

An Overview of Scientific, Technical and Medical Publishing and the Value it adds to Research Outputs

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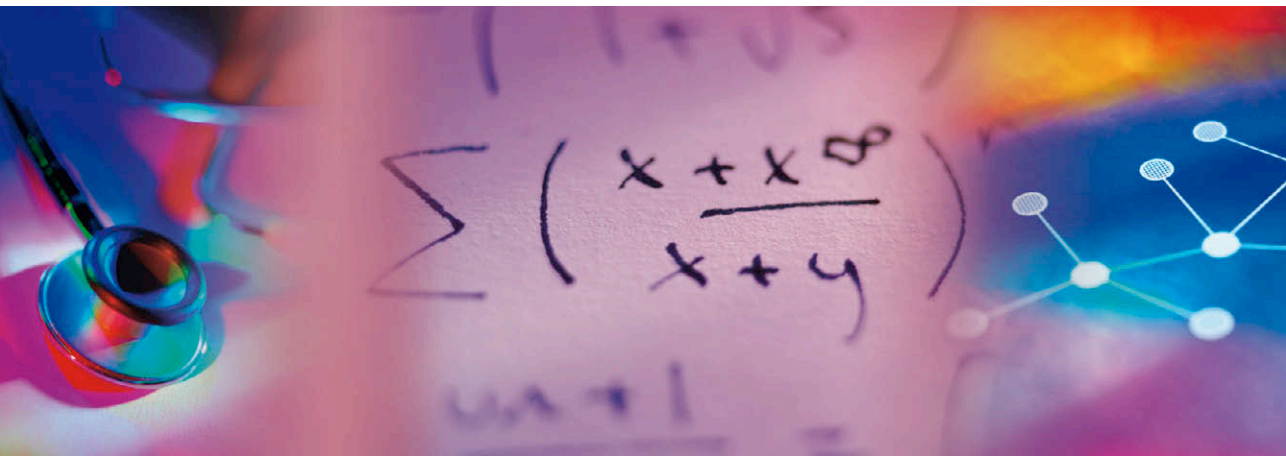


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Copyright Statement

International Association of STM Publishers
3rd Floor, Prama House
267 Banbury Road
Oxford OX2 7HT
United Kingdom

Executive Summary

- Society benefits from the pursuit, distribution, preservation, and usage of scientific discovery and knowledge.
- Scientific, technical and medical (STM) publishers are trusted partners of the international research community in these activities and an indispensable link in the chain of registering, certifying, formalising, improving, disseminating, preserving, and using scientific information – making long-term investments in publications around which emerging, and established scientific communities coalesce and evolve.
- Global access to scientific information for investigators at research institutions is easy and widespread due in no small part to the entrepreneurial efforts of STM publishers to successfully convert paper-based to online dissemination. Publishers are experimenting with data mining and visualisation tools, semantic web applications, online navigation aids, flexible displays, free access to the recent archive of published articles, and Web 2.0 applications, as well as supporting the development of international standards, to enhance online publications and websites and maximise the discoverability of science.
- STM publishers consist of learned societies, university presses, and independent companies. Collectively they employ 110,000 – 120,000 people around the world either directly or indirectly. Well over 40% of these individuals are employed in the EU alone¹. These workers support the emergence and growth of an enormous volume of scientific information – around 1.4 million articles annually². The value these workers add to scientific discourse has an economic cost which must be recovered.
- Because STM publishers seek to increase availability and usage of scientific information in the interest of general societal development, they welcome cooperation with governments, libraries, researchers, institutions, service providers, NGOs and national and international organisations in examining and evaluating how the usage and dissemination of scientific information can be maximised.

1 Ware, *Scientific Publishing in Transition*, Sept. 2006, p. 3.

2 *Ibid*, p. 7. Note also that Wiley and the PA estimated 1.4 million in their 2004 submissions to the UK House Select Cmte on Science & Technology.

What do STM publishers do?

STM publishers contribute and add value to the pursuit, distribution, preservation, and usage of scientific discovery and knowledge in the following ways:

Registration

- by registering an author's precedence and promoting the advancement and contributions of researchers, clinicians, and academics which, in turn, lead to new industries, medicines, treatments, materials, technological innovations, and environmentally-friendly processes which directly benefit human health and welfare and the world's economy

Certification

- by organising, managing, and financially and technologically supporting the system of quality control known as peer review – a system essential to maintaining trust in the integrity, and the excellence, of science
- by establishing, in partnership with the scientific community, codes of ethical practice for scholarly scientific publication
- by vigorously defending the integrity of the published scientific record, and the moral rights of authors, against plagiarism, distortion, or mutilation

Formalisation

- by developing, implementing, and improving author-friendly production workflows which improve the ease, speed, and quality of the author's publishing experience – freeing them to spend more time advancing the frontiers of human knowledge
- by supporting and adopting international standards and protocols that improve the accessibility of research and support the cost containment efforts of research libraries through the discovery of "appropriate copies"

Improvement

- by investing in the workers and technology needed to add readability, value, and online accessibility to original research through processes such as substantive copy/technical editing, verifying references and inserting tags to create online links, preparation of illustrations or special graphics, typesetting, XML coding for web dissemination and layout, visual enhancement, reference linking, and indexing
- by integrating machine-readable tags in online research to foster the development of the semantic web – and the further advancement of science
- by providing value-added material which emphasises the scope and significance of research results to broad non-specialist audiences
- by facilitating the creation of authoritative multi-author, multi-national, multi-language, multi-format, and, in the case of books, multi-edition scientific works derived from original publications

Dissemination

- by providing global forums for emerging, and established scientific communities to coalesce or evolve through cross-fertilisation of knowledge
- by fostering communication and understanding between different segments of the scientific community
- by facilitating understanding and highlighting the relevance of new research tools and technologies
- by facilitating awareness of research results through podcasts, RSS feeds and customised citation and table-of-contents alerting services
- by creating global distribution systems which save authors from having to publish their research on a country-by-country basis

Preservation

- by digitising pre-electronic era scientific content as far back as the 1800s to create fixed versions of electronic articles for future reference and citation according to standards and methodologies that facilitate future preservation and curation
- by migrating digitised content onto new technological platforms and making it accessible to new generations of online investigators
- by participating in and financially supporting independent trusted digital archives that insure long-term preservation of digital files

Use

- by fostering interoperability with industry-standard citation manager software – improving the productivity of researchers
- by enriching the content, functionality, and design of online publications and websites with user-friendly navigation, graphics, taxonomy, personalisation, search, browse, analysis, retrieval, and linking tools designed to provide scientists with seamless and instant access to essential research in a globally standardised format
- by providing forums and training for researchers to improve their knowledge of, and skills in, the use of online research tools and techniques
- by actively seeking to maximise the discoverability of scientific research to general and specialist search engines
- by funding ongoing research into online user needs, limitations, and preferences to better understand and support scientists' desires, tasks, and workflows

Because of their activities, STM publishers form a core part of the process of scholarly communication and are an integral part of scientific research itself.

Although STM publishers are perhaps best known for scientific journals, they also provide print and online forums for scholarly reference works, authoritative handbooks, and thought-provoking book series. STM publishers sponsor, and in many cases organise and manage scientific and technical conferences, seminars, and symposia.

The journals which STM publishers, and their editorial boards, create, when taken together, form a structure that organises and formalises the scholarly research literature. Each journal has a recognised editorial perspective and orientation on which researchers rely. The informal but widely recognised hierarchy of journals that researchers have defined in the various fields of science provides an easy-to-use, clearly defined context for judging research quality and rank, two factors used by funding bodies and the research community itself to determine critically important personal and professional rewards.

STM publisher journals also provide an important method for scientists to navigate the ever-increasing volume of published material. Journals allow researchers to separate usable, certified, trust-worthy and professionally collected information from “pseudo-science” and informal (draft) communications.

The role of the publisher is often confused with that of the printer or manufacturer, but the role is, of course, much wider. STM publishers frequently make 3–7 year investments in the development of new journals around which emerging scientific communities seek to coalesce. These journals in new, niche markets both reflect, and help shape, the development of emerging scientific fields – frequently the source of major breakthroughs that directly benefit human health and welfare. STM publishers also expand, re-focus (or close) existing journals in parallel with key developments in their fields.

There is no publishing “for free”

- Publishing in all media has associated costs. Electronic publishing has costs not found in print publishing. The costs to deliver both are higher than for print or electronic only. Publishing costs remain, whether funded by supply-side (producer-pays) or demand-side (consumer-pays) models.
- The total cost of publishing a journal article with a print and electronic edition depends on multiple factors, but has been estimated to average between € 1100 and 3000³ (US\$ 1500–4000). The variance in estimates reflects the fact that articles that are rejected as a result of the process of peer-review, nonetheless carry substantial costs which, in these estimates, are borne by the published articles only. As rejection rates of different journals vary, so do the costs per published article. As a result, the estimated € 1100–3000 average can rise substantially for high-quality, prestige journals because the published articles must bear the costs of handling the rejected ones.
- Publisher development of electronic journal content, functionality, and design has revolutionised scientists' ability to discover and navigate the literature. More content is available to more users than at any time in history while the cost of use of each article has fallen significantly and will continue to fall⁴. The STM publishing industry has made this possible through the application of sustainable business models and the collective investment of hundreds of millions of euros in electronic developments⁵.
- Publishing is an integral part of doing research. Unpublished research might just as well have not been carried out at all. The cost of publishing is integral to the cost of doing research and without support in the form of publication in a well-respected journal, research remains largely unrecognised.

Publishers agree that raw research data should be made freely available. Publishers encourage the public posting of the raw data outputs of research, and some demand it as a condition of publication. Sets or sub-sets of data that are submitted to a journal with a paper should, wherever possible, be made freely accessible to other scholars.

However, the journal subscription (or article processing charge) covers publication costs incurred after the research itself is completed: for registration, management of peer review, dissemination and archiving (as described above). It must also cover the

3 Estimate based on publisher “author pays” charges and the Open Society Institute’s (OSI) 2003 “Guide to Business Planning for Launching an Open Access Journal” guidelines of US\$ 3750 per article when identifying minimum revenues required per article. Publishing industry consultants John Cox Associates also estimated mean costs per article to be between US\$ 3500 and US\$ 4000 in 2004.

4 Ware, Scientific Publishing in Transition, Sept. 2006, p. 15 and http://www.jisc.ac.uk/uploaded_documents/nesli2_usstudy.pdf This Nesli2 study, dated March 2005, states “The study has demonstrated that for most libraries the average cost per request is low in relation to the cost of an inter-library loan (£ 4.99 for the form alone) and normally considerably lower than pay per view on the current models... p. 9.

5 Ibid. (p. 3). See also Elsevier’s 2004 Written Evidence to the UK House Select Cmte (p. 1, 4) which notes an investment of “approximately £200 million in its electronic platform, ScienceDirect, and in other initiatives...”

fundamental system costs of launching, building, developing and evolving the journal itself. While peer review ensures the quality and scientific integrity of articles, it is the journal “brand name” that places those articles in context for readers.

Peer review is taken on by academics *pro bono*, but the management of this process still requires significant financial resources. One example of this is the millions of euros that publishers invest annually in editorial office management systems which facilitate online peer review. Where editorial administration takes place within the university system, it is usual for the costs to be charged back to the publisher under a full economic costing model. These editorial office expenses constitute a significant and growing part of the publishers’ cost-base.

The costs of journal publishing include the costs of managing not only the peer review and the creation and management of journals themselves, but also the costs of substantive editing, verifying references and inserting tags to create the online links, preparing illustrations or special graphics, typesetting, coding for web dissemination (e.g., in XML) and layout. Journals with a high rejection rate incur much higher average costs of peer review management than those with lower rejection rates, since the published articles must bear the costs of handling the rejected ones.

The total publication cost for a journal article including print is generally thought to average between € 1100 and € 3000⁶ (\$ 1500 – \$ 4000). Eliminating the print edition could save a small percentage of these costs (this is true for subscription, ‘hybrid’, and open access journals) but many libraries and users are as yet unwilling to give up print. Also, eliminating print could have impacts that might in fact increase costs elsewhere or reduce income. For example, at some journals, the loss of print would mean the loss of advertising revenue and/or revenue from membership or personal subscriptions – revenue used to offset the costs of journal publishing. Replicating these in an electronic-only world might require considerable further investments.

Journal prices (as well as article processing charges), apart from covering costs, in most cases also include an element of profit (in the case of independent publishers) or surplus (for not-for-profit publishers, i.e., scholarly societies). Profits are a major source for reinvestment and innovation. Society publishers frequently use surpluses from journals to support other activities such as conferences, travel and research grants or public education.

Journals pricing has been a topic of debate, and perceived high prices and price increases have been one of the factors driving the discussions around open access publishing. The reasons for journal price increases include:

⁶ Estimate based on publisher “author pays” charges and the Open Society Institute’s (OSI) 2003 “Guide to Business Planning for Launching an Open Access Journal” guidelines of US\$ 3750 per article when identifying minimum revenues required per article. Publishing industry consultants John Cox Associates also estimated mean costs per article to be between US\$ 3500 and US\$ 4000 in 2004.

- **Increased numbers of articles** produced by researchers (as described in The Scale of STM Publishing section of this paper), at around 3% annually⁷, and **increased average length of articles**. This is a fundamental driver for journal costs, as it leads to the increased size of journals.
- **Increased special requirements** of features such as specialised language, graphics, chemical compounds, citations, linking, images and links to numeric databases.
- **Value-added attributes** associated with electronic publishing, such as the provision of navigation, search, retrieval, analysis, and linking options.
- The follow-on effects of **fewer institutions carrying the fixed-cost base** of the journal, and **currency effects**⁸.
- **Relative economic inefficiency of new journals** when they are started, which factored into overall subscription inflation can contribute up to 1%⁹ of a price increase.
- **Inflation** (especially salary and paper costs) which has run at about 3.3%¹⁰ per year for the last two decades or more.

The development of online versions of scientific journals has also led to greatly increased access to the scientific literature at greatly reduced costs per use and, for journals increasing the numbers of articles published; there is evidence that prices paid per article have actually decreased over the years¹¹. Reductions in cost per use have been possible largely because the very low marginal costs of electronic distribution have allowed publishers to offer access to sets of journals for relatively small additional licence fees compared to previous total print subscriptions at the institution. Over 90% of STM journals are now online¹², and in many cases their publishers have retrospectively digitised earlier hard copy material back to the first volumes, making them electronically accessible as well.

On the demand side, libraries have formed consortia to enhance their buying power in negotiating electronic licences with publishers, which has also resulted in increased access to more journals for their readers.

7 Ibid, (p. 7).

8 Ibid, (p. 13).

9 King, The cost of journal publishing: a literature review and commentary, *Learned Publishing* (20) 2, Apr. 2007, (p. 95, 98–99).

10 Ware, *Scientific Publishing in Transition*, Sept. 2006, (p. 13).

11 Based on: Creaser, C., Maynard, S. and White, S. (2005). LISU Annual Library Statistics 2005, (p. 133) Table 3.7 Average Price Paid for Materials, All HE Sector Serials, 5 year change, and assuming the average number of articles per journal purchased remains stable or increases over the period.

12 ALPSP Survey, *Scholarly Publishing Practice: Academic journal publishers' policies and practices in online publishing*, 2005, (p. 1).

STM Publishers and the Goal of Open Access

Open access (OA) is most commonly defined as making original research freely accessible on the web, ideally immediately on publication¹³. STM publishers are currently either implementing, or testing, ways to harmonise this visionary goal with economic reality.

Because of their position of trust in the chain of registering, certifying, formalising, improving, disseminating, preserving, and using scientific information, STM publishers look for the following characteristics in new business models:

- They must be truly sustainable.
- They must ensure scientific quality and integrity.
- They must not undermine peer review.
- They must recognise the value that publishers add to scientific discourse and must recover the economic cost of that value.
- They must allow authors to have a choice where to publish. (STM publishers view it as an integral part of academic freedom that authors are allowed to decide when and where they publish their research results.)

Business models being used or tested to make original research freely and immediately accessible on the web

Open access journals¹⁴ use a variety of business models, i.e., scientific grants, membership subscriptions, sponsorship/advertising, commercial reprints, classified advertising, subscriptions to print editions, volunteer labour, and subsidy or support in kind by the host organisation. The best-known approach is the author-side payment model, where an article processing charge (mostly in the range € 1500 to € 2200)¹⁵ is levied on each accepted article.

Self-archiving

Another route to making original research freely accessible on the web is via self-archiving, whereby the author posts a version of the article (typically the revised manuscript after peer review but prior to copy editing – known as the “author final version” rather than the final published article) to an open web-based repository. These repositories can either be central, subject-based collections (e.g., the physics repository *arXiv.org*) or organised to collect the output of a particular institution.

13 Some argue that it also includes the ability to make free use of the online article subject only to minimal constraints. Ware, *Scientific Publishing in Transition*, Sept. 2006, (p. 16).

14 It should be noted that the number of STM open access journals is a matter subject to debate. Two sources on this question, Ulrich's Periodicals Directory (<http://www.ulrichsweb.com/ulrichsweb/>) and the Directory of Open Access Journals (<http://www.doaj.org/>), list some 3,000 journals across all of scholarly publishing they consider to be open access. Consensus has not been reached however about such issues as the subset of these journals that fall into scientific, technical, and medical fields; the minimum criteria for inclusion in such a list; or an objective weighting of their scope and significance.

15 Estimate based on publisher “author pays” charges.

There is a wide range of reports of the costs of introducing and managing an institutional repository. The Massachusetts Institute of Technology (MIT) estimated the annual running costs for their DSpace repository at \$ 285k¹⁶. A survey for the Association of Research Libraries (ARL) in 2006 found that start-up costs could be as high as \$ 1,800,000 and estimates of the ongoing operations budget for implementers ranged from \$ 8600 to \$ 500,000¹⁷. The US National Institutes of Health (NIH) has reported that the cost of handling submissions and administering their self-archiving policy was \$ 1 million for fiscal year 2005¹⁸. NIH also estimated that if the compliance rate was 100% (65,000 articles a year), the cost would be \$ 3.5 million a year¹⁹ but it is widely believed that their estimates of current and projected costs may be a considerable underestimate and do not include important elements such as staff time. Regardless of which estimate is believed, it is clear that institutional repositories have significant costs which from a public policy perspective should be subject to cost-benefit analysis.

Overview of results to date

Publishers are by and large neutral as to which business model to use – whether subscription model or author-pays – as long as the model is sustainable and maintains journal quality. Many publishers offer a pay-to-publish open access option. Author- or funder-pays publishing as a business model has some attractions (e.g., linking publication costs directly to research funding) but also encounters some difficulties (e.g., impact on high-output research-intensive institutions vs. low-output corporate subscribers).

Unlike author- or funder-pays publishing, self-archiving does not secure any funding to cover publication costs. Instead, it builds on the value added by the formal publication process (peer review in particular) and provides access in parallel to the official publisher's platform.

Most publishers allow authors to self-archive early versions of their own articles in a non-systematic way. However, there is strong evidence that the free availability of any post-peer review version in systematic subject repositories or interlinked institutional repositories will undermine the ability to sell subscriptions²⁰. If this happens, publication costs would need to be covered in some other way. Publishers do not believe that self-archiving offers a sustainable alternative for scientific publishing. Also, there are serious potential risks with institutional repositories in terms of quality control and the potential for a reduction in journal revenues. Problems with quality control could endanger the integrity of the scientific record and a reduction in revenues could jeopardize the continuation of certain societies and smaller publishers, further reducing the breadth and quality of STM output. As noted earlier, there will also be significant

16 Ware, *Scientific Publishing in Transition*, Sept. 2006, (p. 25).

17 Bailey, *Institutional Repositories*, SPEC Kit 292, Jul. 2006, (p. 15).

18 National Institutes of Health, *Report on the NIH Public Access Policy*, Jan. 2006, (p. 4), http://publicaccess.nih.gov/Final_Report_20060201.pdf

19 *Ibid*, (p. 4).

20 Beckett and Inger, *Self-Archiving and Journal Subscriptions: Co-existence or Competition?*, Oct. 2006, (p. 24).

costs which may be duplicative and, from a public policy perspective, should be subject to cost-benefit analysis.

Imposing uniform dates after which research articles must be freely accessible on the web (so-called “embargo periods”) is not a viable solution for this issue either. First, it does not recognise the legitimate practices and needs of different fields of science. Second, it neither fully secures subscription revenues, nor does it fully realise the OA goal of immediate availability. Third, a short delay removes, or at least decreases, incentives for subscribers to take out a subscription and for authors to pay for publication with open access, thus making uniform embargo periods the least feasible option in terms of economic sustainability.

Whereas in general scientists should be free to decide themselves where to publish, it is recognised that funders of research may make it a condition of funding that some version of any resulting articles are deposited in a repository to be made freely accessible on the web. If funders do, however, require those articles to be published in peer-reviewed journals, they should take into account the cost of publishing and make payment out of grants possible. More responsible funding bodies, such as the Wellcome Trust, explicitly do so²¹.

Proposal for pilot study

Inspired by the successful British Library pilot on electronic legal deposit, STM publishers have partnered with the European Science Foundation (ESF), Goettingen State and University Library, Max Planck Society and Institut National de Recherche en Informatique et en Automatique (INRIA) to submit a funding proposal to the European Commission eContentplus programme. If successful, the Publishing & Ecology of European Research (PEER) project will develop an “observatory” to monitor the effects of systematic archiving over time.

Participating publishers will collectively contribute c.300 journals to the project from a wide range of types and subjects and allow deposit of manuscripts that have incorporated changes from peer review, and been accepted for publication in the participating journals, into European repositories where they would be made freely accessible after embargo periods appropriate to the discipline and the journal economics. Supporting research studies are envisioned to address issues such as:

- How large-scale archiving will affect journal viability
- Whether it increases access
- How it will affect the broader ecology of European research
- Factors influencing the readiness to deposit in institutional and disciplinary repositories and the associated costs
- Models to illustrate how traditional publishing systems can coexist with self-archiving

21 http://www.wellcome.ac.uk/doc_WTD002766.html

The scale of STM publishing

- There are about 2000 publishers worldwide²², producing around 1.4 million articles²³ annually.
- The numbers of articles published each year, as well as the number of journals, have both increased steadily for over two centuries, by about 3% and 3.5% respectively²⁴. The growth in number of researchers, at about 3% per year²⁵, is equally persistent, and there are now approximately 5.5 million researchers worldwide²⁶.
- STM journal publishing has transformed itself in just over a decade from a largely paper-based activity to a fully online, electronic one.

There are about 2000 STM publishers²⁷, made up of learned societies, university presses, and independent publishers. Their respective shares of article output are about 30%, 4% and 64%²⁸. They employ around 90,000 people globally, of which 36,000 (40%) are employed in the EU. Another 20–30,000 full time employees globally²⁹ are indirectly supported by STM publishing, such as suppliers, freelancers, or external editors.

The global revenue from English-language STM (scientific, technical and medical) journals is estimated at about € 5.2 billion³⁰ (US\$ 7 billion) for 2006. This is a subset of the wider STM publishing output, which includes books, secondary information services, abstracting and indexing (A&I) databases, etc.

Overall, there are about 23,000 scholarly journals in the world, collectively publishing 1.4 million articles a year³¹. The number of articles published each year and the number of journals have both grown steadily for over two centuries, by about 3% and 3.5% respectively³². The reason is the equally persistent growth in the number of researchers, with a rate of about 3% per year³³ and now stands at around 5.5 million³⁴.

22 <http://www.publications.parliament.uk/pa/cm200304/cmselect/cmsctech/399/399we96.htm>

23 Ware, *Scientific Publishing in Transition*, Sept. 2006, (p. 7). Note also that Wiley and the PA estimated 1.4 million in their 2004 submissions to the UK House Select Cmte on Science & Technology.

24 Mabe, *The growth and number of journals*, *Serials* (16) 2 2003, p. 193 and Ware, *Scientific Publishing in Transition*, Sept. 2006, (p. 7).

25 Mabe and Amin, *Growth Dynamics of scholarly and scientific journals*, *Scientometrics*, Vol. 51, No. 1 (2001) 147–162, (p. 158).

26 UNESCO Science Report, 2005, (p. 17).

27 <http://www.publications.parliament.uk/pa/cm200304/cmselect/cmsctech/399/399we96.htm>

28 Elsevier analysis of ISI Journal Citation database as cited in Ware, *Scientific Publishing in Transition*, Sept. 2006, (p. 11).

29 Ware, *Scientific Publishing in Transition*, Sept. 2006, (p. 3).

30 Represents an average of EPS and Simba estimates as noted in Ware, *Scientific Publishing in Transition*, Sept. 2006, p. 6 and footnote 1.

31 Ware, *Scientific Publishing in Transition*, Sept. 2006, (p. 7) Note also that Wiley and the PA estimated 1.4 million in their 2004 submissions to the UK House Select Cmte on Science & Technology.

32 Mabe, *The growth and number of journals*, *Serials* (16) 2 2003, (p. 193) and Ware, *Scientific Publishing in Transition*, Sept. 2006, (p. 7).

33 Mabe and Amin, *Growth Dynamics of scholarly and scientific journals*, *Scientometrics*, Vol. 51, No. 1 (2001) 147–162, (p. 158)

34 UNESCO Science Report, 2005, (p. 17).

However, during the same time, library journal acquisition budgets have not grown accordingly, and less than 1 % of total R&D is spent on journals³⁵.

STM journal publishing has transformed itself in just over a decade from a largely paper-based activity to a fully online, electronic one. Over 10 million readers globally use articles electronically³⁶. Article downloads are around 1.5 billion annually and rising exponentially³⁷.

35 Communication from the Commission to the European Parliament, the Council and the European Economic and Social Committee, On Scientific Information in the Digital Age: Access, Dissemination and Preservation, Feb. 2007, (p.6).

36 Ware, Scientific Publishing in Transition, Sept. 2006, (p. 10).

37 A Response by the International Association of Scientific, Technical & Medical Publishers (STM) to the Study on the economic and technical evolution of the scientific publication markets in Europe, Final Report – January 2006, (p. 7).

Appendix A

The Journal Article Publishing Process

Author submits article via Journal-maintained online site

[Publisher investments begin here.]



Publisher logs submission



Journal Editor chooses referees and sends to referees



Referees (Peers) review



Journal Editor looks at peer reviewer recommendations



Author is sent peer reviews and editor comments



Author revises article



Journal Editor rejects article, or agrees to publish



Publisher receives transfer of copyright or publishing license from author



Article copy edited by publisher



Article composed and “typeset” for online and print by publisher



Author sent article for final proofing



Article posted online and printed by publisher

Search & Finding tools created by publisher

Journal subscribers receive online access and/or print copy

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