

# Scholarly Communication in a Knowledge-Based Economy

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## ABSTRACT

This paper draws on three studies focusing on research practices and scholarly communication, the transition from print to digital delivery in scientific publishing and online publishing business models.<sup>1</sup> It argues that research practices are changing, bringing new research communication and dissemination needs. Online distribution fundamentally changes the underlying economic characteristics of content products, fosters the development of new business models and changes cost and industry structures. As a result, scholarly communication is evolving, with the emergence of the Big Deal, author pays publishing, open access archives and repositories, and a variety of hybrid publishing models. The challenge is to provide an integrated and sustainable scholarly communication system that encompasses all forms of research output, makes it easy for researchers to communicate their results and for users to access their findings. The question is, which of the emerging models for scholarly communication are sustainable and which maximises economic and social returns on investment in research?

## 1. INTRODUCTION

The knowledge economy has been defined as: "...one in which the generation and exploitation of knowledge has come to play the predominant part in the creation of wealth. It is not simply about pushing back the frontiers of knowledge; it is also about the more effective use and exploitation of all types of knowledge in all manner of economic activities." (DTI 1998). In a knowledge economy, the capacity of the innovation system to create *and* disseminate the latest scientific and technical information is an important determinant of national prosperity (OECD 1997).

This paper argues that research practices are changing, bringing new research communication and dissemination needs. Online distribution fundamentally changes the underlying economic characteristics of content products, fosters the development of new business models and changes cost and industry structures. As a result, scholarly communication is evolving, with the emergence of the Big Deal, author pays publishing, open access archives and repositories, and a variety of hybrid publishing models. The ongoing challenge is to use information and communication technologies (ICTs) to provide an integrated and sustainable scholarly communication system that encompasses all forms of research output, makes it easy for researchers to communicate their results and for users to access their findings. The question is, which of the emerging models for scholarly communication are sustainable and which maximises economic and social returns on investment in research?

## 2. CHANGING RESEARCH PRACTICES AND EMERGING NEEDS

A new mode of knowledge production has emerged (Gibbons, et al. 1994; Gibbons 2001; Nowotny, et al. 2001, 2003; Etzkowitz 2002; Etzkowitz & Leydesdorff 1997; etc.). There is

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<sup>1</sup> Houghton, J.W. (2005) *Digital Broadband Content: Scientific Publishing*, Organisation for Economic Cooperation and Development, Paris (forthcoming); Houghton, J.W. (2004) 'Economics of Publishing and the Future of Scholarly Communication,' In Eds. Gorman, G.E. & Rowland, F. (2004) *International Year Book of Library and Information Management 2004-2005: Scholarly Publishing in an Electronic Era*, Facet Publishing, London; and Houghton, J.W., Steele, C. and Henty, M. (2003) *Changing Research Practices in the Digital Information and Communication Environment*, Department of Education, Science and Training, Canberra.

increasing diversity in the location of research activities; increasing focus on interdisciplinary, multidisciplinary and transdisciplinary research; increasing focus on problems, rather than techniques; greater emphasis on collaborative work and communication; and greater emphasis on more diverse and informal modes of communication. As a result, there is increasing demand for access to a wider range of more diverse sources; for access mechanisms that cut across disciplinary silos; and for access to, and management of, non-traditional, non-text digital objects (Houghton, et al. 2003).

The US National Research Council (2001, p5) noted that: “the rapidly expanding availability of primary sources of data in digital form may be shifting the balance of research away from working with secondary sources such as scholarly publications... New automated systems, and perhaps new intermediary institutions for searching and authenticating information, will develop to provide these services, much as libraries and scholarly publications served these roles in the past.” The UK’s Joint Information Systems Committee (2002) suggested that multimedia and distributed computing grids are developments which extend the processes of scholarly communication, while at the same time presenting considerable management challenges. They pointed to the need for new pricing and publishing models, new applications of intellectual property law and new approaches to the preservation of digital content.

### **3. ECONOMICS OF ONLINE DISTRIBUTION**

Online distribution changes cost structures. Characteristically, content products have high first copy costs and low subsequent copy or marginal costs of production. Nevertheless, when content is printed, packaged and distributed there remain significant costs in the production and distribution of physical copies. Making the same content available online reduces these producers’ costs dramatically, with no physical (re)production and distribution activities and no inventory. New investment in producers’ technical infrastructure is required, but the long-term impact of online distribution tends to be to reduce marginal cost of production to near zero and shift the distribution of costs towards fixed costs. Current and emerging content business models can be seen as responses to changing cost structures.

Bakos and Brynjolfsson (2000, p117) suggested that with online distribution goods that were previously aggregated to save transaction or distribution costs may be disaggregated (eg. newspapers), but new aggregations may emerge to exploit the potential of bundling for profit maximisation. The Big Deal is one such aggregation. Some analysts have extended the logic of bundling from the content itself (ie. papers in a journal) to subscription (ie. bundling over time) and site licensing (ie. bundling users) (Bakos and Brynjolfsson 1999; Bakos, Brynjolfsson and Lichtman 1999; Bakos and Brynjolfsson 2000). Just as different consumers may have a different willingness to pay, so too the same consumer may have a different willingness to pay at different times. If provision of access over time costs very little, it may be more profitable to provide a long-term subscription than to provide for individual uses in short periods of time (eg. pay-per-view) (Bakos and Brynjolfsson 2000, p131). Similarly, site and consortial licensing aggregates individual subscribers and allows the supplier to charge at the individuals’ average willingness to pay.<sup>2</sup>

### **4. EVOLVING PUBLISHING BUSINESS MODELS**

Current scholarly communication practices reflect the emergence of three major business models which depend upon online delivery:

- The, so called, Big Deal – where institutional subscribers pay for access to online aggregations of titles through consortia or site licensing arrangements;

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<sup>2</sup> The emerging business model for e-books also features bundling and subscription – with the delivery of e-books through the major online journal access systems (eg. Elsevier ScienceDirect, Springer LINK, Wiley Interscience, Blackwell Synergy, etc.) and elsewhere on a subscription or pay-per-view basis (EPS 2004a).

- Open access publishing supported by author charges (“author pays” publishing) – where authors, their employers or funders contribute to the costs of publication; and
- Open access archives and repositories – where organisations support institutional repositories and/or subject archives.

There are also a number of hybrids, such as delayed open access (where journals allow open access after a period during which they are accessible to subscribers only), and open choice (where authors can choose to pay author fees and make their works open access, or choose not to pay and make their works subscription only). Each model has advantages and disadvantages.

#### 4.1 The “Big Deal”

One major advantage of the Big Deal is that it gives researchers access to many more titles than is typically the case with individual subscriptions (Table 1). This can be particularly important for researchers in interdisciplinary fields and in circumstances where greater breadth of knowledge and flexibility in focus is required (Houghton et al. 2003). Such deals also reduce per title and per article costs within the overall package. Bundling and site licensing can also increase budgetary certainty for research libraries through multi-year deals with agreed price increases. This can be an attractive feature for libraries, which often operate on fixed multi-year budgets. Aggregating subscriptions and site licensing has also encouraged libraries to form purchasing consortia, which have often enabled them to negotiate better deals than they could have obtained individually.

**Table 1 Advantages and disadvantages of the “Big Deal”**

Advantages	Disadvantages
Improved access, with access to more titles – which suits researchers in emerging interdisciplinary areas and tends to lead to higher use.	Tends to lock libraries into the major bundles and makes it more difficult to cancel titles.
Reduces the per title and per article costs to users of the overall package.	Tends to reduce substitutability and choice, and may reduce price elasticity of demand.
Can increase budgetary certainty for research libraries through multi-year deals with fixed price increases agreed up-front.	Tends to squeeze out smaller publishers who cannot offer access to large bundles (ie. becomes competition between publishers rather than titles).
Can increase access through consortial deals, especially for those previously poorly served.	May influence impact factors in favour of titles within the bundle and strengthen the position of the major publishers.
	Because publishers try to build up the bundle and price it, rather than individual titles, there is less pressure to axe low demand titles. As a result, aggregate fixed (first copy) costs increase.
	Access may sometimes be more restrictive than that for print subscriptions (eg. access for walk-in library users may be cut by either publisher or library logon requirements).
	Concern over access to previously subscribed to back issues if subscription is terminated (ie. cut off from everything, not just new issues).
	Concern over long term archival integrity, if left in the hands of publishers.

However, a number of disadvantages have been associated with the “Big Deal”. For example:

- Such deals tend to lock libraries into the major bundles available and make it more difficult for them to cancel subscriptions (Franklin 2002; Key Perspectives 2004; CESTMJP 2004; etc.). Aside from questions of value for money and efficiency, such deals reduce substitutability and may reduce price elasticity of demand and, thereby, downward pressure on prices.
- Such deals tend to squeeze out smaller independent publishers who cannot offer access to large bundles, with research libraries taking the titles that are available from major commercial publishers as a part of the bundle and cancelling titles from smaller publishers to pay for them (Prosser 2004).<sup>3</sup>
- Such deals may influence citation patterns and impact factors in favour of titles within the bundle, because they are more easily accessible. This may increase the desirability of that publisher's titles over those of others, reduce substitutability and, thereby, enable them to increase their prices in the future (Guedon 2001, p46).
- Because publishers price a bundle of titles rather than individual titles, there is less pressure for them to remove low demand titles from their portfolios. This may enable low demand/low use titles that would otherwise have been cancelled to continue as a part of a bundle, which remains viable because of other titles within the aggregation. As a result, the number of titles may increase, increasing aggregate fixed costs within the system (Houghton 2001; SQW 2003, p5).

While there is increasing flexibility within the Big Deals, there remain concerns relating to the mechanics, economic and scholarly outcomes of major bundled subscriptions and site licensing arrangements (Frazier 2001; Gatten & Sanville 2004; CESTMJP 2004, p22; etc.).

Summarising the operation of the STM publishing market, the UK's Competition Commission and Office of Fair Trading suggested that neither journal prices nor market share are sufficient to explain the, so called, serials crisis by themselves, it is the interrelation between them that gives cause for concern (HCSTC 2004a, p47). The purchasing practices of research libraries are such that there is limited price competition in the STM journal market, because "if a very well-regarded but expensive journal increases its price further, it is the cheaper, but less-well regarded journals in the same field that are cancelled, so that the subscription to the leading journal can be maintained. This means that a publisher sometimes has the potential to increase his market share by raising his prices" (Competition Commission 2001, p15; Office of Fair Trading 2002, p15). SQW (2003, 2004, p9) concluded that "This market does not behave conventionally. It is not well positioned to deliver the benefits of unfettered free markets and if left as it is could produce outcomes which are in the interests of very few." (HCSTC 2004a, p47).

#### **4.2 Open access ("author pays") publishing**

In the *author pays publishing* model, the costs of peer review and the production of journals are met by charging authors a per article or per page fee for publication, submission or some combination of both, and/or from donations or institutional support.<sup>4</sup>

There are a number of advantages and disadvantages to "author pays" publishing (Table 2). Perhaps the most significant advantage is the possibility of enhanced access, with greater dissemination of research findings likely to bring higher return on investment in R&D. Indeed, there is some evidence to suggest that citation and use is higher for online and open access articles than for articles that are available on a subscription or pay-per-view basis (HCSTC

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<sup>3</sup> This has encouraged the independent society and institutional publishers to attempt to create their own collective subscription and licensing deals (eg. ALPSP, BioOne, Project Euclid, etc.) (SQW 2003; Key Perspectives 2004).

<sup>4</sup> Relatively few open access journals are entirely author pays, with many using donations, bequests, institutional support, priced add-ons or auxiliary services to support publication.

2004a, p76; Lawrence 2001a; Odlyzko 2002; Prosser 2003; Kurtz 2004; Walker 2004),<sup>5</sup> although others have challenged this suggestion (Richardson and Saxby 2004). However, citations reflect research use only. They take no account of wider use (eg. by medical practitioners, consulting engineers, etc.) and the potential for open access to facilitate the diffusion of research findings to a much wider range of potential users – far beyond the core research institutions that have had access to the subscription-based literature.

**Table 2 Advantages and disadvantages of “author pays” publishing**

Advantages	Disadvantages
Increases access to the findings of research, thereby likely increasing social returns from investment in research.	May lead to inequality of access, with publishing based on means rather than merit.
Costs should be lower than subscription-based models, due to lack of need for licensing, subscription management, and access control.	May not work for the humanities, arts and social sciences, where research funding is more limited.
Scales publication to research funding and activity, rather than research library budgets (ie. better matches demand and supply).	May make it more difficult to establish a new journal, thereby reducing the number of titles over time and making it difficult for new areas of scholarship to find an outlet.
Journals compete for authors rather than subscribers, so likely to increase substitutability between titles.	May create a disincentive to publish, thereby reducing the impact of R&D and the return on R&D spending.
	May have a detrimental impact on institutional and society publishers, who have used subscription revenues to subsidise other activities.
	May raise quality concerns due to economic pressure to lower rejection rates to control costs.
	Will shift the costs of publishing, and may lead to organisations and countries that are major producers of scientific and scholarly works paying more in author charges than they would for subscription fees in a reader pays system.
	May create a free rider problem, with open access for previously paying users in the private sector (eg. pharmaceutical firms).

It has also been suggested that author pays publishing supported may be a more economically efficient model, because:

- It is likely to be lower cost than subscription-based publishing, with no need for licensing, subscription management and access control – although author payments systems will be required (PLoS 2003; SQW 2004, p2; HCSTC 2004a, p73);
- The system scales to research funding and activity rather than research library budgets, which have not kept pace with the expansion of research activity (PLoS 2003; HCSTC 2004a);
- It bypasses some of the failings of the subscription model – such as the lack of competition between journal titles and articles (being “must have” items for readers), poor transmission of price signals, non-price sensitive research library acquisition practices, etc. (McCabe 1998a; Houghton 2001; SQW 2004); and
- It increases competition between journal titles, as there is greater substitutability between titles for authors than there is for readers/subscribers, and thereby puts

<sup>5</sup> BioMed Central reported that during the first half of 2004, open access articles in *Nucleic Acids Research* were downloaded 52% more frequently, on average, than were subscription articles in the same journal.

downward pressure on publisher costs as they compete (in part) for authors on article production costs (Bergstrom and Bergstrom 2004a, 2004b).

There are also potential disadvantages to “author pays” publishing. For example:

- There are potential difficulties in moving to any system that introduces financial means as a condition of publishing. For example, where publication is supported through research grant funding there may be further accentuation of the *Mathew Principle*,<sup>6</sup> with publication dependent upon research funding and research funding dependent upon publication. There are also concerns about publishing opportunities for young researchers entering a field who may initially have limited financial backing.
- Author fees are likely to represent a small fraction of research funding in science, technical and medical fields, but an author pays system may not work in areas of the humanities, arts and social sciences where there is more limited research funding. Publication-based, rather than submission-based, author pays publishing would also be more difficult in fields with higher average article rejection rates.
- An author pays model may introduce an incentive to publish less at the individual, institutional and perhaps even national levels – because of affordability. Obviously, such an outcome would be the opposite of what most proponents of open access seek to achieve, and would undermine some of the potential benefits of open access.
- When author charges are levied for accepted articles there is an economic incentive for publishers to accept a higher proportion of articles, which may have negative implications for quality and scholarship. However, perceptions of quality and journal impact factors should lead authors to continue to value high-quality titles and seek to publish in them, thereby allowing high-quality journals to compete for authors with lower fee alternatives.<sup>7</sup>
- An entirely author pays system may make it more difficult to establish a new journal, which would lack the established reputation of existing titles and not be as attractive to would-be authors (King and Tenopir 2004; Odlyzko 2004). Conversely, it might be argued that with revenue tied to submissions and publication rather than subscription sales, revenue should be more predictable and cash flow more manageable and it would be easier to find support to launch open access journals.
- An author pays system could have a detrimental impact on institutional and society publishers, who use their subscription revenues to subsidise other activities (Willinsky 2003; Worlock 2004; Morris 2004; etc.). While this may be true and adjustments may be required, making formerly hidden cross-subsidies more transparent could be seen as a benefit.<sup>8</sup>
- An author pays system shifts the costs of publishing, and may lead to countries and organisations that are major producers of scientific and technical knowledge paying more in author charges than they would for subscription fees in a reader pays system (Elsevier 2004, p2; Okerson 2004a; Davis, et al. 2004, p20; etc.). Obviously, access for authors from developing countries and less well funded organisations must be considered, with schemes required to facilitate participation which mirror those that have been established to enable reader access to the subscription literature (SQW 2004, p21; HCSTC 2004a).

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<sup>6</sup> After the Bible passage: "For unto every one that hath shall be given, and he shall have abundance: but from him that hath not shall be taken away even that which he hath." (Mathew 25:29). Now commonly paraphrased as "The rich get richer and the poor get poorer".

<sup>7</sup> In a small survey of publishers of open access journals, Hedlund, et al. (2004) found an average 50% rejection rate, comparable to the print journal average, suggesting that pressure for higher acceptance rates had not emerged to date.

<sup>8</sup> In its response to the House of Commons Science and Technology Committee Report on Scientific Publishing, the UK Government noted that: "The Government agrees that cost transparency will help the academic world to understand the pricing regime and the products they are receiving." (HCSTC 2004b, p20).

- In fields where there is extensive application of research (eg. medicine, engineering, computer science, management, etc.) many of the users (ie. readers) do not contribute as authors. With a shift from reader pays subscriptions to author pays open access, these readers become free-riders (HCSTC 2004a). However, the maximisation of benefits from public expenditure on research comes through wide dissemination and commercialisation. To the extent that knowledge is a public good, there can be no free-riders.

“Author pays” publishing alternatives are becoming more widely available, but with so many issues unresolved there remain doubts as to its sustainability (Zandonella 2003; Willinsky 2003; McCabe and Synder 2004a, 2004b; HCSTC 2004a, 2004b; etc.).

### 4.3 Open access archives and repositories

Open access archives are typically subject or discipline based, offering open and free access to pre-print and/or post-print papers in a particular discipline or subject area. Open access repositories are typically institutionally based, offering the same level of open and free access to the work and outputs of particular institutions. Subject-based open access archives have been available for a number of years, and are often overseen by a group of experts associated with the archive (eg. ArXiv). Institutional repositories are a somewhat more recent development. They operate in much the same way, but are associated with an organisation, such as a university or research institute, rather than a subject area or discipline.

**Table 3 Advantages and disadvantages of open access archives & repositories**

Advantages	Disadvantages
Access free and open to all, likely maximising the dissemination of research findings and thereby social welfare benefits from R&D spending.	Control over quality and posting may vary from archive to archive and institution to institution.
Speed of dissemination is greater than subscription-based or open access publishing (author pays).	Concern over the handling of copyright for archives/repositories and publishing (eg. possible limitations on posting published material and potential IP conflicts).
May help to overcome the publishing bias towards publication of successful findings.	Potential lack of market segmentation for authors and access control over their works.
May contribute to the creation of a more complete record of scholarship (eg. institutional repositories recording the institutions’ entire output).	Relatively low rates of posting to most institutional repositories to date (ie. population issue).
Because of the availability of OAI standards and guidelines and a number of open source / freeware software systems archives & repositories could be a relatively low cost alternative.	
Potential for repositories to integrate with e-science data repositories and a range of other forms of digital objects, and thereby provide enhanced support for collaborative and inter-disciplinary research.	
Potential to contribute to enhanced measurement, and greater quality and ease of research assessment at both institutional and/or individual levels.	

There are a number of pros and cons (Table 3). Open access archives and repositories exhibit all the advantages of open access, including speed and breadth of dissemination. An important additional feature of institutional repositories is that they can host a range of objects, including pre-print and post-print articles *and* a range of other digital objects (eg. monographs, reports, laboratory and field notes, data, analytical software, audio, video and

image files, etc.). Thus, open access repositories are better adapted to the needs of emerging modes of inter-disciplinary and collaborative research (Lynch 2003; Houghton et al. 2003). With the availability of OAI standards and guidelines, and a number of open source and/or freeware software systems for the establishment and operation of archives and repositories, they may also represent a relatively low cost alternative for providing dissemination of and access to research.

Importantly, where there is institutional support or mandate, repositories can become a more complete record of science than traditional scientific publishing. For example, there is a natural tendency for both researchers and editors to publish “success stories”, rather than focus on a record of failed or inconclusive research. Were funders and/or institutions to require it, repositories could become a source of information about the findings from *all* projects and experiments undertaken (HCSTC 2004a, 2004b). Such information could be enormously valuable in the reduction of duplicative work and pursuit of “blind alleys”, contributing significantly to reducing costs and increasing the efficiency of research.

Nevertheless, there are a number of challenges confronting the development of open access archives and repositories. These include:

- Control over quality and posting, which is essential for the development of trust among readers and, perhaps, among authors. While neither archives nor repositories have been peer-reviewed in the same way as scholarly journals, there are a variety of measures that can be taken to ensure a level of quality is maintained. Examples include the oversight of archive operations by an expert advisory board and control over institutional repository postings equivalent to that exercised over institutional presses and/or institutional working paper series, and various levels of internal and external peer review.
- The handling of copyright for archive/repository publishing, with freedom to post potentially limited by copyright agreements with some publishers – although it was recently reported that more than 80% of publishers currently allow self-archiving after publication (HCSTC 2004a, p57).<sup>9</sup> Perhaps the major issue is clarification of the respective intellectual property rights of researchers and their employers, and the development of standard licensing contracts by institutions or sectors (eg. universities) in support of research dissemination (eg. creative commons licensing).
- To date, the level of posting to institutional repositories has been limited. This may simply be a matter of awareness and opportunity. Authors may be concerned about the possibility of pre-posting jeopardising their chances of publication. Crucially, authors have little incentive to undertake self-archiving while research evaluation remains linked almost exclusively to traditional publishing forms. Open access repositories are unlikely to fully succeed until linked to research evaluation.

## 5. FUTURE BUSINESS MODELS

Open access archives and repositories, particularly institutional repositories, may have some advantages over more traditional and limited forms of scholarly communication. The capacity of institutional repositories to cater for a greater range of digital objects; link into and integrate with e-science databases and data repositories, thereby offering greater support for collaborative, interdisciplinary research; provide a showcase for the intellectual output of the institution; support institutional e-learning and the needs of lifelong learners; and support open access to research findings offer significant advantages. However, they cannot replace journal and monograph publishing at present, because of the central role it plays in quality control and research evaluation.

In the immediate future there is likely to be a period of experimentation, with an unbundling of the elements, new combinations and more transparency in relation to the costs involved –

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<sup>9</sup> A checklist of publisher policies can be found at [www.sherpa.ac.uk/romeo.php](http://www.sherpa.ac.uk/romeo.php).



facilitating increased economic efficiency through a better matching of costs and benefits. In the longer term, emerging alternatives may gradually replace some of the objects and activities that have been central to scholarly publishing in the print era.

The most central object in scholarly publishing has been the *journal*. For authors the journal title is a brand, built upon quality control, prestige of editorial affiliations, citation and impact factors. For readers, however, the availability of online journal databases and the tendency to search online for authors or by keywords mean that readers are increasingly accessing articles independently. The journal may become somewhat less important as a result. The journal has also played important non-publishing roles, such as forming the basis for networks of scholars wherein the editor forms a focal point around which the editorial board, regular reviewers, contributors and readers orbit (Houghton et al. 2003). Journals have also provided fora for ongoing discussion of particular topics (SQW 2003). However, there are alternatives developing based upon emerging ICT applications – such as discussion groups, web logs, etc. Friedlander and Bessette (2003, p9) observed that the nature and role of scholarly journals are changing, and Smith (2000) suggested that with the development of the web, journals no longer form the primary communication medium. For most of the roles traditionally played by the journal alternatives are emerging and are being used – albeit, to date, in rather experimental ways.

Few activities in scholarly publishing are more central than *peer review*, but here too there are changes underway. There is some concern that peer review is not working well, especially for multi-disciplinary or trans-disciplinary research (Odlyzko 2002; Jefferson et al. 2003; Peek 2003). More importantly, in the increasingly multi-disciplinary, multi-site, collaborative world of research both the value of, and necessity for, peer review may decline. Whereas, in the past, an individual scholar might report findings, it is now increasingly the case that reports of research findings reflect the collaborative work of a number of scholars, institutional and stakeholder interests. By implication at least, they have all seen, vetted and, in some senses, peer reviewed the material. Moreover, as primary data are more widely available via open access databases and papers more commonly include direct links to accessible data elements, reported findings are more readily replicable and checkable. There are also new, technology-based alternatives to peer review emerging, such as online commentary and reader reviews, threaded discussion (Nadasdy 1997; Varian 1998; Singer 2000), as well as procedures for, and controls over, posting to archives and repositories – such as institutional affiliation and status, or what Kling et al. (2002) referred to as Guild Publishing and the substitution of peer review by “career review”.

These developments suggest that the evolution of the scholarly communication and publishing system may involve the dissolution of existing and emergence of new combinations of objects, activities and responsibilities. This could involve, for example, the rise of open access subject archives and institutional repositories populated by free-standing digital objects of all kinds, with quality control based around career review, online user commentary and more formalised but diffuse review processes, and impacts measured as hits, downloads, citations and links, which reflect the use and impact of the work more fully than do citations alone. Such a reconfiguration of objects and activities would likely provoke adjustment of stakeholder responsibilities (Owen 2002). This could involve commercial publishing firms shifting their emphasis from content/copyright-based publishing to value adding activities built around open access objects (eg. harvesting content from open access archives and repositories, packaging and adding value through the addition of abstracting and indexing and a range of powerful searching, linking, interrogation, access and usage reporting functions). For publishers, this may also involve the development of products and services that increase value for targeted vertical markets (Akie, et al. 2004).

Whatever the future holds, any new system must take account of: the roles of existing stakeholders, objects and activities; the emerging and changing needs of researchers and the impacts of e-science and the related “data delude”; the emerging opportunities afforded

by rapidly developing ICT applications; and the underlying economic characteristics of information in its various forms.

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