaro-europe.net):
"As a partner organisation within the European academic community, our mission is to enhance scientific communication by improving the speed, simplicity and cost, which we aim to do through innovations in scholarly publishing.
We strive to provide effective and efficient e-publishing services to individual scientists and scientific organisations through the use of a shared organizational structure and the utilization of open source and standard base software tools wherever possible.
We are committed to supporting our customers by facilitating scientific communication and the publishing process in a way that allows them to retain ownership of their work as well as present their own profile or identity."

The contracting partners in the FIGARO consortium are the universities of Utrecht and Delft in the Netherlands, Oldenburg in Germany, and through their libraries, the University of

Hamburg with its computing centre, the University of Firenze in Italy with its university press and the private software house Daidalos in the Netherlands. As assistant contractors feature the university press of Leuven, Belgium, the R&D department NetLab of Lund University in Sweden, the publishing houses Lemma in the Netherlands and DiG in Poland, the research group Delft Cluster and the well known Scholarly Publishing & Academic Research Coalition (SPARC) from the US.

Utrecht Library is FIGARO's co-ordinator. The contracting partners will build a publishing platform for the academic community and the assistant contractors will test this platform by providing and publishing content.

FIGARO has three overall strategic objectives :
1. Realise technical innovation in the fields of collaborative document modelling and the development and implementation of a www-based shared workflow model.
2. Realise business process innovation through the establishment of a collaborative business model for e-publishing within a virtual community of academic institutions and SME's.
3. The actual building of a networked organisation and production platform based on the results of the aforementioned innovations. This networked organisation also constitutes an effective distribution channel for emerging technologies and new standards in this field.

FIGARO aims at supporting a variety of publishing models with one technical and organisational infrastructure, which is modular and also allows for the use of as many or as few modules as needed.
So FIGARO will support:
- journals,
- publication sites with or without peer reviewing; peer reviewing may take place before or after publication;
- institutional repositories and other forms of open archives;
- co-publishing with traditional publishers, producing the electronic version of a journal which is already published in print.

The reason for offering extensive as well as limited options is that many scientists are not yet ready to use fully new ways of publishing. These scholars are provided with an infrastructure that facilitates a gradual transition from traditional publishing to highly sophisticated models.

4. FIGARO's business model

There are two relevant aspects to FIGARO's business model.
The first one is the network organisation and the second one is the financial model. The outlines of both will be explained in this section.

FIGARO's network organisation
FIGARO is a network organisation, which implies that it is not hierarchical: there is no boss of FIGARO. The main reason for this organisational structure is the need for a strong input from the customers. Any hierarchical intermediary organisation sooner or later will have its own persistence as its main objective. Such an attitude is an obstacle for permanent innovation, while on the other hand, this innovation is absolutely necessary in a rapidly changing environment like the e-publishing environment.

The idea of a network organisation is based on the creation of added value resulting from various specialisations and strong points of the participating partners. This added value has to guarantee that the whole will be more than the sum of the individual nodes in the network. A lot of organisations are already involved in one way or the other in the field of academic e-publishing:

- academic publishers, profit as well as not for profit;
- facilitators of e-publishing processes, like information technology companies but also university libraries;
- facilitators of certain aspects related to e-publishing: printing on demand, digital right management, payment transfer, etc.

All these organisations have their own models, procedures and workflows. They do exist, more or less successfully, and there is no need for creating just one more organisation in one of these fields. However, for any organisation in any domain it is always possible to operate better, more efficient, cheaper, faster, more flexible, more innovative, and to improve the quality of its services. So the idea of FIGARO is to connect these organisations in a flexible network organisation in which best practices will be gathered and distributed. For each of the partners there will be added value. These added values should be tailored to every participating organisation and can for this reason be different in each case:

- some need the technological support for the whole publishing process;
- some partners need technological support for their workflow in e-publishing;
- some need advanced authoring tools related to the workflow support systems they already use;
- some need printing on demand services;
- some need a network of 'brothers in arms' to share, for instance, their information products in an budgetary neutral way;
- some are in urgent need of peer reviewers and are seeking publishing partners from the same discipline to share their reviewers network.

The network organisation contains the following categories of partners: service providers, front offices and a co-ordinator.

The most important service provider is the back office for the e-publishing process; the technical infrastructure facilitating the customers to become publishers themselves. This part of the organisation will be created in the FIGARO project. It supplies the front offices with software tools, know-how documentation, instruction and assistance in overcoming certain hurdles with people.
There also may be other service providers, which are engaged, for instance, in marketing, printing on demand, digital right management, or payment services. Some or all of these service providers may co-operate with each other, but this is not obligatory.

The front offices are intermediaries to the academic community. They serve scientists, editorial boards, academic organisations, etc. that provide the content to be published. In a way the front office are the franchisees of the FIGARO services. A front office can be a university press or a university library which is supporting academic e-publishing, and it can also be a traditional publishing company which makes its print material electronically available with the help of the FIGARO services.
The support given by the front offices can vary depending on the content provider's request for support. This support can cover all technical facilities, as well as project management for

setting-up new publications and implementing the project results. However, it can also be limited to a simple helpdesk function.

On the basis of their experiences, the front offices play an important role in the feedback and evaluation of the tools that are offered by FIGARO.

The main constraints for front offices are:
- requirements concerning the quality (control) of the publication's content;
- requirements as to the quality of support given by the front office;
- principles concerning cost calculation for using the infrastructure and for the front office services;
- the way FIGARO is mentioned in their services and products.

The role of the co-ordinator is essentially to ensure that the whole of the FIGARO organisation is more that the sum of the parts. The co-ordinator is responsible for:
- recruiting new front offices;
- referring new content providers to existing front offices;
- taking care that the front offices meet the FIGARO constraints;
- stimulating synergy between front offices;
- regulating the dynamics within the network.

An important characteristic of this business model is that there is no central branding. Front offices or content providers may keep their own branding. If, for instance, Leuven University Press makes use of FIGARO's infrastructure, its publications will still be products of Leuven University Press. They are facilitated by FIGARO, but still have their own branding, which may be expressed as follows: "Published by Leuven University Press, within the infrastructure of FIGARO".

This construction has no simple equivalent in the classical publishing world. In fact, the traditional publishing role is now divided among several partners: the back office, the front office and the content provider. The way the publisher's role is divided depends on the relation between the partners, more precisely of the extent in which the services of the service providers are used by a front office and the services of the front office are used by the content provider.

In the present model of scientific communication, the journal integrates four basic functions of scholarly publishing:
- registration (establishing intellectual property);
- certification (certifying the quality/validity of the research);
- awareness (assuring accessibility);
- archiving (preserving for future use).

FIGARO disaggregates these functions and allows them to be fulfilled independently by different partners, and it especially separates the content from the services that add value to the content.

For the relation between the back office an the front offices, perhaps a comparison can be made with the LINUX community, with the front offices in the role of developing users adding code value and the back office being comparable to the packaging and re-distribution unit (Raymond, 1999). The back office is a clearinghouse for explicit, i.e. coded and documented experience, but it is also the service station of a European community of practice of e-publishing bodies.

The co-ordinator is responsible for stimulating and, if necessary, organising the feedback from the users of the services. Related to the organisational concept the supporting technology

has to be very much tailored to the needs, requirements and gaps experiences by the FIGARO partners. As they are all different in at least some respects, the supporting facilities should be flexible too. This implies that the technological infrastructure should have a modular structure and the tools should allow for application in different environments.

The network organisation can be represented graphically as follows.
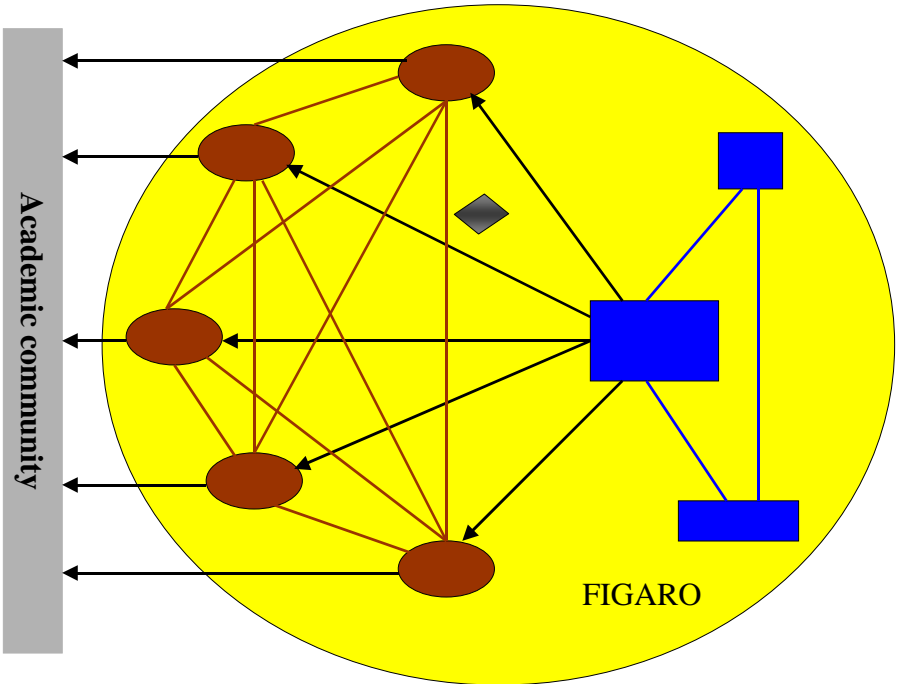
Service provider

Front Office

Co-ordinator

FIGARO's financial model

An important characteristic of FIGARO is that it is not for profit, which implies that it is operating on a cost recovery base. This does not mean that there can be no co-operation with a partner who is working on a profit base, but this partner should not make a profit directly out of the use of FIGARO's services; the profit has to be a result of the added value of the partner itself.

The back office is a financially independent entity, operating on a cost recovery base.
The costs for maintenance and innovation of the back office and also the costs of the co-ordination are paid by the front offices. This implies that the more use is made of the back office, the lower the cost per user will be, because the costs do not increase proportionally with the extent of the use.
Of course, a front office needs money to pay for these services. The front office itself can collect its money in a number of ways:

- Structural funding from its parent institution. This may, for instance, be the case with a university library. If this library has a task in supporting e-publishing in its parent institution, it may pay the use of the FIGARO tools by the university community, out of the library budget, provided by the university.
- The traditional model of subscription fees. This may, for instance, be the case in co-publishing activities with a commercial publisher.
- New models. The philosophy of FIGARO is consistent with a thrive towards open access and thus to work towards new financial models for academic publishing.

To prevent misunderstanding: "Open Access" does not mean that there are no costs involved. Of course there are costs involved in publishing activities. "Open Access" does mean that the costs are not paid by the reader. This is fair, because, actually, every scientific journal has some kind of monopoly from the viewpoint of the reader: the reader has no alternative, he needs the information contained in a journal and cannot trade an expensive journal for another, cheaper one, without being handicapped by loss of (often essential) information.

A useful description of Open Access is provided by BioMed Central (Velterop, 2002):
The article is universally and freely accessible via the Internet in an easily readable format and deposited immediately upon publication without embargo in agreed format in at least one widely and internationally recognised freely accessible repository.

So who does pay in Open Access models? There may be several possibilities:
- The authors may pay for publication, as a kind of page charges. The Florida Entomological Society, for instance, lets authors pay when they want (in addition to a print article) immediate free web access (a so-called IFWA fee) (Walker, 2001). Authors do profit from this online access, because it is shown that the number of citations rises by providing web access (Lawrence, 2001).
- Authors, or the institutions which employ them, may pay for the peer review because they profit from the acceptance of their contribution.
- Institutions or societies may support a journal or site when they need a medium for their own discipline. This, for instance, is the case with the International Journal of Integrated Care (IJIC), published with the infrastructure of Roquade. The start of this journal was supported by a number of research groups working in this field (http://www.ijic.org/).
- Institutions or societies may buy the right for their members to publish in a certain journal or on a site. This is the case with BioMed Central, a profit organisation introducing new financial models for academic e-publishing (http://www.biomedcentral.com/).
- Finally, of course, there is the possibility of grants, donations, or sponsorships, by (inter)national funding agencies, organisations like SPARC, or others.

5. Conclusions

It is difficult to predict the future for academic publishing. Furthermore, we would be shortsighted if we were to prescribe a standard for what the future should look like. Therefore, it would be unmindful to impose a preferred model onto scientific communication. The academic community should initiate the flexible facilitation of new structures in scientific information processes that are advantageous to the academic community itself. FIGARO is an

initiative that has this ambition. It holds benefits for the academic community as well as for the partners that have taken the initiative.

There are a number of challenges in the present developments in academic publishing:
- the innovative use of technology;
- the restoration of the primacy of communication;
- the development of new measures for the impact of a publication in the academic community;
- the development of new business models, aiming at open access.

An important development in this context is the world wide growing movement towards "Open access". The Public Library of Science (http://www.publiclibraryofscience.org/), the Budapest Open Access Initiative (http://www.soros.org/openaccess/), and SPARC (http://www.arl.org/sparc) are examples of initiatives that support this movement. They support models other than the traditional one, for the publishing process as well as for the economic aspects.

For the financial aspects, however, there appears to be a dilemma. It is rather easy to construct a completely new economical model for academic publishing, in accordance with the interests of the academic community. However, it is rather difficult to imagine how the present economic model may evolve into this new model.

So we are confronted with uncertainty and for some time there may even be some chaos. In my opinion this is a useful stage before a new order in academic publishing will arise. FIGARO aims at making a contribution to the emergence of this new order.

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