

Are Hypermedia Scholarly Journals a New Genre or an Old Genre in a New Medium?

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Abstract:

This paper aims to provide an overview of developments to date in the evolution of the scholarly journal in terms of the transformation of the form and function of the artefacts of scholarly communication (journals and the articles they contain). The paper starts by first outlining three critical theoretical perspectives. It then proceeds to consider the transformations in the form and function of journals that are occurring or might occur. In each of these cases the insights from the relevant body of theory are drawn upon. The paper concludes by speculating on the future of the form and functions of the journal based on the discussion of theory and the literature.

1. Introduction

This paper aims to provide an overview of developments to date in the evolution of the scholarly journal. The intent is to see how three inter-related theoretical perspectives reinforce the various stories told by the research literature in the field. This paper looks at this evolution in terms of the transformation of the form and function of the artefacts of scholarly communication (journals and the articles they contain).

For the purposes of this discussion, form is defined as the appearance, organisation, delivery mechanism and type of content associated with the scholarly journal. Some of this form is tied to the delivery technology and hence may or must change if the technology changes.

Function is defined specifically as those functions provided by the scholarly journal and its articles to the scholarly community. These functions can be summarised as:

- defining a citeable unit for acknowledgment
- fixing a scholar's views at a particular time
- providing gate keeping or filtering of material
- providing timely communication of results and ideas
- enabling access to information within a given discipline

The paper starts by first outlining the three theoretical perspectives. It then proceeds to consider the transformations in the form and function of journals that are occurring or might occur. In each of these cases the insights from the relevant body of theory are drawn upon. The paper concludes by speculating on the future of the form and functions of the journal based on the discussion of theory and the literature.

2. Theoretical Perspectives

2.1 Ecology of communicative transactions

The work of Kaufer and Carley starts from a fairly standard theoretical model of partners in communicative transactions exchanging communications with each other but then moves on to focus on the entire interaction cycle of communication as the unit of analysis. This shifts the focus from particular elements in the communicative transaction to a single communication ecology. This ecology of communicative transactions consists of agents exchanging communicative transactions within an evolving open systems ecology [Kaufer and Carley, 1993]. Agents include people and books (shorthand for any written material that is both printed and mass-circulated, and presumably generalisable to 'fixed' electronic text as well).

The idea of the ecological structural framework is to regard all these components of communication as "mutually defining, coadaptive, and coevolving components of single ecology" [Kaufer and Carley, 1993, p. 95]. The critical terms here are coadaptive and coevolving. This model is an extraordinarily powerful one when discussing a rapidly changing field such as electronic scholarly publishing. Kaufer and Carley's analysis serves as a reminder not to assume that the obvious factors are driving the process, and to be aware of the complex interdependencies between technologies, stakeholders and the scholarly environment.

The existing print journal is an example of what Kaufer and Carley call a 'book agent', by which they mean anything that is both printed and mass-circulated. Associated with any form of written communication in their analysis are the concepts of *fixity* (the degree to which communication technology enables the communication to be retransmitted without change), *reach* (characterised as lying somewhere on a number of orthogonal axes: impact (immediate to ultimate), potential (actual to expected), and cognitive comprehensiveness) and *distance* (the separation between writer and reader caused by any combination of space, time and culture). Communications technologies can extend an author's reach through *asynchronicity* (which removes the requirement that partners in a communicative transaction have to be coex-

istent in time, (and, by implication, in space), *durability* (the length of time the content of a communication is available for interaction) and *multiplicity* (the number of communication partners that can be communicated with at the same time).

2.2 Punctuated equilibrium and speciation

Drawing on Kaufer and Carley's idea that the system of scholarly communication behaves like an ecology (as does the information industry as a whole - see [Odlyzko, 1997]), what happens if ideas from the studies of 'real' ecologies are brought to bear on this new domain?

One fruitful approach appears to be the punctuated equilibrium model, first outlined in [Eldredge and Gould, 1972]. They propose that the development of new species occurs when parts of the breeding population become cut off from the rest of the population in different environments. These cut-off parts adapt to the new environmental challenges by evolving into new species that then no longer need to change [Benton, 1993, p. 33]. If the surrounding environment then also changes, a few of the newly developed species are already preadapted and will quickly out-compete their ancestral relatives. In the fossil record, this then shows up as a sudden change from one organism to another. This addition to standard evolutionary theory has now been "accepted ... as a valuable addition to evolutionary theory" [Gould and Eldredge, 1993, p. 223].

Punctuated equilibrium has also started to be applied outside the domain of biology. Within the science disciplines, punctuated equilibrium is sufficiently well known to be used without explanation in editorial material [Rubenstein, 1995]. Fields of application in the domain of business include organisational change [Fox-Wolfgramm et al., 1998], product innovation [Eisenhardt and Tabrizi, 1995] and technology diffusion [Loch and Huberman, 1998]. The application of punctuated equilibrium to the ecology of scholarly journal publishing has not (to the author's knowledge) been attempted before and may well yield valuable new insights into its likely evolution.

Kaufer and Carley's analysis has modelled the process of communication as an ecology. Presumably, scholarly communication is a part of the overall communication ecology. Under this analysis, an individual journal title is analogous to a species, with changes in particular articles being the equivalent of changes at the sub-organism level. What then is the environmental change within this scholarly communication ecology that might drive such formation of new species (speciation)?

One excellent candidate is change in the scholarly communication space caused by new technologies. The most important of these technologies for scholars since the middle of this century have been the communication and computing technologies. These have provided the potential for transformations of both professional practices and intermediary processes. The stakeholders who have been affected are publishers, scholars (as both consumers and producers of content), scholarly societies (as representatives of scholars and as publishing intermediaries in their own right) and librarians.

Most recently, the rise of the Internet and its increased possibilities for electronic publishing have provided a new ecological niche that is being colonised by all sorts of communications products, scholarly journals included. Is it possible that the move to the new electronic environment might involve the development of new species of scholarly communication artefacts?

2.3 Genre-based framework for new media

This idea of an ecology of communicative transactions deals with the overall environment within which print communication takes place. The theory of punctuated equilibrium focuses on the processes of change within that environment. Neither are directly applicable to the design of the specific communications artefacts themselves. The final theoretical perspective

looks beyond the technology but is much more obviously applicable to new media and their implications.

A genre-based framework for new media is based on the work of Phil Agre ([Agre, 1995a], [Agre, 1995b], [Agre, 1995c]), but primarily on [Agre, 1995b]. This presents a framework for media design based on an inquiry into the role of genres in people's activities. [Agre, 1995a] deals with the natures of communities and how they operate, and [Agre, 1995c] focuses more on the forms and use of information. His main argument is that any design of a communications system using new media requires a focus on the "social relationships around a given type of communication" [Agre, 1995b]. New media are never precisely defined, but presumably include mass media (such as radio and television), electronic text on CD-ROM, multimedia offerings of all sorts and the whole cluster of technologies around the Internet.

The central concept in this social focus is genre - "the expectable forms of communication that fit into particular forms of activity involving relationships between communities of people" [Agre, 1995b]. The power of genres for Agre can be summarised by saying that "in analytical terms, they are the meeting-point between the process of producing media materials and the process of using them" [Agre, 1995b]. He discusses the insights that applying this theory provides under the headings of communities, activities, relationships, media, and genres.

A community is defined by Agre as the set of people who occupy a given structural location in an institution or society. In the context of scholarship, a very broad application of community might be all scholars. A narrow definition might be a particular discipline such as physics or a narrow sub-discipline like string-theory cosmology.

Community implies "shared forms of activity within a particular institutional logic" [Agre, 1995c]. These activities include both physical actions and cognitive and emotional processes. The genre "needs to 'fit' with the whole complex of 'external' and 'internal' aspects of the activity" [Agre, 1995b]. Scholarly *activities* include writing and reading articles, conference papers and books, taking part in the processes of journal publishing by refereeing and editing, teaching, researching, collaborating with other scholars, communicating with the wider community, applying for grants, and administration.

Communities express themselves in shared patterns of activity, but the sense of community comes from the quality of shared *relationships* within that community. The links that bind scholarly communities together include those that derive from the university system of education (graduates from particular departments, protégés of a particular researcher), those that come from membership in formally constituted scholarly societies, informal networks that often form or are renewed at conferences, and membership of electronic mailing lists. Members of such scholarly communities are in turn linked to publishers through activities like refereeing and editing.

Media are defined as the "specific technical means of communication" used in activities [Agre, 1995b]. Agre notes that the affordances of a medium condition how it will be used. Affordances is a term used in the Human Computer Interaction community to describe what a particular thing or piece of software affords, or allows the user to do. For instance, a pen affords writing, ear-cleaning, head-scratching, etc.

A genre is a "relatively stable, expectable form of communication" [Agre, 1995b]. In Agre's analysis, genres are intimately embedded into his framework for thinking about new media: they are designed or have evolved for specific communities and "fit into particular activities in the lives of that community's members" [Agre, 1995b]. They are also usually closely linked to a particular medium.

Consistent with Kaufer and Carley's theme of an evolving ecology of communicative transactions, Agre argues that "it helps to think of a genre in historical terms as the product of an ongoing process of coevolution between its producers and consumers" [Agre, 1995b]. Genres coevolve with the network of practices in which they participate, they shape the activities of

members of communities, and they are shaped by those activities in turn [Agre, 1995c, p. 227].

Other researchers have also found this idea of genres very fruitful. Levy argues that “each genre has a characteristic rhythm of fixity and fluidity” [Levy, 1994]. Nunberg has discussed (in the context of applying genre theory to electronic newspapers) that genres mold their environment [Nunberg, 1993]. Furuta and Marshall have discussed the way in which genres can act as a reflection of the underlying technology in the context of Web homepages [Furuta and Marshall, 1995]. Yates and Sumner argue that “the new burden for providing fixity in communications is being met by increased reliance on genre” [Yates and Sumner, 1997, p. 3].

2.4 Integrating the perspectives

These different theoretical perspectives have been drawn from different disciplines, but are nonetheless inter-related. It is important to realise that the three main bodies of theory operate on three different, but related, levels. The first, the ecology of communication, addresses the overall environment in which scholarly communication takes place and which scholarly journals ‘inhabit’. The second, punctuated equilibrium, addresses the ways in which changes might take place within such an ecology. The third, a genre-based framework for new media, addresses the task of designing a new ‘species’ of journal to inhabit such a changed ecology.

The work of Kaufer and Carley provides a range of precisely defined characteristics of the communication process that can be examined in the context of hypermedia scholarly journals. Their idea of an evolving open systems ecology is an extraordinarily powerful way to think about the interactions with the evolving field of electronic scholarly publishing. They also provide a number of specific suggestions with respect to new communication technologies that will need to be considered in the light of the possibilities inherent in those technologies.

Gould and Eldredge’s model of punctuated equilibrium change in species builds on the idea of the communications ecology to analyse the processes of change and make predictions about both the rate of change and ability to predict developments from known starting points.

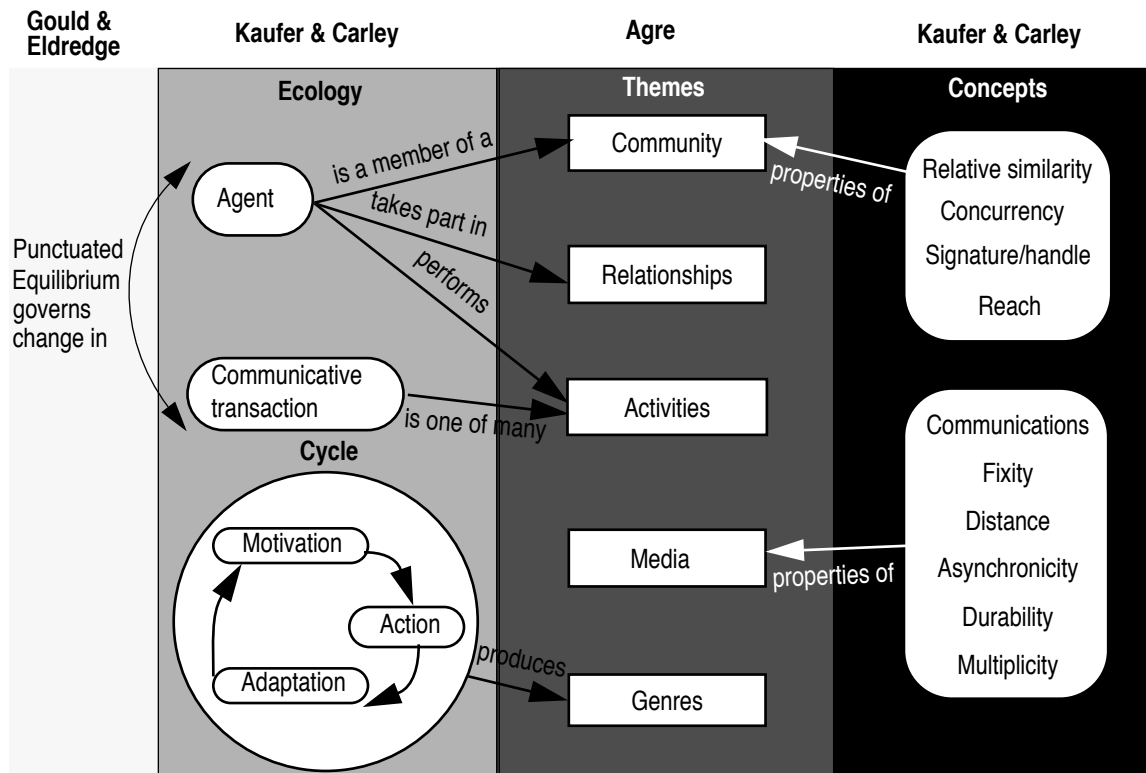
Agre’s theoretical perspective provides a very useful way to think about some of the key components in the ecology that surrounds hypermedia scholarly journals. The notions of community, activity, relationship, medium and genre are all very powerful ways of conceptualising what happens when we use a journal.

Figure 1 shows the linkages between these three theoretical perspectives. The concepts of agent and communicative transaction from Kaufer & Carley’s ecology of the communicative transaction are both linked to Agre’s perspectives. An agent is a member of (at least one) community, takes part in relationships with members of that community, and performs activities (both within the community and outside it). The communicative transaction is one of those activities. Kaufer and Carley’s concepts of relative similarity and concurrency are both properties of the community. The members of the community also have particular mental models, signatures, and reach. Communications, fixity, distance, asynchronicity, durability and multiplicity are all properties of the medium of communication. During its process of evolution Kaufer and Carley’s communicative transaction cycle produces (among other things) Agre’s genres. Finally, Gould & Eldredge’s augmentation of the theory of evolution with their mechanism of punctuated equilibrium governs the processes of change within the ecology. Thus the three perspectives complement and inform each other. Each has its own concerns, but links powerfully to the other. Together, they provide a rich base for this paper.

3 Transformations in the form of journals

The journal as we know it has been quite stable in its form since the development of mass-printing technologies (with the exception of greater use of colour during the last decade or so). The journal environment is rapidly changing and moving towards an online hypermedia envi-

Figure 1: Integrated Theoretical Perspectives



ronment [Treloar, 1996]. What transformations (if any) will occur in the form of the scholarly journal as it moves into such an environment?

3.1 Insights from theory

Ecology of communicative transactions

Of the properties inherent in Kauffer and Carley's model of communicating agents, *fixity* and *durability* relate most directly to the form of the scholarly journal.

Fixity is the extent to which a communication technology enables the communication to be retransmitted without change. Print, of course, is an example of a medium that is inherently highly fixed. Electronic text is much less highly fixed (unless stored on a read-only device). It is quite easy to alter an electronic text accessed across a network, either on the server at source, or in transit between the reader and the client. The user may not be aware that any change had taken place, or that what they are reading is not what was originally written by the author. This is particularly a problem if the electronic text is changing frequently without this being marked in some obvious way. In the world of print, articles are defined packages of content and books have editions to indicate significant change. Online publications may change on a daily basis either without any indicator or at best a version number. Some online journals (eg. *Public Access Computer Systems Review*) now allow the author the option of updating a published article. In this environment, how can a reader know which version has been cited? Clearly, the current system of scholarly communication requires the fixity principle to be maintained in an online form.

Durability is defined in terms of how long the content of a communication is available for interaction [Kauffer and Carley, 1994, p. 34], and is a property of the medium (ie. of the form) of the communicative artefact. Durable texts diffuse more widely and for longer, and thus increase the author's reach. Durability is a problem for the transmission of texts across time as

well as distance, in the sense that it may be difficult to access an older electronic text because of technological change. Either the text may have to be migrated to a newer technology (violating the fixity principle by altering it), or it may be unable to be accessed (violating the durability principle by making it impossible to transmit it onwards). It is essential for electronic texts to be durable so that they can be accessed and cited into the foreseeable future. Of course, this durability may be made possible through migration of content [Graham, 1997].

In discussing the development of print, Kaufer and Carley point out that new media “coexist with, rather than replace, established media” [Kaufer and Carley, 1993, p. 6]. Rather than pitting print against the previous oral and written cultures, they argue a more useful question is “what additional possibilities became available to speakers and writers once they could also rely on print?” [Kaufer and Carley, 1993, p. 6]. One might well extend this to ask what additional possibilities become available once writers can rely on hypermedia? These are ideas that some of the leading edge e-journals are just starting to explore.

On the subject of electronic print, Kaufer and Carley suggest a profitable research area might be to analyse how things like electronic mail and bulletin boards (and by extension electronic journals) allow the “diffusion of new ideas to the right people, over print alone” [Kaufer and Carley, 1993, p. 393]. Targeted mailing lists exist already, but no one seems to be suggesting targeted e-journals. However, it is possible to list requests for updates on topics of interest with a number of online services. The Amazon.Com online bookstore allows a user to list keywords and to be emailed when new books with these keywords become available. *The Journal of Biological Chemistry Online* allows a reader to indicate they wish to receive email when a specified article of interest is cited. It is quite possible that in the near future a scholar could have a series of alerting requests with a range of services providing a constant stream of messages about new discoveries and references to other scholars’ (or their own) work. This is simply a logical extension of the old Strategic Dissemination of Information (SDI) services that libraries have been providing (more recently in conjunction with online databases) for decades. The difference now is that it can be user initiated and operate on the full text of journals, not just databases of journal surrogates.

In their analysis of academe and the role of print journals, Kaufer and Carley argue that in diffusing new ideas journals are simultaneously faster than book publication or face-to-face interaction (due to their frequency of issue and increased reach respectively), and slower than newspapers (due to the gatekeeper function of peer review). The consensus according to Kaufer and Carley is that many scientists regard the speed of journals as too slow, particularly in very fast-moving fields. This is clearly an area where e-journals can have a significant impact. E-journals can diffuse new ideas more quickly because of a range of factors:

- faster refereeing processes through use of email
- faster production processes through electronic submission
- faster appearance because there is no need to wait until a print issue is full before publishing
- faster delivery because there is no need to physically move anything to the reader

Kaufer and Carley argue for a non-deterministic view of the effects of new technologies, taking account of other sociocultural variables as well. They do, however, admit that the benefits of hindsight are much greater when looking at print than when considering the newer technologies. They make the explicit point that “researchers interested in (the newer technologies of communication) might learn something by analogy with our treatment of print” [Kaufer and Carley, 1993, p. 17]. This is a theme echoed by a number of other researchers in the field [Fjällbrant, 1997], [Rowland et al., 1995].

One of the things that such a researcher might learn is not to assume that a new communications technology implies a qualitative difference. Kaufer and Carley argue strongly for first considering the new on a common quantitative continuum with the old:

To ignore historical continuities across technologies is to reveal more than a historical ignorance of what came before. It is to remain primarily ignorant of the technologies

we now take for granted. [Kaufer and Carley, 1993, p. 18].

These insights imply both that changes in journal form will not solely be driven by technology and that the history of the scholarly journal may well have much to say about its future.

Punctuated equilibrium and speciation

The punctuated equilibrium model suggests that the equivalent of the sub-population adapting might be those journals now making the move into an online existence (with those who are making a break with paper altogether, rather than retaining parallel publishing, being best adapted). Within a relatively short period of time (far shorter in the world of publishing than in geological time), the remaining journals will need to either adapt and move to online or die out. This will appear in the equivalent of the fossil record (library serials holdings?) as a quite quick transition from print only to electronic only. The emerging consensus among researchers into electronic scholarly publishing is that the transition should effectively be complete by 2010 - 2020.

Another insight provided by the punctuated equilibrium model is that the record of species in the fossil record manifests itself as long periods of stasis, punctuated by rapid change or sudden jumps from one species to the next. The last of these punctuatory jumps in scholarly communication was the spread of printing, followed by hundreds of years of relative stasis in the form (although not the numbers) of the scholarly journal. The current changes in communication technologies may well be the trigger for another punctuatory jump followed by another period of relative stasis. This second period of stasis will probably be shorter given the pace of technological change.

A final insight from the domain of palaeobiology is that patterns of speciation and extinction are chaotic, strongly influenced by the environment around them and very difficult to predict (as opposed to easy to infer with the benefit of hindsight). Stephen Jay Gould argues that if the history of life on Earth were to be replayed from the beginning, the likelihood of *homo sapiens* arising are vanishingly small [Gould, 1989]. The implications of this for any attempt to predict developments in electronic publishing technologies (and by implication the form of e-journals that rely on those technologies) are clear. These developments will also be hard to predict and influenced by the wider computing and communication environment.

One of the critical developments in the understanding of the effects of punctuated equilibrium on speciation and evolution is the fossil fauna of the Burgess Shale, described by Stephen Jay Gould in his book *Wonderful Life* [Gould, 1989]. These organisms date back to 530 million years ago, just after the 'Cambrian explosion' - a time of dramatic diversification in evolution. The importance of the Burgess Shale is that it preserves many anatomical designs that existed for a while and then disappeared, never to be seen again. In accounting for this astonishing diversity, Gould points to three main factors:

- the first filling of the ecological barrel, providing empty ecological niches that life could rapidly colonise;
- a directional history for genetic systems, making significant change harder over time;
- early diversification and later locking-in as a property of all systems.

The Internet provides those empty ecological niches for new journals to colonise. The directional history of technology developments is evident in the ways that particular technology patterns (the dominance of Windows, the *de facto* use of Adobe's PDF as a page description standard) rapidly become widespread and resistant to change. The early diversification and later locking in are occurring around us in the e-journal domain at this very moment.

Genres and new media

Philip Agre has analysed the design of new media in terms of genre theory [Agre, 1995b]. Three of his specific categories of analysis (communities, media and genres) provide a range of useful insights into changes in the form of hypermedia scholarly journals.

Different scholarly *communities* have always had quite different formatting requirements for print journals, traditions of using such journals and access to new technology. The Science, Technology and Medicine (STM) disciplines have always required more from their print publications in the way of the need for diagrams, equations, photographs and non-Roman symbols. There is some evidence ([Zuckerman and Merton, 1979], [Beyer, 1978]) that rejection rates in STM journals are significantly lower than in the social sciences and humanities. By the nature of their disciplines, the STM communities have tended to have earlier access to high technology of all sorts, including networked desktop computers. It is likely therefore that the STM journals will make the move to electronic delivery first and also use the more innovative delivery and presentation technologies. At present this seems to be the trend, with scholarly societies in the STM field driving the development of (mostly parallel delivery but soon electronic only) e-journals. Among the large commercial journal publishers, it is those with a large STM component (Elsevier, Blackwell Science) that are leading the move to parallel delivery.

With respect to *media* one of the most obvious differences between traditional print journal publishing and electronic journal publishing is the medium in which they are presented. Print has always been used for journals, monographs, conference proceedings, preprints, informal newsletters and the like. Off-line electronic media like CD-ROM and floppy disk have also been used for all of the above. The predominant electronic delivery mechanism at the moment (and into the future) seems to be some form of computer network, either the Internet or whatever it evolves into. The affordances of the e-journal are clearly a concern to a number of readers, as indicated in their survey responses, and the design of new e-journals need to take account of these concerns and support existing usage patterns (where possible) or substitute improved alternatives (where not). The use of a live table of contents at the start of an e-journal as a (partial) replacement for being able to flip through the print pages of the paternal is one such example.

Finally, the scholarly journal as we perceive it today is a mature example of a *genre* that has evolved to be useful to members of a scholarly community. It is perhaps misleading to talk about the scholarly journal as a genre. In practice, there are a number of variant sub-genres including less formal newsletters, 'letters'-type journals (*Physical Review Letters*), journals with an editor but no peer-review and anonymously peer-reviewed journals. Members of such sub-genres can be placed on continuums of refereeing rigour, type of content and speed of publication. Any replacement for the scholarly print journal will either need to reproduce the functions of this genre or replace them with new functions that are more useful.

One of the critical issues is the question of whether hypermedia scholarly journals are a new genre or just an old genre in a new medium. In a real sense, this relates to the question of evolution versus revolution. At what point does an evolving new thing move from being quantitatively different to quantitatively new? Kaufer and Carley argue that researchers should not leap to declare something qualitatively different before first exploring the possibility of mere quantitative difference [Kaufer and Carley, 1993, p. 17].

Agre also points out that technology developments do not behave in the same way as developments in other fields because of what economists call path dependencies:

... media industries are powerfully path-dependent because of effects deriving from the compatibility of different commodities ... Once proprietary standards become entrenched in the marketplace, so that compatibility effects create ever-higher barriers to entry for potential competitors, their owners can start to extract rents from a variety of other parties. Moreover, network externalities (costs to individuals that derive from everyone else's choices) mean that dominance over a market tends to expand once it is established. [Agre, 1995b]

A good example of this in the domain of electronic publishing is the way in which Adobe's Acrobat technology is now the *de facto* standard for the distribution of 'electronic print'. As recently as three years ago there were a number of competitor technologies, some with supe-

rior technology offerings in some respects [Gruman, 1995]. Acrobat managed to gain a slight edge and that was enough to cause a swing in favour of its PDF technology to such an extent that the alternatives are no longer available on the market.

3.2 Insights from research literature

A wide range of researchers have been thinking about, researching on and writing about electronic scholarly journals for at least the last two decades. What insights into transformations in the form of scholarly journals can be drawn from this work?

A study by Julene Butler [Butler, 1995a] received responses from 199 contributors (authors and editors) to e-journals relating to perceived benefits and disadvantages of electronic publication and to informal recognition and rewards. A number of her benefits and disadvantages are relevant to the form of the scholarly journal. Perceived disadvantages were inadequate graphics (listed by 38% of all respondents selecting this option), archival instability (35%) and potential for text alteration (8%). Advantages related to the form of the journal were speed of publication (71% of respondents) and the ability to publish materials unique to electronic formats (18%).

Harter and Kim have been pursuing a line of research dealing with citation analysis within and to e-journals. Part of their research dealt with the data formats and access methods used in the pool of e-journals they were studying [Harter and Kim, 1996a]. They found that, at that time (1995), the majority of the e-journals used ASCII text. HTML and Postscript were the second and third most commonly used formats. In this survey, PDF was used less than OCLC's proprietary Guidon format (now obsolete). The main form of access was WWW (66.4% of e-journals) followed by Gopher (42.4%), FTP (41.6%) and Listserv (38.4%) - the numbers do not sum to 100% because many journals used more than one access method. It is important to realise that these online technologies are quite new and without the centuries of development that underpin the print journal literature. This is visible in access problems: the portion of this study dealing with citations to other online literature tried to follow these references to test their accessibility. Only 51.8% of these references could successfully be retrieved. For the online references that were Web URLs, this percentage only rose to 66%.

Professor Schauder's study questions dealing with the preferred form of electronic scholarly publications [Schauder, 1994b, p.91] found little difference in respondents' attitudes, with CD-ROM, floppy-disk or networked media all deemed either preferred or suitable. His respondents were only moderately concerned that remote printouts appear identical to print originals, although there was a difference in responses by discipline area. Respondents from Physical Sciences and Engineering ranked this as more necessary than those from Arts, Social Sciences, Law and Business, with respondents from Biological Sciences and Medicine being least concerned about print fidelity.

The study by Berge and Collins [Berge and Collins, 1996] of the readership of the *IPCT Journal* found that most respondents (in 1994) preferred ASCII format documents delivered via email. At that time, the preferred retrieval mechanism (40.9%) was via Gopher. They surmised that preferences would tip in favour of retrieval from the Web (as in fact occurred).

A survey of editors, authors and readers of *Journal of Biological Chemistry* (both print and online) [Gotsch and Reich, 1997] found that scientists regarded the print and online versions of the journal as complementary. Advantages of the online version were rapidity of searching, convenience, timeliness and efficiency of storage. Stated advantages of the print version were ease of reading, quality of figures, serendipity of discovery through browsing (repeatedly referred to), independence from technology while reading, and portability. These two sets of affordances do not overlap, and it is very difficult to see how retain all the print advantages while moving to an online only version of the journal. When asked about desirable enhancements to the online version, the two most popular choices were more hypertext links and links to a bibliographic manager (both of which have now been implemented).

Woolfrey's study of the readers of the *Canadian Journal of Communication* found that about half were interested in receiving the journal electronically [Woolfrey, 1995]. She concluded that this was so they could search a journal database for articles.

A survey by Hitchcock, et. al. [Hitchcock, 1996] of STM journals available online in 1995 found that at that time Postscript still dominated at the more technical end of the spectrum. ASCII was being mostly used as an archival format. The main changes in the form of the journal that they anticipated were changes to the structure (more broadly-based e-journals) and frequency of publication (articles released as approved rather than waiting for a gap in a printing schedule). Their later survey [Hitchcock et al., 1997] argued that journal formats based on HTML (as the native document language of the Web) and Postscript (as the *de facto* standard for printing from digital publication systems) will inevitably dominate e-journal production. They found that PDF (as a dialect of Postscript offering significant compression options) had come to dominate the available formats. In their view, whether a journal adopted HTML or PDF depended on the origins of the journal and its production arrangements. HTML typically was used where the formatting requirements were less critical. PDF was used for journals that had begun as paper only and were now moving to parallel delivery.

Olsen's study of users of electronic versions of ACS journals [Olsen, 1994], undertaken as part of the CORE Project at Cornell, was largely carried out before the Web technologies and used informants with no experience of e-journals. As a result, much of her reported interview material deals less with new things that e-journals could offer and more with the indispensable attributes of print. Her list of key points related to print journals derived from her interviews was:

- the need to view high-quality graphics with text
- the poor ergonomics of reading on screen
- deficiencies of slow screen scrolling relative to fast page flipping
- the importance of serendipity
- the ability to annotate the text
- the 'weight' of text on paper
- the ability to browse

The improvements over print expected of an electronic system included:

- ease of access to the literature
- ease of searching
- reduced lag times in access to recent literature
- creation of a personal database of articles
- reduced space for storage

She argues that:

In the same way as the printed text on paper has been honed over the centuries to achieve useability, so will the electronic text have to be designed and presented to allow users to achieve their objectives in using the material [Olsen, 1994, p. 32].

The question is, given the list of indispensable attributes (some of which will be very difficult or impossible to provide in an online environment) demanded by the scholars she interviewed how could one proceed to do this design? It is the author's belief that it should be possible to trade off some of the benefits of print for the extra advantages of online publishing. Olsen's conclusion is that:

Building an electronic journal system cannot be viewed as the same kind of task as building the text systems we have experienced thus far in information systems development ... (it) will require a new frame of mind, an imaginative approach, and an unconventional configuration of technology [Olsen, 1994, p. 73].

Stewart's separate analysis of interview data [Stewart, 1996] from users of the CORE system shows that all of the respondents ranked most of Olsen's list of essential functions as at least

‘important’. Their three areas of concern regarding an ideal e-journal system were period of coverage, presentation of graphics and presentation of text. Interestingly, fewer of Stewart’s respondents than Schauder’s [Schauder, 1994b] regarded exactly the same presentation of text online (via page images) as important.

Stewart’s conclusion (quoting [Schaffner, 1994]) is that

Electronic journals must, at the start, at least serve the basic functions that print journals have traditionally served. Once the transition has been made, new technologies may allow us to add new roles, to drop some of the traditional roles, or to fill them in intrinsically different ways [Schaffner, 1994, p. 240].

The question is, if it is not possible to provide some of these functions (fast flipping between pages, easy annotation) will added features like full-text searching and hypermedia additions be sufficient compensation?

Schaffner herself argues that enabling technologies may not be sufficient to bring about major change and that new forms of communication are slow to develop and take full advantage of new capabilities [Schaffner, 1994].

The analysis of user responses to the CORE system reported in [Entlich, 1994] provides a number of interesting pieces of data as well as some significant conclusions. He found that the ratio of printing to viewing of articles was 1:4. This was consistent across the two CORE interfaces (Scepter and Pixlook). (It is also consistent with anecdotal evidence about use of PDF documents inside Adobe). The interpretation of the CORE group with respect to printing is that “online full-text systems are used . . . as a convenient way to discover articles of interest, but not to read them in depth” [Entlich, 1994, p. 110]. This article ends by applying the insights from the CORE project to the form and functionality of the then (ie. late 1995) current e-journals. Their main conclusions were:

- limitations in HTML’s display of special characters remains a problem
- publishers should not overestimate the technical abilities or patience of their users
- there is no reason to expect that the tendency observed in the CORE users to read little on-screen and print articles for closer scrutiny will be any different for Web e-journals
- failure to provide adequate searching is commonplace
- assumptions that users will learn to how use a particular search system effectively are misplaced
- rapid response time is critical and therefore HTML abstracts (at the least) should be provided for PDF articles.

Loch and Huberman, in their application of punctuated equilibrium theory to technology diffusion [Loch and Huberman, 1998], argue that in an environment where there are two alternative technology solutions, with one being superior, both technologies exhibit positive externalities (performance benefits from others using the same technology). The externalities initially produce two stable usage equilibria, one for each technology. These equilibria are subject to sudden punctuatory shifts, with one technology being adopted as the new standard. Critically, they found that the time before such an equilibrium punctuation takes place is dependent on the rate of incremental improvement of both technologies and on the system’s resistance to switching between equilibria.

Ann Okerson and James O’Donnell make the excellent point that changes in technology change the way in which we categorise the world. She provides as an example the telephone directory and the novel. Both are currently included (for most of us) in the category ‘book’. As efficient on-line indices with free-text searching and hyperlinks begin to replace the telephone directory, it will no longer be thought of as a book. This removal of an item from the category will in turn subtly redefine the category for us. As they delightfully put it:

Even as we are all reading our Jane Austen on a summer’s day in a hammock twenty years from now, the ‘book’ will have changed by virtue of the things that won’t be in

book form any longer.” [Okerson and O’Donnell, 1995, p. 2]

A good way to end this discussion of the effect of changes in the form of the scholarly journal is with a quote from Gotsch and Reich’s survey of scholars associated with *JBC*:

The results of the survey point to a group very much in transition. Their answers can perhaps best be likened to respondents who were asked about the Iron Horse in the 19th Century. It was obvious that the steam locomotive was something important but no one had an inkling that it would revolutionise transportation to the extent that it did. [Gotsch and Reich, 1997]

4 Transformations in the function of journals

As we have seen, new technologies make possible changes in the form of journals. These changes, coupled with other potentials in the technologies allow us to start to think about how the functions themselves of the scholarly journal might change.

4.1 Insights from theoretical perspectives

Ecology of communicative transactions

The concepts in Kaufer and Carley’s model that relate to the functions of the scholarly journal are *reach*, *asynchronicity*, and *multiplicity*.

Reach for an individual can be defined as the number of people whose mental model is affected by a signed communication from that individual. Reach is a property of the author, but technology can extend an author’s reach. Technology extends communication at a distance through asynchronicity, durability, and multiplicity.

Asynchronicity removes the requirement that partners in a communicative transaction have to be coexistent in time (and by implication, in space). A move to online hypermedia journals will not replace this existing property of print journals. However, such a move does have the potential to enhance discussion around journal articles, particularly with innovations like the open peer commentary associated with journals like *JIME*.

Multiplicity is “the number of communication partners that can be communicated with at the same time” [Kaufer and Carley, 1994, p. 35]. Multiplicity implies greater distance and greater speed in spreading information. Network technologies provide for the largest potential asynchronicity, durability and multiplicity of any communications technologies to date. One of the attractions of e-journals is their ability to dramatically increase multiplicity. Large consortium licences allow groups of institutions to gain access to journal titles online that they had not previously subscribed to in print, at no or little extra cost. There is no (or little) incremental opportunity cost to the publishers in increasing such access. As an example, Deakin University now has a site licence for all of the Project Muse journals (available online at <http://muse.jhu.edu/>), even though it had not subscribed to many of them previously. As a multi-site institution, having the full text online also simplifies access to titles that had been previously only been easily available within the campus on which they had been located.

Kaufer and Carley argue for a necessary role for print in the activities of scholarly professions, in the sense that large diverse professions need to be structured around printed texts. But print is merely a supporting technology, not a deterministic one. The nature of professions depend on the characteristics of a group, and not the medium through which they communicate. Like the later technologies of electronic mail, print increased the reach of individuals within a profession, and thus supported a wider geographical spread of members. Print also bound the members of a profession more closely together through shared experiences of common printed materials in the forms of journals and newsletters. In diffusing new ideas, journals are simultaneously faster than book publication or face-to-face interaction (due to their frequency

of issue and increased reach respectively), and slower than newspapers (due to the gatekeeper function of peer review). The obvious question is whether the current system is too fast or too slow. The consensus, according to Kaufer and Carley, is that many scientists regard the speed of journals as too slow, particularly in very fast-moving fields.

Punctuated equilibrium and speciation

The significance of the punctuated equilibrium model to the transformation of the functions of the scholarly journal is that speciation (and hence changes in the scholarly journal) are driven by environmental change. For example, one could (just) imagine the reward structures for scholarship altering so that publishing refereed journal articles was regarded as significantly inferior to excellent teaching. In this case, the pressures for changes in scholarly communication would be quite severe. However, if one makes the reasonable assumption that scholarship is not going to be radically transformed in the next century, then it follows that the functions of scholarship currently embodied in the print scholarly journal system will not dramatically alter either. Instead, technological transformation should allow scholars to carry out their existing functions more effectively and in different ways.

Genres and new media

Two of Agre's categories of analysis (*activities* and *relationships*) are relevant to the functions of the scholarly journal and its transformation into an online hypermedia environment.

The functions of the scholarly journal are designed to support the *activities* of scholarship. These activities, of writing and reading articles, conference papers and books, and taking part in the processes of journal publishing by refereeing and editing are a core part of the scholarly life. They serve as the way in which research is communicated to one's peers and validated as worthy of dissemination. Any functional transformation associated with new hypermedia journals needs to build on this established rich pattern of activities.

Scholarly journals also need to support the *relationships* within scholarly communities. Hypermedia journals should do no less than existing print journals, but can potentially do much more, through increased possibilities for feedback to the author and interaction between author and reader. The sort of online peer commentary being trialled by The Journal of Interactive Media in Education (available online at <http://www-jime.open.ac.uk/>) is an excellent example of how the form of a journal can provide a sense of embedding within an online community.

4.2 Insights from research literature

Julene Butler's study on scholarly reward systems [Butler, 1995a] contained a number of questions relevant to journal function. The two most frequently selected disadvantages were the perception that e-journals were not real publications (63% of respondents) and that they were less prestigious (54%). These perceptions will inhibit the ability of e-journals to communicate effectively. High-ranking advantages were that e-journals allowed the author to reach the best audience (55%) and enhance scholarly dialogue (48%), both critical journal functions. Importantly, only 22% of Butler's respondents felt that their superiors rated e-journal publication as equal to or better than print. If not changed, this will act as a significant brake on any transformation of the journal.

Harter and Kim's citation study looked by implication at whether e-journals were fulfilling the function of acting as an accessible journal of record and effective means of communication. One of their significant findings was that the citation styles of the online references in the e-journals they were considering was frequently inconsistent, incomplete and/or inaccessible [Harter and Kim, 1996b]. This means that they were deficient in contrast to print publications. As they point out, "clearly the accessibility of cited online resources is potentially a very serious problem in the conduct of research and scholarship" [Harter and Kim, 1996b]. Moreover,

even among e-journals, there was very little citation of the e-journal literature. Their conclusion: “e-journals presently play almost no role in scholarly communication, as measured by references cited” [Harter and Kim, 1996b].

One of the assumptions made in the design of *IPCT Journal* and reported by [Berge and Collins, 1996] was that scholars read articles, not journals. This has implications for the future of the journal itself, and the bundling of articles into issues. If scholars are primarily interested in articles, then what function does the journal now have? Only 10% of their respondents indicated that they would be retrieving all the articles in a specified issue. Only one article was named by over 50% of the respondents. This fits with anecdotal and citation study evidence from the print world that most scholars do not read entire articles and that most articles are read very little. The implications of this will be taken up in the Conclusion to this paper.

[Hitchcock et al., 1997] cites one example of a publisher that is using the potentials of online publishing to broaden the functions of the journal into wider support for the activities performed by a scholarly community (as discussed by Agre). The Institute of Physics (IoP) is providing a range of online services in conjunction with its delivery of the full text of its journals. These include:

- free access to the Letters and Rapid Communications sections of 12 of their most prestigious journals
- advance notice of abstracts of forthcoming papers
- product finder service
- directory of peers' email addresses
- jobs exchange
- ability for users to customise their login screens.

Highwire Press is also working with the American Association for the Advancement of Science (AAAS) to extend their online version of the prestigious journal *Science* (available at <http://www.sciencemag.org/>). *Science Online* now offers *Science Now* (daily articles that will appear in the next issue of *Science* as well as additional material), *Next Wave* (a range of resources for the next generation of scientists), *Science Careers* (with links to employers, job listings and a resumé bank), and *Science E-MarketPlace* (which provides information about products and advertisers appearing in *Science*). This is a deliberate move to transform the *Science World* site into a location that can provide a range of additional services for the scientific community. A number of scientific professional societies (the American Society for Biology and Molecular Biology, the American Chemical Society and the American Meteorological Society) have found this additional content sufficiently useful that they have licensed access to *Science Now* and *Next Wave* for their own members.

It will be interesting to see if other publishers take up this initiative. It is certainly in line with the current trend for general web directories like Altavista and Yahoo and Web-focused organisations like Netscape to transform themselves into Internet portals for their user communities.

[Hitchcock et al., 1997] also points out the general trend of publishers changing the functions of the journal by providing a range of integrative services as part of their offerings. Three of the current eLib projects he describes as taking this tack are:

- NewsAgent for Libraries (personalised information services, information filtering, software agents, metadata)
- Open Journal Project (derived hypertext links for collections of resources)
- SuperJournal Project (value-added features such as search, display, and multimedia based on clusters of journals in subject areas)

5. Conclusions

5.1 Transformations in the form of journals

Future of the print journal as communication artefact

Changes in communication technologies have always taken time to be adopted. Typically, it takes a while for the implications of the new technologies to be appreciated. The conclusion is that the scholarly journal will continue its transition into an online environment but will do so in two overlapping phases.

The first phase chronologically is the development of new e-journals which have never had a separate print existence (or where the print is clearly secondary). With the exception of a few early projects this commenced in the early 1990's and is continuing today. These e-journals often have features impossible to provide in print, but still provide printable versions (often in PDF or HTML) of their articles. This still ties the articles to the lowest common denominator of print. The technology for reading on screen will improve. People will become more accustomed to using the interface features (hyperlinks, searching, zooming, interactivity, dynamic content, etc.) that are impossible in paper. Workable onscreen annotation systems will appear. Gradually, the gap between the online and print versions will become so great that authors will write for the online environment and their articles will not be printable in any useable way. Print scholarly journals will gradually wither and die. People will not have shelves full of journal reprints, but disks full of journal 'rebytes'. Only then will we have the true hypermedia online journal.

The second phase is the move to parallel publishing by the existing print journal publishers, driven by a variety of factors. In time (perhaps as soon as next year), the parallel publishing initiatives will start to drop print and provide the journal online only (with a printable version, probably as PDF) for users who wish to use this. Once this transition starts, the print journals will continue along the same path as the original e-journals with about a five to ten year lag-time.

The transition to online delivery only for the overwhelming majority of scholarly journals will be complete by 2020. The transition will not be linear, but will follow the classic sigmoid (S-shaped) curve. Different disciplines will move at different rates and for different reasons. The drivers for this transition are complex (and have been discussed already) but will certainly include journal economics, speed of communication, and the limitations of static media.

The journal as a genre will continue but in altered form. It has always been a means to an end, not an end in itself. In its current print incarnation it has been (until recently) the best way of performing the various functions necessary for efficient and effective scholarly communication. A better set of technologies should enable the same functions (and probably additional ones) in a better way. Of course, such technologies may well bring with them new limitations and disadvantages.

A new technology stasis?

Punctuated equilibrium argues for relatively rapid large scale shifts after long periods of stasis. This has certainly been true in the domain of scholarly publishing. Applying this insight to the new electronic publishing technologies suggests that, after the current phase of rapid development in computing and communications hardware and software, there will be a return to another period of relative stasis. Signs that this might be the case are:

- A convergence on the de-facto standards of HTML for on-screen display of articles and PDF for printable versions
- A noticeable slowing in the release timetables of new versions of critical software such as browsers
- The approaching quantum-mechanical barriers to the continual operation of Moore's Law

- to provide ever cheaper and faster chip technology
- The lack of anything dramatically different (in the way the arrival of Web was, for example) on the technology horizon.

These all argue for incremental rather than dramatic change over the next 20 years (which was the case also for the first 50 years of printing in Europe).

5.2 Transformations in the function of journals

Evolution or revolution?

The scholarly journal in its current form performs a number of critical functions for the scholarly community. These functions are deeply embedded into the nature of contemporary scholarship and will need to continue to be performed into the future. The evidence is that these functions are still important. To the extent that e-journals do not fulfil these functions, they will be regarded as inferior.

At present, e-journals (as such) are having little impact on the processes of scholarship. Parallel published journals will have slightly greater impact (because of greater reach) than their print equivalents. Over time, provided they can do at least all that p-journals do now, the new e-journals will increase their impact because of the additional features they offer. Moves to make e-journals more closely embedded in the processes of scholarship will support this trend.

The conclusion is that we will see gradual evolution in the functions of the scholarly journal as it becomes transformed (and faster evolution in its form), not revolution.

5.3 Final thoughts

If one considers the current state of electronic scholarly communication, it displays many of the characteristics of the early explosion in the diversity of life on earth. The new ecological niche is that of online publishing, free from many of the constraints of the print world. The analogy should probably not be pushed too far, but in a moment of whimsy one might think of the first e-journal as being a little like the first lungfish pushing its way arduously up some primeval beach on its way to start the colonisation of the land.

It is certainly true that the last decade has seen a great diversity of forms of electronic scholarly communication: ftp-based journals, mailing lists, journals on CD-ROM, Web-based journals, MUDs/MUSHs/MOOs as collaborative and publishing spaces, and proprietary SGML-based journals. We are starting to see some of this diversity being narrowed down as particular forms are abandoned, and as the scholarly world standardises on a subset of these early experiments. Early proprietary experiments like the OCLC Guidon interface have been abandoned in favour of open standards like the Web. Many electronic publishers are choosing to standardise on Acrobat for parallel print/electronic delivery, or where the formatting requirements make HTML problematic.

In terms of the theory of punctuated equilibrium, it appears that we are in the middle of a punctuatory jump after the stasis of the last century (at least) of print journal publishing. New species of communication artefacts are emerging to fill the new online niches. Existing players in the scholarly communication ecology are changing their roles and evolving within the new environment. If the analogy with punctuated equilibrium holds, then a new period of stasis should be anticipated. The prediction of this paper is that the overwhelming majority of print scholarly journals will have completed their transition to an online existence by 2010, and we will then see another (although perhaps shorter, due to the accelerating pace of technological change) period of relative stasis. In the move to this new online status quo, there is the potential for new stakeholders to emerge and existing stakeholders to redefine their roles. It is hoped that this paper has served to illuminate some of this change.

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