Economic models of the Digital Library

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Executive Summary

The study of Economic Models of the Digital Library was conducted during the first four months of 1999. A review of relevant literature revealed that current economic models tend to focus on specific digital library activities rather than modelling entire libraries as organisations. Furthermore, economic modelling is conducted only after developers have addressed a host of technical, cultural and political issues. Thus, economic models of the production and delivery of specific digital library services and products were identified and selected for evaluation. Four models of electronic journal production and delivery, a model of a resource discovery network consisting of a centre and a number of hubs, and a model of a national electronic reserve service similar to Higher Education ON demand (HERON) were selected.

The models

Journal production and delivery

Four models of electronic journal production and delivery were tested. The basic model was of a non-commercial (e.g. published by a Learned Society) digital journal funded from sales of subscriptions and individual articles. It was included for comparison with current practice. Production of print was ignored, as this would introduce significant costs which are not incurred in the other models. The second model was of a non-commercial journal that is available to users free of charge on the Internet. This model was based on the work of Harnad. The third was based on a market model based on that described by Fishwick *et al.* in a recent eLib supporting study. The fourth model was of a

non-commercial journal with costs recovered through a combination of a modest submission fee and sales of subscriptions and individual articles.

Resource discovery network

An eLib supporting study conducted by Haynes *et al.* evaluated three different models for the transition of Subject Based Gateways from project to service status and recommended that one of those models be funded (Haynes *et al.* 1998). Subsequently, the JISC published a call for proposals to establish a 'Resource Discovery Network Centre'. The model explored in the report is based on Haynes *et al'*s study and on subsequent publications by the Joint Information Systems Committee (JISC) of the UK Higher Education Funding Councils.

National electronic reserve service

The eLib programme has funded a supporting study on the impact of electronic reserve on higher education, and funded HERON, a national electronic reserve service. The JISC has also collaborated with the Publishers Association to create pricing models that suit both HE stakeholders and publishers. The model of a national electronic reserve service (NERS) explored in the report is based on HERON, other recent publications and market developments.

Methods

Selected models were tested using *Ithink Analyst,* a software package designed to facilitate visualisation of the interrelationships which characterise specific processes. *Ithink* was used to represent graphically the interrelationships that characterise each of the digital library activities modelled. The models were designed to facilitate greater understanding of the economic factors and the economic relationships between different

stakeholders. The elements in the models then had numbers, ranges of numbers, or equations added, and simulations were run.

Results

Journals

A reduction in costs of the size predicted by Harnad and others is unlikely to be realised in a digital environment. Nevertheless, it is clear that non-commercial electronic journals recovering full costs (including an overhead on staff costs of 120%) and making a profit of 10% can be sold at a reasonable subscription price as long as they have at least 500 subscribers. An electronic journal recovering costs through subscription only could sell 500 subscriptions at £148.43 p.a., and 1000 subscriptions at £74.22 p.a. A modest submission fee would reduce the subscription fee even further.

Cost recovery wholly by submission fees is also viable. Fees would be significantly higher than those predicted by Harnad, but would fall well within the range of rates charged for submission to many US journals. As the latter also charge subscription fees the total cost to the HE sector is far higher than that of a Harnad-based model.

The Fishwick model is expensive. Submission fees are not insignificant and they pay primarily for work that is unpaid in other models. Furthermore, although authors contribute 10% to production costs, the effect on subscription fees is small. Nevertheless, like the other models, the subscription fees required are modest compared with fees of commercial publishers. The Fishwick model includes author royalty payments as an incentive to publish only high-quality material. Model simulations show that a very successful paper could recoup the original submission fee through such royalties.

Resource discovery network

Sponsorship at the level proposed by Haynes *et al.* would be sufficient to support the RDN if JISC funding is continued. Simulations based on the assumption that the JISC withdraws all funds after an initial three-year period were also run. The RDN would then require sponsorship at double the rate proposed by Haynes *et al.* or would be required to recover costs from other sources, such as sponsorship. The possibility of subscription income was explored. This could be a viable source of income but, if RDN resources are restricted to the UK HE community, it would be limited. Thus, subscriptions income would be only one constituent of the income profile.

National electronic reserve service

Two pricing mechanisms for electronic reserve materials were explored in the models, 'text substitution' and 'library substitution'. The models showed that in economic terms, ER does not compare favourably with a print reserve collection. Libraries spending their current reserve collection budgets could afford electronic resources only if 'library substitution' materials constituted more than 90% of the collection. Unfortunately, such a collection would generate for publishers only a fraction of the income generated by the equivalent print collection.

The degree of duplication between materials selected by lecturers and materials held in the repository is considered to key to the success of HERON. The results of simulations designed to test the level of duplication are not encouraging. They suggest that even when duplication occurs at the highest rate tested, NERS resources are still expensive compared with equivalent print resources.

Conclusions

The models have clearly demonstrated some of the economic problems associated with certain digital library initiatives, and indicate some of the more promising avenues for

further work. Further research is, however, needed before an economic model for the entire digital library can be considered to have been developed.

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Contents

1 Preface and introduction

This report presents the results of a supporting study funded by the UK Electronic Libraries Programme (eLib) into economic models of the academic digital library. Rather than modelling the whole system, current economic models tend to focus on specific digital library activities. It was therefore necessary to identify and select models to be compared and evaluated. The scope of this project was limited in time and resources, and the term "digital library" covers a wide range of different types of activity. Consequently, some areas were deliberately excluded from the study. Some of these exclusions are noted below:

There was no attempt to estimate the infrastructure costs associated with delivering electronic resources in digital libraries. Technology is advancing at such a pace that in the current climate, associated costs are both unpredictable and unstable. Investment in infrastructure that effectively enables all stakeholders to conduct much of their business electronically will be required. The models described here were all based on the assumption that the HE sector will invest in sufficient infrastructure to support digital/hybrid library activities.

The authors are aware of the importance of metadata to digital library activities and are aware of initiatives to develop metadata standards such as the Dublin Core (DC). All eLib projects were required to include DC metadata in the resources that they developed. Clearly, some initiatives will be required to create metadata for existing resources, for example, retrodigitisation projects. The cost of this activity has not been explored and, in any case, the authors are not aware of any relevant economic model that could have been used.

The project focused largely on economic models of text-based activities. The economics of digital library activities involving other media have not been explored.

Developments of electronic books for individual use that are portable and facilitate bookmarking, annotation etc. in the form of the Rocket eBook and other similar tools, while important, are probably not library developments and thus, too, were not explored.

The authors acknowledge the importance of all these areas to digital library development but were unable to explore them within the scope and length of this project.

As this is an eLib study, funded by the UK Higher Education Funding Councils, there is an inevitable emphasis on the UK situation. We did not consider in detail initiatives that are underway elsewhere, although we have taken due regard of publications and reports of relevance from abroad.

Finally, readers should note that we have regularly used the word "she". This should be taken to mean "he or she" throughout.

2 Economic models of digital library resources and services

2.1 Introduction

The starting point for a study of economic models of the digital library such as this must be an understanding of the meaning of the term 'digital library'. Numerous definitions of the term have been proposed. They vary considerably with regard to their proximity to the concept of a traditional library. The latter classifies, catalogues, and provides access to quality-controlled information resources. It also offers related services and tends to restrict access to a well-defined user group (Harter 1996). The term digital library is used less precisely and may refer to anything from a limited list of hotlinks to the entire content of the Internet. The only common factor in these definitions is the idea of digitisation (Harter 1996). A study of economic models of the digital library requires a definition. Although the UK Electronic Libraries Programme (eLib) and the US Digital Libraries Programme have done a great deal to progress the concept of digital library and, latterly, the hybrid library (Oppenheim and Smithson 1999), a clear and universal concept is still lacking. Before an economic model of a digital library could be tested, not only would a clear definition be required but considerable progress should have been made towards development and implementation. Such progress has been made with regard to specific digital library resources and services. Thus, with a view to exploring economic models of the digital library in a systematic and useful manner this study focuses on models of specific digital library resources and services. It takes as a starting point the different areas of the eLib programme.

This chapter will review and compare economic models of the academic digital library. Until now, empirical testing of economic models of digital libraries has been limited. Economic issues tend to be tested after solutions have been found to the more pressing technical, cultural and legal issues because no library manager or user would consider paying for a service that had not been shown to be technically sound, legal and useful to its target audience (Elsevier Science 1996). The pace of development of different elements of the digital library has varied over the last two decades. This document will include models of aspects of the academic digital library that are sufficiently developed to be modelled.

As electronic alternatives to traditional library services are developed, shifts occur in the roles and activities undertaken by different stakeholder in the academic information delivery chain. Consequently, there have been sometimes unanticipated changes in the apportionment of costs and benefits to those stakeholders. Many roles are still fluid and change will continue until effective models are established. There will be no attempt here to predict the future. This report evaluates and compares only models that have been proposed or tested. A useful economic model of the digital library must accurately represent all stakeholders in the academic information delivery chain, their relationships to the supply and delivery of digital resources, and the associated costs and benefits. The principal stakeholders involved in digital libraries are:

- academics as authors;

- academics as editors and referees;

- end users (inc. academics as researchers, students, and clinical, professional and industrial users of electronic academic information);

- academics as teachers and recommenders of texts;

- HE librarians;

- HE computing support departments;

- publishers of both primary and secondary literature (commercial, not for profit, University presses, etc.) and other electronic content suppliers (such as museums);

- booksellers;

- funding bodies;

- subscription agents;

- national libraries;

- document suppliers such as the British Library Document Supply Centre (BLDSC);

- reproduction rights organisations;

- intermediaries such as the National Electronic Site Licence Initiative (NESLI) and Higher Education Resources ONdemand (HERON);

- Internet service providers and other aggregators and distributors (including companies such as CatchWord and Ingenta which provide Internet publishing for publishers); and

- The Higher Education Digitisation Service (HEDS).

These stakeholders are both individuals and organisations of both present and future generations. Some groups have a more direct stake than others. Arguably, the most important are academics as authors; academics as users of scholarly information; academics as teachers; HE libraries and librarians; publishers; and information brokers (including subscription agents and document supply agencies).

2.2 Economics of digital library services

When considering the economics of digital libraries it can be tempting to focus on financial factors that are directly related to digital library services, for example the price of resources and infrastructure. It is important, however, to be aware of other economic

factors. These include the cost of downloading bandwidth-hungry images and time spent filtering information in an environment where the signal-to-noise ratio is minuscule. While the authors acknowledge the importance of these factors it was beyond the scope of this project to determine their economic impact.

2.3 Electronic journals and electronic individual article supply

2.3.1 The serials crisis

Much of the incentive for the development of electronic journals and electronic individual article supply (eIAS) services has arisen from the financial pressure on libraries caused by: (1) budget restrictions; (2) an explosion in scholarly information; and (3) the fact that, over the last two decades, journal prices have consistently increased well above the general rate of inflation (Stoller *et al.* 1996; Tenopir and King 1997). Librarians have become increasingly critical of publishers, focusing on journal subscription prices as the significant factor in the serials crisis. It may be argued that this single contributing factor is overemphasised in discussion of the serials crisis. The problems faced by academic libraries as a result of budget restrictions is significant. The explosion in scholarly information is not only a key factor but one driven from within HE. However, library budget cuts are one element of a larger problem facing the HE sector which cannot be addressed within the scope of this study. Furthermore, attempts to address the problems associated with the scholarly information explosion tend to focus more on alternative and cheaper formats for publication (Bot *et al.* 1998; Fishwick *et al.* 1998; Harnad 1996; Harnad and Hemus 1997; O'Donnel 1996) than on reducing the quantity of published research output. Librarians continue to focus on journal subscription prices and they appear to have legitimate cause for complaint. There is evidence that the market for commercial journals is anti-competitive (Wyly 1998) and at

the very least, does not show much price elasticity. Furthermore, rationalisation, in the form of mergers, has occurred and although users may expect this trend to drive prices down, it has resulted instead in significant price rises (McCabe 1998).

2.3.2 Publication costs

The advent of electronic publishing has been hailed by some as an opportunity to overcome these problems. It is argued that electronic publication is much cheaper than publication of hard copy (Bot *et al.* 1998; Fishwick *et al.* 1998; Harnad 1996; Harnad and Hemus 1997; O'Donnel 1996). Proponents of this argument maintain that the cost to print and distribute a journal represents a significant proportion of the total publication cost. Content is received and refereed free of charge and typically, the author assigns copyright to the publisher who is then free to package the material in any appropriate format and distribute it for a fee. In an electronic environment, the cost of distributing content is negligible and thus, the total publication cost for an electronic journal should be significantly lower than it is for a print journal.

Publishers, among others, argue that fixed costs (or first-copy costs) represent at least 70% of journal production costs and thus that a change in delivery medium could save at most 30% of total costs (Day 1998; Frey 1997; Garson 1996; Lesk 1997; Lustig 1998; Varian 1998). Furthermore, libraries expect publishers to supply electronic journals in multiple formats (ICOLC 1998a) and end users expect additional functionality from electronic journals, for example multimedia elements, hot links to references, links from abstracting and indexing services or from OPACs to full text (Elliot 1997; King 1998; Mabe 1998; Neal 1997). Clearly, to succeed, any move to replace print journals with electronic journals must be supported by end users and those users will not invest time and effort in learning to use electronic journals unless there appears to be clear advantage

in doing so (Elsevier 1996; McKnight 1997); added functionality , or speed of delivery are examples.   However, additional features require time and personnel with expensive skills which adds to production costs. It is argued that this makes electronic journals at least as expensive to produce as print journals (Day 1998; Hunter 1997; Hunter 1998). A publisher distributing an electronic journal for a fee must also meet the additional cost of controlling access. This is likely to be small if a well-established system such as ATHENS is used (http://www.athens.ac.uk). ATHENS is a JISC-supported service which provides a single password to HE users for accessing new datasets and services within the UK HE community and manages password accounts for the service suppliers. However, although ATHENS is clearly valuable to the HE community, its use may not be consistent with a publisher's commitment to supply statistics on usage to libraries (see section below titled Measurement of use and performance indicators). Another consideration is that libraries consider it important, having paid for a subscription to a journal, that the volume is still available to their users even if they cancel the subscription at a later date (Electronic Publishing Services Ltd 1999). A publisher can fulfil this requirement by supplying the basic journal content on a portable medium such as a CD-ROM or by granting permission to the library to create and/or archive a digital copy. If a publisher itself were to guarantee online access in perpetuity it must migrate such content to new technologies when current technologies become obsolete (Day 1998). These additional costs make it less likely that electronic journals will be cheaper to produce than print journals. To date, publishers have found electronic publishing to be even more expensive than anticipated (Albert Prior, personal communication, 8 February 1999).

2.3.3 The relationship between cost and price

On balance, it seems that the additional costs associated with publishing a new value-added product outweigh the costs of reproduction and distribution that are saved.

Nevertheless, the argument that journals are overpriced remains valid. It is important that journals are priced at a level sufficient to recover costs. In a print environment this has never been a problem. On the contrary, commercial journal publishers make large profits, and are sometimes more profitable than companies like Microsoft (Odlyzko 1998). Correlation between cost and price is not strong. As an example, Odlyzko cites the 'three most prestigious maths journals' which are published by a commercial publisher, a university and a scholarly society respectively. Prices vary by a factor of seven, suggesting that first-copy costs are not the primary factor determining price (Odlyzko 1998). Journals are priced according to what the market will bear (Hunter 1998) and, until recently, the market has been relatively inelastic; academic journals are considered to be 'must have' items and one cannot easily be substituted for another should the latter become too expensive (Tenopir and King 1997). Thus, profit margins in print commercial academic journal publishing generally fall within the range 40–60%. When compared with, for example, school text publishing at approximately 12–15%, database publishing at approximately 18–20%, or fiction publishing at approximately 5%, it is clear that commercial publishers of print journals have continued to extract large profits despite the financial pressures facing libraries (David Worlock, personal communication, 11 February 1999). There is a clear need for academic libraries to demonstrate to publishers that the demand for scholarly journals is not inelastic. However, while there are no alternatives to the 'must have' material offered by publishers it is very difficult for libraries to do so.

2.3.4 Non-commercial electronic journal publication in higher education

As a solution to the serials crisis various stakeholders within the HE sector have proposed that academics bypass commercial companies and publish electronic journals themselves (Duranceau 1995; Harnad & Hemus 1997; Varian 1998). There has also been an initiative

in the US called the Scholarly Publishing and Academic Resources Coalition (SPARC) which aims to facilitate origination and publication of affordable journals which compete with expensive commercial journals. SPARC will support sympathetic publishers by guaranteeing a market for their journals (see http://www.lib.utexas.edu/ejour/SPARC.html). Alternative journal publication models such as these often focus on cost savings gained by: (1) automating the editorial function (Varian 1998; Pope & Miller 1998); (2) dispensing with desk editorial work such as marking up and proof reading (Duranceau 1995; Varian 1998); and of course, (3) distributing the material electronically (Durancea 1995; Harnad 1996; Harnad and Hemus 1997). Whether costs are reduced or not, a viable economic model must include a cost-recovery mechanism. Furthermore, that mechanism should be transparent as users and contributors will consider a publication to be unstable if it has no apparent means of recovering costs (Hitchcock *et al.*1996).   The additional costs associated with charging subscription fees (e.g. maintaining accounts and restricting access) combined with the 'gift culture' of the Internet that effectively requires most content to be available free of charge, make it difficult to recover costs directly from users (C. McKnight, personal communication, 8 February 1999). An alternative to the traditional subscription model recovers costs from authors in the form of page charges and makes journals available to users free of charge (Harnad 1996; Harnad and Hemus 1997). An important element of this model is that page charges should be levied at a rate acceptable to authors as a fee for widespread distribution of their papers; Harnad and Hemus suggest 'dozens rather than hundreds of dollars per page … $400 for a 20-page article' (Harnad and Hemus 1997). Clearly, papers that are refereed and then rejected must also be paid for by the model. Variations on this model would recover costs by charging only for submission and/or acceptance.   In common with the models of others who propose to bypass publishers,

Harnad's model and variations of it require a reduction in publishing costs when compared with print journals.

The Institute of Physics Publishing Publishing (IoPP) and Deutsche Physikalische Gesellschaft (DPG) have recently launched a new pure electronic journal, the *New Journal of Physics*, that is based on this type of model (http://www.njp.org/). The journal was started after widespread international consultation with librarians and physicists. It is available on the Internet free of charge to users. Authors are required to pay $500 on acceptance of their papers. A discount is available for IoP or DPG members. Authors are invited to submit only articles of 'outstanding scientific quality; likely to be widely read and highly cited'. Presumably, this criterion is intended to keep the rejection rate low so that the publication fee can cover the costs of papers that are refereed and rejected. The rejection rate of papers in science disciplines tends to be much lower than in social sciences at rates of around 10–30% (Harnad and Hemus 1997). This initiative suggests that IoPP and DPG consider it viable that the *New Journal of Physics* be financed by author acceptance fees of only $500. A journal consisting of, say, 120 papers would be produced for only $60 000. If a journal produced at this cost were to adopt subscription as a price mechanism it could recover costs by selling 1000 subscriptions for only $60 or 500 subscriptions for only $120. Either rate would be very cheap for a physics journal. This comparison suggests either that: (1) those publishers who claim that 'no-frills' electronic publishing is almost as expensive as print publishing are wrong; or (2) that the cost of journal production in either format bears no relation to the subscription price and that many commercial publishers are determined to maintain high margins.

2.3.5 Economic characteristics of the academic information delivery chain

2.3.5.1 Authors and editors

Among these models, there are undoubtedly some that accurately represent the economics of publishing electronic journals at reduced cost. However, the journals produced would almost certainly not incorporate the additional functionality demanded by users as it would be too costly to do so. The incentive for authors to submit their papers to these 'bargain basement' publications and for academics to leave the editorial boards of quality commercial journals to sit on the boards of these journals is unclear (Kostelnick 1999).

The importance of academics in their capacity as authors and editors must be recognised if a useful economic model of electronic journals is to be developed. Authors are not simply content originators; they drive the information explosion by seeking the most prestigious outlets for their increasing quantities of journal articles (Lesk 1997). Both authors and editors then apply pressure to ensure that their institutional libraries hold the journals to which they are affiliated either as authors or as editors. Thus, academics as authors and editors effectively represent demand in this 'market' (Fishwick *et al.* 1998; Lesk 1997).

2.3.5.2 Libraries

The economic model of electronic journal publication proposed by Andrew Odlyzko identifies library costs as the significant element in the 'serials crisis'. Odlyzko argues that a system-wide perspective reveals that the serials crisis is a library cost crisis (Odlyzko 1999). Libraries have focused on subscription prices as a visible problem which contributes to library budget crises but, in fact, for every $1 spent on journal

acquisition, $2 is spent on processing, storing and handling print journals (Odlyzko 1998, 1999). Furthermore, if publishers were to include many library functions in their delivery systems, libraries subscribing to their electronic journals would save so much in operating costs that they could afford to pay subscription fees at or above their current levels (Odlyzko 1999). Comparative cost–benefit analyses of a hard-copy journal collection and access to an electronic archive, conducted at the University of Michigan supports Odlyzko's arguments that holding a traditional journal collection is an inefficient use of library resources (Guthrie 1997). However, the cost to publishers of compensating for the relative lack of information skills among end users when compared with librarians is not insignificant. 'Ease and relevance of retrieval is directly proportional to the work put into the data beforehand' (Sturdy 1998), and that work represents additional cost. One reason why publishers have found electronic publishing to be more expensive than anticipated is that they have included in their systems some functions that, in a print environment, were undertaken by other information professionals (Albert Prior, personal communication, 8 February 1999).

A controversial element in Odlyzko's model is his explanation of how publishers will make available in digital form archives of previously published volumes. Odlyzko claims that digitisation costs are small (as low as $0.60 per page) and suggests that publishers digitise their back runs and make them available to libraries. This, he says, would be a one-off investment for a publisher migrating to the digital environment (Odlyzko 1999). Experience of projects in the UK electronic libraries programme (eLib) indicates that creation of accurate, searchable digital text is much more expensive than Odlyzko suggests (£2.50/page, Halliday *et al* 1998). Furthermore, the cost of this activity would not be recovered quickly. The cost of digitising journal archives is a major market

entry problem for existing commercial publishers of academic journals (David Worlock, personal communciation, 9 February 1999).

Odlyzko acknowledges that costs vary significantly depending on what level of functionality is required. He claims that the last 20% of functionality accounts for 80% of the costs. Reports suggests that, for users, a primary interest in electronic journals arises from the added functionality of the new medium (Elliot 1997; Neal 1997). Odlyzko's model requires users to differentiate essential functions from those that are nice to have. At present this distinction is likely to be arbitrary. The SuperJournal project found use of electronic journals to be 'an essential pre-condition for answering the question of what readers really want' (Mabe 1998). Until exploitation of functionality has been developed and explored, it will be difficult for anyone to identify the essential functions of electronic journals in the 21st century.

2.3.5.3 Users

A system-wide view of the costs and benefits of producing and delivering journal articles must acknowledge the costs and benefits to users. Some of these are referred to above, for example additional functionality is an added benefit as is access to users' desktops; time taken to visit the library is directly related to use of library resources (Lesk 1997). However, the time that it takes to identify high-quality information and to download it to the desktop is a cost as is time spent learning to use a new interface. This is demonstrated by the fact that users will not invest time learning to use a new system unless a critical mass of material is available using that system (Elsevier 1996; Rowland *et al.* 1997). All of these factors will affect users' uptake of electronic journals but many of them are fluid and are difficult to quantify (see below for a discussion on economic factors related to user behaviour in the online environment).

2.3.6 Pricing mechanisms

The pricing mechanism in traditional journal publishing (annual subscription per title) creates a very low-risk market for journal publishers. The consumer base is widespread and payment is made in advance. In an electronic environment, it is unnecessary to bundle articles into issues before distributing them; it is possible to distribute individual articles on-demand at very low cost to the publisher. It is possible also to reconfigure bundles to better meet the needs of researchers in specific disciplines and subject areas, e.g. to include in a bundle articles from a variety of journals which may be published by a range of different publishers.

2.3.6.1 Bundling

For electronic journals, a very low-risk pricing mechanism from the publishers' point of view is a site licence arrangement whereby a publisher's entire list is licensed to one or more institutions as a single product. This is known as bundling. This not only guarantees payment in advance; it also secures payment for low-use journals which subscribing institutions might otherwise cancel.

The UK Pilot Site Licence Initiative (PSLI) is a high-profile example which used bundling as a pricing mechanism. Pricing schemes adopted by publishers participating in the PSLI varied but all represented some form of bundling. Several of the publishers effectively extracted more revenue by offering as a single product all of the titles on their lists. Institutions valued these titles differently; i.e. on a single subscription basis institutions A and B would have subscribed to different titles but during the PSLI both institutions paid for a collection of titles which included their selected journals among others.

The PSLI represented an opportunity to introduce electronic journals to large numbers of users throughout the UK. However, its value as a means of testing the pricing mechanisms and pricing levels was limited. Not only were the costs subsidised by the JISC but publishers were not necessarily testing realistic pricing models. The Institute of Physics Publishing, for example, made electronic copy of its journals available free of charge to institutions that subscribed to hard copy of those titles. An IoPP representative at that time described this pricing strategy as unrealistic and said that charges would be introduced (Dixon 1998).The PSLI was criticised for propping up the 'serials crisis'; not only did it mask the effect of rising subscription prices (Carter 1997), it also sustained circulation levels of high-cost, low-use journals that many libraries would otherwise have cancelled (Hitchcock *et al.* 1997).

For the duration of the initiative, use of PSLI journals was limited; the PSLI resources were used heavily at only six institutions (HEFCE 1998). It was possible however, to identify 'core' materials that were heavily used and a large number of titles that were used only occasionally. HEFCE suggested that, in future, institutions may use these data to negotiate different rates of discount on titles published by a single publisher (HEFCE 1998). If institutions succeed in these negotiations, one of the benefits of a bundled site licence may be lost to those publishers.

When the PSLI ended, the National Electronic Site Licence Initiative (NESLI) was established. NESLI is a service rather than a project. It was established with JISC funds but the cost of content provided to institutions is not subsidised and NESLI must become self financing. NESLI will attempt to address the issues raised by the PSLI with a view to meeting the needs of libraries and end users in the UK HE community. A model licence has been developed with a view to agreeing standard terms with publishers. Not all publishers will agree to all of these terms, but the journals of those that do will be

offered through a seamless interface which allows users to access the journals of a range of publishers. The variety of proprietary systems required to access PSLI journals proved to be frustrating for users (HEFCE 1998). The formal launch of the NESLI service is expected in October 1999.

Institutions will also be granted ownership of the electronic copy of journals to which they subscribe; i.e. access will not be withdrawn when subscriptions are cancelled. Other issues being explored include the facility to subscribe to subject-based clusters of journals from a variety of publishers, the facility to link to NESLI journal articles from library OPAC entries, and supply of useful management information in the form of statistics on 'hits' at various levels including table of contents, abstracts and full text. An important difference between NESLI and the PSLI is that the latter tied the price of electronic copy of journals to the price of hard copy offering subscriptions only to parallel publications. NESLI aims to offer access to the electronic format alone if publishers are willing and institutions wish to subscribe on those terms (NESLI 1999). Thus, if Odlyzko is correct and the 'serials crisis' is largely related to the cost of handling and storing print journals, NESLI will enable libraries significantly to reduce the costs associated with journal subscriptions.

2.3.6.2 Price differentiation

As well as facilitating sale of products in bundles that vary in size and content from an article to a publishers' entire list, the electronic environment facilitates price differentiation, i.e. varying the price of information with willingness to pay. An example of the potential for price differentiation was identified by researchers working on the ACORN project at Loughborough University. It was suggested that if charges for journal articles from the electronic reserve service were introduced, they may be escalated towards the exam period. This would effectively reduce the load at peak times by

charging a higher rate to students who cram for exams (Kingston *et al.* 1997). Price differentiation can be implemented only if differences in user types are easily observable (Varian 1996). In a print environment, it is possible to differentiate between different types of journal subscriber, for example professional vs. educational or library vs. individual. However, it is very difficult to observe user characteristics beyond this, e.g. to observe the quantity of articles read by any researcher or their relative use of tables of contents, abstracts, and full-text articles. In an electronic environment, it is feasible to observe different types of use. Thus, it should be possible to differentiate between users based on the quality and quantity of the information that they require or for which they are willing to pay (Varian 1996). For example, some users may be willing to pay for additional functionality such as hotlinks to all citations in a paper, while others would be willing to forgo this facility to access the text at a cheaper rate. It is increasingly common for authors to publish the text of their research papers on the Internet despite publishers' attempts to protect their exclusive right to publish. It has been predicted that when publishers have to cede exclusivity on individual papers, they will begin to trade in added value, for example retrieval services tailored to individual needs (Hitchcock *et al.* 1997).

2.3.6.3 *PEAK: exploring bundling and price differentiation*

The PEAK project at the University of Michigan is a collaborative venture with Elsevier Science which aims to test three different pricing models for electronic journals. The models are based on the economic theory on bundling and on price differentiation. (see Bakos and Brynjolfsson 1997; Varian 1996). It is argued that: (1) 'non-linear pricing is facilitated by lower transaction costs for fine-grained purchases and feasible direct usage monitoring' by publishers or libraries; and (2) that bundling can extract revenue from those who value content differently (MacKie-Mason and Riveros 1997).

A key research objective of PEAK is generalisability to other user populations. The number of possible dimensions which can be manipulated when defining a bundle is very large, for example, the 'article component (abstract, references, text etc.); time limit on usage (unlimited, per use, per year etc.); and usage rights (read only, read and print etc.)' (Mackie-Mason and Riveros 1997). To infer anything from data gathered during PEAK, it was necessary that the variables be limited. Only three different pricing mechanisms are being tested (Kiernan 1998). These are described below.

1. The electronic journal is supplied on the same terms as a traditional print subscription, i.e. articles are made available on an issue-by-issue basis to all authorised users at a subscribing university.

2. The Institution pays in advance for a specific number of articles and may then access articles from any of the 1100 titles available from Elsevier in electronic form. The fee paid is $5.46 per article. If the institution has used these 'vouchers' and wishes to purchase more it must pay for them at the higher rate of $7. Thus, Elsevier and the institution share the risk. Note that both the reduced voucher price of $5.46 and the higher rate of $7 are very low and when converted at the current exchange rate ($1.571/£1 on 19 May 1999) both are cheaper than the price of an interlibrary loan request from the British Library (£4.95).

3. Articles are ordered as required and are paid for either by the institution or by individual users within institutions. Articles are more expensive to order in this way than they are in model 2.

When an individual has ordered an article through PEAK, it is made available to all users at that individual's institution and use of that article is then monitored. On average, each article has been accessed 2.5 times. The three pricing mechanisms operated by PEAK are effectively two-part tariff schemes as institutions are required to pay $25K to the

University of Michigan to join PEAK and then they incur fees for journals and/or articles. Although there are three discrete pricing schemes, participating institutions need not restrict themselves to one. They may, for example, subscribe to 'core journals' and buy vouchers for additional provision.   Ten institutions are participating in the PEAK project. Very few results have been reported by PEAK researchers but initial results indicate that the traditional subscription is the least popular pricing model (Kiernan 1998). The PEAK project is due to end in August 1999.

2.3.6.4 *Electronic individual article supply*

One of the pricing mechanisms being tested by PEAK is electronic individual article supply (eIAS).   This mechanism effectively disintegrates the traditional product and increases the publisher's risk. The publisher is no longer paid in advance for a package of around 120 articles to be delivered in 6 or 12 issues throughout the year. The publisher can no longer focus marketing effort on the 120-article bundle and its identifiable market; each article must sell on its own merits and thus is an individual product.

The eIAS model characterises access or 'just-in-time' provision as an alternative to holdings or 'just-in-case' provision. Users can benefit from access to a much wider range of titles than the institution could afford if it maintained journal subscriptions. Furthermore, comparison of the costs of access and holdings models indicate that the former is economically efficient for libraries and is popular with end users (Bevan *et al.* 1998; Kingma 1996; Butler 1996b). However, to date, the scale of comparative studies conducted has been limited; there may be economies or diseconomies of scale inherent in a large-scale access model which are not yet evident (Kingma 1996; Butler 1996b). IAS in those studies was not a seamless process whereby the end user searched, identified and received articles directly from the supplier and had them delivered electronically to

her desktop. Although end users had access to the OPACs of collaborating universities and thus were able to identify the location of requested items, orders were made via librarians at the borrowing and lending libraries and documents were supplied in hard copy by post or courier. To date, access models have tended to rely on library privilege whereby libraries are legally permitted, without paying a copyright fee, to supply an individual with a single copy of a document for the purposes of research or private study. However, users must sign a print request before they receive their copy of the requested document. Thus, the process whereby the end user searches, identifies and receives the required resource is necessarily interrupted and this interruption represents a significant additional library administration cost. Furthermore, widespread adoption of an access model which relies on library privilege would undermine the economic incentive to publish as libraries would cancel journal subscriptions thus reducing subscription bases and publishers would receive no alternative revenue from article supply. Publishers are unlikely to comply with library requests for permission to fulfil ILL requests electronically (see ICOLC 1998a; Hunter 1998).

Alternative copyright-cleared sources of individual articles in electronic form are available. It is difficult to assess their relative costs and benefits when compared with subscription, however, as services offering copyright-cleared articles tend to operate complex price differentiation policies. These policies can be based on several of the following variables: the country from which a request originates; the type of user; the number of requests; the type of delivery; and the speed of delivery (FIDDO 1997). Most services offer at least two alternative payment mechanisms, including, most commonly, pay-as-you-go schemes based on credit card payment and payment in advance based on deposit accounts or pre-paid forms (FIDDO 1997).

One drawback of pricing electronic articles individually is that the facility to hotlink to citations is less attractive when every link incurs an additional fee (Hitchcock *et al.* 1996).

It is worth noting that JISC has agreed in principle to provide sums to help launch an eIAS service in the UK under JISC/PA auspices, but the details of the Tender call have yet to be concluded.

2.3.6.5 *Scholarly communication and the market*

A recent eLib supporting study compared different models for pricing electronic scholarly journal articles including those based on bundling, price differentiation and IAS (Fishwick *et al.* 1998).

Fishwick *et al.* consider the current academic information delivery chain to be inefficient due to a number of distortions in the supply–demand chain. Among these are that: (1) authors represent a principal source of demand for publication but make no contribution to publication costs; (2) those consuming the information, i.e. the readers, seldom pay for it, preferring instead to obtain it from libraries; and (3) much of the journal publication work is undertaken by editors and referees without payment, or with minimal honoraria.

Fishwick *et al.* propose an alternative model which introduces 'normal' market feedback mechanisms into the academic information delivery chain with a view to overcoming the serials crisis and developing an efficient market for scholarly articles. The most efficient pricing mechanism would be determined by the market; a number of alternatives would be available in the first instance. Publication would be funded by authors and users both of whom contribute to demand. The publisher would receive usage-based payment at a level sufficient to sustain the model. Editors and referees would be paid to encourage efficiency, and authors would receive royalties to encourage them to submit for

publication only material of the highest quality. Papers would then be available individually or in customised bundles from the publisher database. Included in the system would be a mechanism to support authors who cannot afford to pay a submission fee. Furthermore, payment by authors would facilitate publication of papers that may be important scientifically but are unlikely to be popular among readers at their time of publication. The current system for selecting papers to be published in a journal, peer review, assesses them based primarily on quality rather than wholly on their likely popularity at the time of publication. The contents of a journal issue will contain a selection of papers, some of which will be widely read at the time of publication and some of which will attract very few readers. In economic terms the former subsidise the latter. When the journal is disaggregated and electronic copy of each article sold on-demand this cross-subsidisation will end and publishers may find it difficult to recover the publication costs of lesser-read papers. The authors of the study acknowledge that publication of such papers may not be guaranteed, and suggest that public support be available to ensure that all important developments are recorded through publication; the merit of all papers would continue to be gauged by peer review. The basic product would be unsophisticated electronic text. Additional functionality would be available for a higher fee. An important element of this model, it is claimed, would be generation of management data based on usage which would be useful to library managers and publishers. This type of feedback is most useful if users are required to prioritise between materials that are available to them. Thus, it is argued that access should be rationed, even to material obtained by site licence. Printing and additional functionality are approached in the same way, i.e. it is suggested that if users are required to pay for prints they will filter before, rather than after they print. This argument suggests that end users waste resources by gathering information that they do not really need. Time, for any student or researcher, is a scarce resource and it takes time to gather information. If

23

end users do need all of the information that they acquire, it may be argued that rationing would prejudice their ability to work effectively.

Fishwick *et al.*'s model incorporates elements from many different economic models including Harnad's model. However, in spirit, the model is the antithesis of Harnad's. Harnad argues convincingly that scholarly communication differs from other types of publication in that it is not a commercial market. Authors of journal articles are not motivated by the promise of royalty payments; they want their papers to be distributed as widely as possible and, in the past, have often paid to acquire offprints so that they could contribute to this dissemination process (Harnad 1996; Harnad and Hemus 1997). This view is reinforced by a recent study of what authors want from publication (Swan and Brown 1999). Fishwick's argument that structural problems in the current system preclude the introduction of an efficient system that would benefit all stakeholders is compelling but uncomfortable for those who consider scholarly communication necessarily to be qualitatively different from trade commodities.   Whether or not the principle of introducing normal market economics into the scholarly communication chain is valid, certain elements of the model proposed by Fishwick *et al.* are problematic:

1. Like many other HE proponents of alternative models for scholarly communication, Fishwick *et al.* claim that print and distribution represent the most significant costs in the journal production process and thus, that distribution in an electronic environment should be significantly cheaper. This would be an important factor in maintaining authors' publication fees at an affordable level. The proportion that print and distribution contribute to publication costs is a contentious issue. However, it may be less important than many authors suggest as publication costs may well be low even though current prices are very high.

2. The basic product proposed by Fishwick *et al.* is unsophisticated electronic text. It may be difficult to persuade authors and editors to abandon print journals in favour of such a 'bargain basement' publication (Kostelnik 1999). However, if submission fees are introduced, and thus submission in high-quality journals is expensive, those authors not in receipt of large research grants may find that they cannot afford to publish in a high-quality publication. Thus, the result could be a two-tier system whereby research that is not grant funded is published in the Fishwick *et al.* alternative system and grant-funded research is published in a more sophisticated format. This problem could be overcome only if all authors, including those in receipt of large grants, are prepared to publish in and thus to support 'alternative' journals that are cost effective for HE such as those proposed by SPARC.   This would require a massive attitude shift among important authors. At present authors publish in the most prestigious journals because to do so carries more weight with regard to research assessment and tenure awards. Authors would have to be persuaded of the utilitarian benefits of publishing in 'alternative' cost-effective journals. It is difficult to imagine how such an attitude shift would come about. International co-operative agreements resulting in HE policy directives may solve the problem but co-operation at a national level let alone at that level is notoriously difficult to achieve.

Because this model differs radically from that proposed by Harnad and his ilk, it was also evaluated in the research reported later in this report.

2.3.7 The models

A variety of different approaches to publishing cost effective electronic journals have been proposed in recent years. Many have common characteristics. Four models will be

tested here. The first is a market model based on that described by (Fishwick *et al* 1998).

The second models non-commercial production of a journal that is available for use free

of charge on the Internet as described by Harnad. The third is a non-commercial journal

funded by users by a combination of subscription and eIAS. The fourth is an alternative

non-commercial journal model proposed by the authors which differs from the third

model only in that costs are recovered through a combination of a modest submission fee

and sales of subscriptions and individual articles.

None of these models assumes that the production process will be conducted entirely by

academics or other stakeholders who have neither experience nor expertise in publishing.

User studies show that professional design is important to user acceptance (Rowland *et*

al. 1997). Journal production and related tasks such as marketing are undertaken more

efficiently by publishing professionals (Day 1998; Rowland *et al.* 1997); this is reflected

in the models.

Tasks that can be automated effectively are automatic in all of the models. The

Conservation Ecology (CE) project has demonstrated that all administrative tasks in the

editorial process can be automated and, in an international enterprise, that an automated

system can be more effective as it is not constrained by a time zone (Pope and Miller

1998). Furthermore, the cost of copy editing *Conservation Ecology* is much cheaper than

the equivalent cost in a print environment because the bulk of formatting is done

automatically[1]. *Conservation Ecology* is published by two permanent employees, a part-

time production editor and a part-time systems administrator. All versions of each

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[1] Automatic formatting is not exclusive to the *Conservation Ecology* project. Blackwell Science

also uses an electronic editing system (BEES) which imposes global style changes on electronic

manuscripts.

manuscript are archived by the software. Metadata can be amended at minimal cost as standards change by using a formatting template. The whole process can be decentralised because all actors in the chain can access files remotely from any networked PC throughout the world. There is no reason why any of the models described here should differ from the others with regard to exploitation of this type of system so editorial costs for each of the models will be based on the CE model.

2.3.7.1 Variables in the models

All evidence to date suggests that people prefer not to read at length on screen . They may use the electronic medium to search and identify resources and they will read small portions of text on screen but having established that they wish to read a substantial amount of text such as a journal paper, users obtain a print (Electronic Publishing Services Ltd 1999; Mabe 1998; McKnight 1997; Summerfield 1999; Woodward *et al.* 1998). Often electronic journals are not even published in a format suited for reading on screen; electronic versions of journals published in parallel print and electronic form tend to be made available in PDF, a format that is cheap to produce in a parallel production process but is designed to be printed (Rowland *et al.* 1997). The models explored here will be used to examine the economic implications for users and/or their institutions of tending to print or read on screen.

One variable with a very significant impact on costs for electronic journal production is the degree of functionality required by users. Most of the models described here require a reduction in production costs. This implies a lack of additional functionality. It has been suggested that users not only want additional functionality but are unwilling to learn to use new systems unless there are clear functional advantages (Elliot 1997; Neal 1997). However, despite their expressed interest in additional functionality, in practice end users are most interested in content, browsing (including linking), and printing (Mabe 1998).

Odlyzko asserts that cost-effective journal production requires users to discriminate between those functions that they need and those that they would like (Odlyzko 1998). However, although it is claimed that added functionality will significantly increase journal production costs (Day 1998; Hunter 1997, 1998) there are no published data which differentiate the costs of different functional elements. Odlyzko estimates that the last 20% of functionality will incur 80% of the total cost but does not attempt to apply this with reference to different functions (Odlyzko 1999). Variations in electronic journal production costs should be explored but it is beyond the scope of this project to do so.

Generally, it is assumed that scholarly journal articles have a limited audience. This characteristic contributes to the expense of publishing such articles. First copy costs are inevitably spread across a relatively small number of potential users. However, some recent work has suggested that the market for journal articles can be expanded (Tuck and Grieves 1998; Odlyzko 1999; Neal 1997). Odlyzko forecasts increasing use of journal articles by pressure groups. This is plausible given the recent shift in political activity among ordinary citizens towards single-issue politics. Researchers at Project Muse found that institutions that had not subscribed to John Hopkins University Press titles in print did subscribe to journals in electronic form (Neal 1997).

2.4 Monographs and texts

2.4.1 Introduction

For the purposes of this report, a monograph is defined as a low-volume work intended for library purchase and use as a resource by researchers. The market for monographs is 'global and export driven' (Owen 1993). In contrast, a textbook is defined as being intended to be used as a teaching resource and for student use. If successful, a textbook may be reprinted or new editions may be issued. Textbooks usually depend on the home

market; they are 'developed or adapted in the local market' (Owen 1993). However, the distinction between textbooks and monographs is not always clear cut. In any case, it is difficult for publishers accurately to predict the size of the market for a work. Some works commissioned as textbooks sell so few copies that perhaps they should be categorised as monographs and some commissioned as monographs are far more successful than anticipated and may reasonably be categorised as textbooks (Wasserman 1998). There may be a greater rationale for supplying a textbook in electronic form than for a monograph. The former is likely to be required by large numbers of students at the same time, while the latter is likely to be consulted by individuals and demand is unlikely to be concentrated to specific time periods. As people do not like to read more than a small amount of text on screen, a monograph in electronic form is unlikely to meet user needs. It would be too expensive, both financially and in time, to print the work. However, if a textbook were required by all students in a large undergraduate class it may be viable as an electronic product as all students in the class could access it at any time, perhaps from their residences, and select those parts that they wished to print. Experience on the ELINOR project (which was run in the mid-1990s) suggests that students do not use electronic text in this way; they use it to identify useful materials which they then borrow from the library shelves (Anne Ramsden, personal communication, 1995; Charles Oppenheim, personal communicaton, 17 February 1999). This experience may however, have been due to design, screen resolution and similar factors. As these factors are constantly improving, so a similar experiment run today may generate different results.

Developments towards electronic books for individual use that are portable and facilitate bookmarking, annotation etc. in the form of Rocket eBook and other similar tools (see

http://www.ebooknet.com for information on this) while important, are not library developments and will not be explored in this study.

2.4.1.1 Monographs

The obvious advantage of digital publishing of monographs is that there is no requirement to invest in inventory (David Worlock, personal communication, 11 February 1999). Nevertheless, digital publication requires investment in first copy costs and, as in most publishing ventures, these represent the most significant proportion of monograph publishing costs. Developments in digital publication of monographs is at a very early stage. The experience of University presses in the US is that if monographs are made available free of charge over the Internet, sales of hard copy increase 2–3-fold. This is attributed to the reluctance of users to read on screen or to spend time and money downloading and printing substantial quantities of text which are available in a more convenient format from booksellers (Winkeler 1997). These early projects have explored the market for digital analogues of print monographs. Studies with journal users suggests that it is inadequate simply to deliver in a digital environment material which has been designed for print; to be useful, digital resources should be designed for the medium (Rowland *et al.* 1997). Those publishers attempting to explore the utility of the digital environment for monograph publishing have come to question its suitability and suggest that this environment may change the very nature of the format. For example, use of open review pre-publication may, ultimately, result in a new format: a hybrid between a journal and a monograph (Armstrong and Lonsdale 1998; Winkeler 1997).

Publishers are aware that for digital monographs to succeed added value is likely to be important. However, they argue that any additional functionality will increase the cost, and therefore, the price of monographs (Armstrong and Lonsdale 1998). In recent years, 'monograph publishing has almost disappeared in many disciplines because short print

runs and library budget problems have made it untenable' (David Worlock, personal communication, 11 February 1999). Any increase in cost and price is likely to exacerbate rather than alleviate this problem.

2.4.1.2 Texts

Publishers have used digital technology to offer university and college teachers the facility to customise texts. For example, Wiley's custom publishing service offers teachers the facility to select chapters from a CD-ROM database of large general texts in a specific subject. Chapters must be drawn from a minimum of two titles and the teacher must order a minimum of 30 copies. The material is collated, bound and delivered to the campus bookseller for sale to students (see http://www.wiley.co.uk/college/eng/gen/cg/sales/cp.html). Perhaps custom publishing by the publisher precludes alternative means for students of obtaining the information. Thus, by adapting to the market, Wiley is more likely to maintain its customer share and profitability. Furthermore, when texts represent good value, students may be more prepared to buy them and become less reliant on library provision for core materials.

Developments at Wiley use digital technology for production but not for delivery and thus this experiment has limited relevance to the digital library. There is no evidence to date to suggest that texts are being produced for electronic delivery. Development work in this area suggests that, as yet, there is no market for digital texts (Filmore 1997, 1998). The Internet can, however, be used effectively to facilitate sale of peripheral products such as self-marking tests for certification of professional skills such as nursing (Filmore 1997, 1998). Such tests are also delivered free as an value-added supplement to a print publication, i.e. effectively as an incentive to buy/use the associated text (see http://www.wiley.co.uk/products/worldwide/canada/src/).

As with journals, publishers are working with academics to explore ways of utilising the digital medium for teaching. A good example is ChemConnections, a Wiley collaboration with the University of California and Beloit College which is grant-funded by the National Science Foundation. ChemConnections comprises a number of modules which can be used over a period of weeks for teaching on a variety of different areas of chemistry (see http://www.wiley.com/college/chemcnx/).

Evidence to date suggests that, as yet, publishers are only exploring the utility of the medium for both text and monograph publishing.   Economic modelling is likely to be explored much later in the development cycle, after products have been shown to be sufficiently useful that libraries and/or academic departments would pay for them. At that time, publishers expect developments such as the digital object identifier (DOI) to be important in facilitating commercial transactions (Armstrong and Lonsdale 1998). 'As yet use of metadata by monograph publishers is inconsistent and ad-hoc … Given the embryonic state of electronic monograph publishing it is likely that a more consolidated approach to charging models will emerge in the future' (Armstrong and Lonsdale 1998).

No economic model for producing and delivering electronic texts has been published. Therefore, this area is not the subject of a modelling exercise here.

2.5 Electronic datasets

The economic model for electronic reference works is better established than for most other areas of the digital library. A database or dataset consisting of a number of databases is generally supplied on licence either on CD-ROM or online. Where both formats are available the price tends to be similar (Gerrard 1999).   Negotiation of licence terms can be undertaken by institutions individually or by consortia. Economic factors related to licence negotiation are covered below in the section on licensing.

In the UK, the Combined Higher Education Software Team (CHEST) negotiates with dataset suppliers on behalf of the JISC to secure favourable access terms for UK Higher Education Institutions (HEIs) and to standardise terms and conditions of use wherever possible. Standardised terms reduce costs for all parties including individual institutions which must adhere to those terms. Networked access to these commercially supplied datasets from one of JISC's data centres (BIDS, EDINA, and MIDAS) is then offered to the HE community. Each individual institution can choose which of the available datasets it wishes to pay for and, for an annual fee, it obtains a site licence. Institutions then supply end users with access to these datasets free at the point of use. CHEST licences are usually agreed for five years so institutions subscribing to a dataset commit to take it until the end of the CHEST agreement. The five-year commitment has been cited by several institutions as a reason for not taking JISC datasets (East and Leach 1997). The price of a dataset is obviously important to institutions when deciding whether or not to subscribe but it is not the only factor. Some JISC datasets are made available to the community free of charge but uptake is still not universal (JISC 1997). One reason may be that use of datasets by end users can increase demand for journals and ILLs, and thus increase pressure on the workload of library staff (East and Leach 1997). Another is that even a 'free' dataset involves the HEI in some opportunity costs.

An economic advantage to institutions of supplying datasets to end users is a reduction in mediated online searching. Furthermore, as more datasets become available online rather than on CD-ROM, technical support and maintenance costs are reduced (East and Leach 1997).

The current annual subscription with a minimum commitment, usually of five years, does not suit many UK HEIs, especially smaller institutions (JISC 1997). A recent survey of attitudes to pricing of JISC-funded databases found that institutions would like the option

of usage-based payment. There was also a call to render prices more equitable by allowing a number of small institutions to subscribe as a consortium which would pay at the same rate as a large institution; institution size would be based on student numbers.

It is difficult to model provision of datasets to the UK HE community as: (1) the term dataset covers a wide range of different types and volumes of content; and (2) the contribution of the JISC and the terms that it demands from suppliers are unclear. As this is not a controversial area and economic relationships are established and work effectively it is not modelled and explored here.

2.6 Electronic reserve and on-demand publishing

2.6.1 Electronic reserve services and on-demand publishing

The term 'electronic reserve collection' may be a misnomer as it implies rationed access whereas 'the digital environment removes the need for this form of rationing as a single digitisation can simultaneously be accessed by any number of readers' (CLA 1998). Nevertheless, the term is used to describe collections of resources, including journal papers and extracts from texts and newspapers, that have been digitised and mounted on campus networks to be accessed by students. The rationale for this is that hard copy can be accessed by only one person at a time but access to digital copy is limited only by the infrastructure required to use it.

Electronic reserve collections (ERCs) have been developed with a view to meeting more effectively the needs of large undergraduate classes which rely increasingly on the library for core reading materials.

Development of ERCs is more widespread in the US than it is in the UK. In the early 1990s, many of those developing ERCs in the US considered it 'fair use' to digitise

copyright resources and make them available electronically. The Conference on Fair Use (CONFU) guidelines were intended to formalise this reading of the law but publishers and librarians were unable to agree on guidelines for electronic reserve use of copyright materials (http://www.utsystem.edu/ogc/intellectualproperty/confu.htm). Nevertheless, many libraries continue to interpret the law in this way (follow links from the following URL for examples http://www.cc.columbia.edu/~rosedale/#Sites).

Use of copyright resources in ERCs in the US must now be licensed just as it is in the UK. In the UK, HE ERC developers have assumed that ER use of copyright materials is not 'fair dealing' and guidelines published recently by the Publishers' Association and the JISC confirm that this is so

(http://www.ukoln.ac.uk/services/elib/papers/pa/licence/fairnote.html). Clearly, the cost of obtaining permissions is important to the economic viability of the whole exercise. This cost includes not only the price for using copyright material but also time spent identifying rightsholders, seeking permission to use their copyright material and, often, chasing that request. The total figure can be as high as ten times the actual copyright fee (Lesk 1997). The cost to rightsholders of administering permissions requests is also significant. At present the Association for Computing Machinery (ACM) grants blanket permission to copy its copyright materials for educational use because the cost of administering applications exceeds the revenue generated (Odlyzko 1999). This suggests that if licensing digital use of copyright materials is to become a viable revenue stream for publishers, copyright fees must be relatively high. Although publishers have been willing to grant permissions free of charge to limited life ER projects, i.e. during development, they charge fees to use their material in ongoing ER services. This may not be a viable revenue stream but many publishers consider ER use of their material to be a threat to their core business. Charging deters widespread adoption of ER as an alternative to text provision or recommendation (Odlyzko 1999). On the other hand, as

long as ER systems do not cannibalise publishers' primary income, a streamlined process may actually generate incremental revenue for them.

Another significant cost associated with ERCs is the cost of digitising text. Odlyzko cites an example of a company that will digitise text for $0.60 per page (Odlyzko 1999) but recent eLib supporting study established £2.50 as a reasonable estimate. Obviously, cost varies with a number of factors such as the cost of identifying and obtaining the original, the condition of the original, the presence or otherwise of special characters, i.e. the degree of manual intervention required to produce a useful file (Halliday et al 1998. 1998).

If publishers begin to supply their texts in electronic form and offer the facility to buy subsections of texts, then the need for HEIs to digitise a significant amount of text will vanish. However, unless publishers digitise all back runs of journals and text back lists, there will be a need to digitise older material. At present, developments in delivering texts in electronic form are embryonic (Armstrong and Lonsdale 1998), so material selected for reserve collections from texts must almost always be digitised if it is to be delivered in electronic form. However, duplication of effort may be avoided if institutions collaborate (see discussion on HERON below).

Very little has been published on the economics of running an ERC. The ACORN Project at Loughborough University compared the costs of traditional and electronic reserve collections of journal papers. A more comprehensive study of the costs and benefits of ERCs was published as an eLib supporting study in 1998 (Halliday et al 1998. 1998). This study was informed by all eLib studies in the electronic reserves (ER) and on-demand publishing (ODP) programme areas, including ACORN.

Another relevant study comparing charging mechanisms was conducted on behalf of a JISC/PA working party following a seminar on pricing in July of that year (Bide *et al.* 1997). This study arose from debate among and between librarians and publishers regarding appropriate pricing mechanisms that would not cannibalise publishers' primary income stream. It considered only licensing of digitised copy from printed books and journals; not licensing of electronic products. The report from the study called for a pricing mechanism that is 'simple and therefore inexpensive to administer … susceptible to centralised administration [and produces] predictable costs for users and revenues for rights holders'. Furthermore, the report recommended that two models be adopted to reflect different types of use of digitised material; a 'textbook substitution' model and a 'library substitution' model. The former would be applied to materials that, in print, publishers would expect students to buy. The pricing mechanism would be based on student numbers and a licence would be granted for a fixed period; probably an academic year. The latter model would be applied to material that, in print, publishers would have expected libraries to buy. In this case, a licence would be granted in perpetuity.

The report referred also to the high cost of digitisation and commended the idea of a central repository of digitised text which would avoid duplication of effort among HEIs and would make it easy for HEIs to identify material for which permission is likely to be granted, as it had been in the past.

The report from this study is particularly useful because it resulted from an ongoing collaborative attempt by publishers and HE representative to resolve many issues that hindered progress with ERC developments. Many of the recommendations in the report appear to have informed the Copyright Licensing Agency (CLA) Higher Education Digitisation White Paper which details the terms on which copyright materials are now licensed by the CLA for digitisation and distribution (CLA 1998). The CLA will continue

to require institutions to request rights on a transactional basis and prices will be set individually by publishers. Publishers will differentiate between material that is likely to substitute for sales of texts to libraries and material that is likely to substitute for sales of texts to students. The latter will be more expensive to compensate for many more 'lost sales'. This differentiation will refer to specific titles; it will not vary between institutions depending on their patterns of use of that title. Thus, although institution A may refer students to title X for further reading while at institution B it is required reading for all students in a class, both institutions A and B will be required to pay at the prescribed rate, be it 'text substitution' or 'library substitution'. This system is not ideal but the alternative, i.e. setting prices with reference to both the title and the institution requesting permission to digitise it would be extremely complex and thus expensive.

The CLA White Paper also specifies the format of digitised text; it should be an 'exact page representation' of the print original. As pages designed to be printed tend not to be suitable for on-screen reading students can be expected to print. At present, students tend to photocopy materials borrowed from a reserve collection (Halliday *et al* 1998) so the library could recover print costs from students without increasing student expenditure. However, support for networked printing is likely to be a significant cost associated with the introduction of an ER system (see Tuck and Grieves 1998 for details of network printing support).

The CLA does not expect institutions to comply with the 'exact page representation' criterion by creating and delivering bitmapped images from printed originals. The White Paper acknowledges that bitmapped images are large files and thus are bandwidth hungry. However, licences may specify the degree of qualitative and quantitative accuracy in digitised text. It may be possible to comply with terms by using suitable software and including disclaimers regarding accuracy (and the CLA anticipates that this

will be the case) but there is no guarantee that this will be the case. As OCR programs tend to generate errors, it may be necessary to proof-read digitised text. This adds considerably to the digitisation cost.

It is not immediately apparent that the eCLA (the name of the new CLA service) will be more efficient than the often criticised CLARCS system for clearing rights in materials to be used in course packs (containing photocopies). A transactional payment mechanism is expensive. The Copyright Clearance Center in the US has operated a transactional system for electronic reserve materials since 1997. In addition to any permission fee it charges $5 per request regardless of whether or not permission is obtained and claims that this charge is required to cover costs (Davis 1997).

The CLA requires from each publisher a mandate to license that publisher's material for use in electronic form in HEIs. The Publishers Licensing Society (PLS) has published a template which publishers can use to mandate the CLA (PLS 1999). Some of the terminology in this template differs from that used by the CLA, i.e. the PLS refers to a 'Bookshop Materials' model and a 'Library Materials' model instead of, respectively, a 'text substitution' and a 'library substitution' model. One more substantial difference between the CLA White Paper and the PLS mandate is that the latter restricts a licence for 'library materials' to 5 years rather than granting it in perpetuity. The PLS mandate also sets the 'Bookshop Materials' model as default and recommends a default price of 5 pence per page. Thus, libraries will be expected to pay for copyright at a rate of 5 pence per page per student in a class. A single 20-page extract for a class of 200 students would cost £200 (£235 inc. VAT) in copyright fees alone. If widely adopted, the terms of this mandate will probably render ER prohibitively expensive.

2.6.1.1 HERON

HERON is an eLib-funded project developing a national database and resource bank of electronic texts to be selected and accessed by HEIs throughout the UK. HEIs will supply details of materials that they require in digital form. HERON will obtain permission for their use and will digitise these materials. HERON is collaborating with rights holders and representative bodies to determine appropriate fee levels and conditions of digitised text and to streamline copyright clearance procedures. The Project will normally clear rights through the CLA and when an institution requires permission to use material that is owned by a publisher or other person who has not mandated the CLA, HERON will seek to secure an agreement directly with the rightsholder. Thus, when HERON has agreed terms with a publisher and an institution seeks to use material owned by that publisher, HERON can approach the company with confidence not only that permission will be granted but that the terms agreed previously will suffice and no lengthy negotiation will be required. Gradually, HERON will accumulate a collection of such agreements making it more efficient for HERON than for any individual institution to seek to clear rights in material to be included in an ER system.

Furthermore, HERON aims to become a repository for digital copy. HEIs seeking permission to digitise material from the CLA, either through HERON or directly, will be asked by the CLA to place a digital copy in a repository such as HERON so that it may be accessed by other users thereafter, thus avoiding duplication of effort. Clearly, any future use of the digital copy would also have to be licensed.

The model described later in this report is informed by the eLib supporting study of ODP/ER services (Halliday *et al* 1998), by cost and charge developments such as those published by the CLA and the PLS, and by HERON. The economic impact of rationalisation of licence negotiation and of digitisation will be explored using the model

as will the ramifications for libraries of the CLA White Paper and the PLS mandate. For example, the textbook substitution model (referred to by the PLS as the Bookshop Materials model) reflects the fact that libraries increasingly provide access to core reading materials that, previously, students would have bought from booksellers. Libraries cannot afford to pay to provide all students with core texts and further reading (Halliday *et al* 1998). The crisis that libraries now face has been precipitated to some degree by student demands that they do so. However, librarians are uncomfortable with the prospect of charging for student reading materials. To do so would be to qualitatively change the role of academic libraries which would then be open to competition from other organisations which charge to supply information (Lesk 1997). Booksellers also would be affected by a move to supply core texts directly through the library.

2.7 Information gateways

Very little work has been done on the economics of information (or subject) gateways, also known as portals and hubs. Cataloguing the Internet is an activity undertaken by various types of organisation to attract users to their sites with a view to promoting their primary products/services or enhancing their reputations. Examples of this type of activity include: (1) BioMedNet which, offering pointers to useful sites among many other discipline-based services, is effectively a discipline-based Internet community owned by Elsevier Science and funded, in part, by advertising (http://www.biomednet.com/gateways/bac); (2) the Wiley student resource centre which includes subject-specific sub-sites each of which revolves around specific high-volume Wiley texts (http://www.wiley.co.uk/products/worldwide/canada/src/index.htm#links); (3) Oppedahl & Larson LLP Patent Law Web Server, a site created and maintained by a professional law firm, which includes links to sources about all aspects of intellectual property (http://www.patents.com/index.sht); and (4) various HE sites which having

created pointers for their own users make them universally available

(http://www.stir.ac.uk/infoserv/) . The perceived quality of these types of pointers is

related to the site on which they are located. For example, links from an HEI may be

considered more credible or impartial than those from a commercial organisation.

Information gateways whose primary purpose is to provide pointers to other networked

resources without promoting a different primary product would appear to be unique to the

UK. The eLib subject-based gateways (SBGs) have co-ordinated identification and

evaluation of Internet resources and provide links to Internet resources within specific

subject areas. Every resource which is linked from an SBG has been assessed by an

expert in the relevant subject area and deemed to be of high-quality. None of the SBG

projects developed an economic model for maintenance and development of a service

beyond the grant-funded period. However, an eLib supporting study conducted by

Haynes *et al.* evaluated three different models for the transition of the SBGs from

project to service status (Haynes *et al.* 1998). These models varied depending on the

proposed funding sources. The first was a JISC-funded service, i.e. one which would

continue to rely on 100% grant funding. The structure of SBG organisation would

remain unchanged. The second model would increase JISC funding in the first two years

with a view to migrating to a service funded 50:50 between JISC and other sponsors.

This model includes a considerable degree of rationalisation in the organisation of SBG

activities. The third model would end JISC funding and require services to find

alternative sources to fund their activities. The Haynes report recommended that the JISC

pursue the second of these models. This required additional JISC funding for two years

to employ a managing director who would seek complementary funding for an ongoing

service. Many of the functions undertaken individually by eLib SBG projects would be

rationalised and centralised to reduce duplication of effort and to allow for greater

integration. Examples of rationalised activities would be training and marketing. Editorial control, however, would be devolved to centres of excellence so that the needs of users would continue to inform development of the service. Subsequently, the JISC published a call for proposals to establish a service which is described by JISC as a 'Resource Discovery Network Centre' (JISC, 1998). The concept of an RDN has been informed by Haynes *et al.*'s study. A contract has just been concluded with the winning bid. The model tested here will be the one recommended in the Haynes report and is informed by relevant JISC publications.

Although Haynes *et al.* estimated the costs for each of the three models that they evaluated, some uncertainties remain. For example, an investigation into the cost of cataloguing Internet resources was inconclusive, with estimates ranging from £3.20 to £34 per record. This discrepancy arises largely from the fact that individual projects created different levels of catalogue record, including varying numbers of key words etc. Therefore, it was difficult to compare costs between projects. In the model developed here, an attempt is made to established the mean cost of producing catalogue records. Costs in the Haynes report are based on SBG project costs and thus do not include institutional overhead. It is assumed that any institution accommodating a service which recovers costs will expect to be remunerated. Institutional overheads are calculated based on staff costs at a rate of 60% and of 120% (see below). Furthermore, there may be economies or diseconomies of scale inherent in the rationalised service that cannot be anticipated. Various 'what if' scenarios will be used to evaluate economic factors relating to the model over the longer term.

2.8 Preservation and archiving

Acceptable archiving and preservation strategies are essential preconditions to the widespread acceptance of electronic journals by authors and librarians. Many questions relating to archiving and preservation require answers before economic factors can be explored. For example, there is the question of who should archive. Publishers are reluctant to accept what, traditionally, has been a library responsibility. They are waiting to find out what the role of national libraries will be in a digital environment before they commit themselves in this regard (Albert Prior, personal communication, 8 February 1999; see also Okerson 1998). Furthermore, the long-term commitment of publishers and other stakeholder groups is questionable. It has been suggested that the only way to ensure 'systematic archiving of electronic publishing would be to assign that role to national institutions funded to do so and backed up by legislation' (Royan 1997). The UK research community generally agrees that preservation should be the responsibility of a publicly funded national agency (Haynes *et al.* 1997; Lievesley and Jones 1998). Preservation issues are of great concern to the UK HE community. They have been the subject of several eLib supporting studies (see http://www.ukoln.ac.uk/services/elib/papers/supporting/), of a British Library Research Study (See http://www.ukoln.ac.uk/services/papers/bl/) and issues continue to be explored by the CEDARS project (D. Greenstein, unpublished paper presented at Preservation Conference, Warwick University, 4 March 1999). Economic modelling however, has not yet been undertaken.

2.8.1 JSTOR

t successful attempt to develop a model for archiving and preservation in electronic form of scholarly journals is JSTOR (Guthrie 1997). One of the aims of JSTOR is to help libraries with space problems. JSTOR is also designed to be a trusted archive.

Development of the archive has depended on the cooperation of publishers holding copyright in the journals included therein. It is important to those publishers that JSTOR should not cannibalise subscription income. Thus, current issues of journals are not included in the JSTOR archive. JSTOR operates a 'moving wall' whereby entire backruns of journal issues are included in the archive except those published during the previous X years. Every year the contents from X-1 years ago are added to the archive. The duration of X varies from publisher to publisher but generally is between 3 and 5 years.

The JSTOR archive is funded by fees from institutions accessing the contents. The JSTOR team has calculated and compared the costs associated with: (1) a centrally managed electronic text archive (including the cost of migrating content to keep pace with technological development); and (2) storage, processing, reshelving and maintenance of a hard-copy collection. A key factor in making JSTOR financially viable is that it is available widely and thus, costs are spread across a large number of institutions both in the US, and now also in the UK. JSTOR aims to be as equitable as possible in pricing access to the archive. Price discrimination is applied with a view to setting prices according to the value derived by each institution. Thus, institutions are banded according to size and annual access fees are varied on that basis. Pay-per-use was dismissed as a possible pricing mechanism because it 'usually yields prices higher than the marginal cost of providing the product' and JSTOR 'did not want to force students and scholars to have to decide whether it would really be 'worth it' to download and print an article' (Guthrie 1997). This contrasts with the view that it is prudent to charge a print fee as this discourages indiscriminate use of printing resources, i.e. a fee would encourage users to filter information before rather than after they have printed (Fishwick *et al.* 1998; Tuck and Grieves 1998).

JSTOR received start-up funding from the Andrew Mellon Foundation but is expected to be self-sustaining over the longer term (Guthrie 1997). JSTOR appears to be a pragmatic and useful model for archiving and providing electronic access to backruns of journals. The capacity of JSTOR, however, is limited; currently the project aims to include backruns of a minimum of 100 journals before the year 2000. To preserve in electronic form and make available worldwide all developments in scholarly communication is a monumental task requiring co-operation on an international scale. It is notoriously difficult to secure international agreement for any type of activity and it is beyond the scope of this project to explore the ramifications of such an initiative.

2.9 Pre-print archives

The most famous example of an electronic pre-print archive is the Physics archive developed by Paul Ginsparg at the Los Alamos National Laboratory (LANL) (http://xxx.lanl.gov). The archive is very successful and is used by authors and readers throughout the world. Development of the archive was funded by a grant from the US National Science Foundation. The full cost of developing and running the archive is not clear. Odlyzko estimated the cost per paper at $5. Then, to pre-empt disagreement on this figure he recalculated using wildly extravagant estimates of the costs of personnel and storage space. He estimated that the upper limit would be $75, i.e. that it could not possibly cost more than $75 per paper to run such an archive (Odlyzko 1998). In the absence of grant funding, a cost-recovery model would be required. Given Odlyzko's figures, if the international physics community were to subscribe to this service either on an individual or institutional basis, the subscription charge would be small. Nevertheless, the administration of subscriptions would increase the total cost. An alternative model might charge authors to place pre-prints in the archive. This would be unlikely to succeed however as authors are reluctant to pay page charges even to submit papers to

journals where the benefits of publication are clear. Harnad is trying to establish a similar pre-print archive in the cognitive sciences. This project (CogPrints) is funded by eLib (see http://cogprints.soton.ac.uk/).

Other than grant funding, no economic model for a pre-print archive has been published and so no model will be explored here. It should be noted however, that increasing use of preprints effectively transfers the information filtering function either to libraries or to end users. Publication in a specific journal confers on a paper a mark of quality that is recognised by the readers. When all papers are freely available and unrefereed, the user must seek to identify high quality papers for herself. The time taken to do so is a cost; thus, in economic terms, preprints are not free. Physicists reading material from the Ginsparg archive tend to read only articles written by colleagues with whose work they are familiar This suggests that they are unwilling to filter the material for themselves. It also makes it difficult for newcomers to establish themselves in the field (Lesk 1997).

2.10 Issues related to digital library service and resource delivery

2.10.1 Licensing

The application of national copyright law to the electronic environment is not straightforward; legislation tends to predate the digital era. Furthermore, the business of providing access to copyright materials in electronic form tends to be international. Combined with the Internet 'gift culture' whereby users expect electronic content to be available free of charge, copyright on its own is inadequate for regulating use of copyright materials. Rather than relying on copyright law, content suppliers tend to use licences to detail precisely the terms on which their copyright material is made available to end users. In the words of Karen Hunter of Elsevier Science, 'publishers view licences

and contracts as a more robust, clearer method of resolving what might otherwise be ambiguities as to permitted use and limitations' (Hunter 1998).

Licence terms have important implications for libraries. As the availability of an increasing proportion of library material depends on relationships beyond the organisational boundary, library managers must consider the impact that this has, among other things, on their ability to control budgets and guarantee access beyond the current licence term.

Clearly, the pricing model detailed in a licence and the level of prices are important in determining the costs and benefits to licensor and licensee. At present, prices tend to be very high for a variety of reasons including: (1) that publishers often tie the price of electronic copy to the print price and offer both formats as a bundle; and (2) that by becoming the source site, the publisher takes on some of the library roles and costs (Okerson 1998).

Although pricing is an important element of a licence agreement it is only one of many issues that determine the costs and benefits conferred on the licensor and licensee. At present, pricing models offered by individual publishers vary considerably and are complex (Robnett 1998; Okerson 1998). Negotiation on a licence terms requires expertise, and takes a great deal of time.

As licensing becomes increasingly important and common so do legal advice and staff with the knowledge and experience required to negotiate favourable and consistent licence terms. Guidelines published by the US Association of Research Libraries (ARL) in 1997 recommend that institutions 'create a contract team' consisting of 'appropriate staff from the library, legal office, purchasing department and information technology division to provide information and develop contract expertise' (Brennan *et al.* 1997).

This type of recommendation suggests that licensing electronic resources is very much more expensive in terms of personnel than acquisition of print resources by library staff. Furthermore, it illustrates the importance to all stakeholders that licences be kept simple and terms be standardised wherever possible. This is the rationale behind CHEST and behind initiatives like the UK National Electronic Site Licence Initiative (NESLI). NESLI has based its model licence on one developed by a collaborative working party of representatives from the JISC and from the Publishers Association (PA) (http://www.nesli.ac.uk/nesli-licence.html). This model has been revised by NESLI in an iterative process involving all stakeholder groups.

When electronic resources were first offered to libraries by publishers, licences tended to be extremely restrictive with regard, for example, to use and users (Okerson 1998). This can be understood with reference to the size and importance of the market to academic publishers and the apparent naivety about copyright among users accustomed to the internet 'gift culture'. A great deal of progress has been made towards increased trust, goodwill and understanding between different stakeholder groups. Librarians have identified licensing issues of importance to them and initiated dialogue with publishers. In the US an informal organisation calling itself the International Coalition of Library Consortia (ICOLC) and representing initially US library consortia, but later also consortia from Australia, the UK and the Netherlands, published a Statement on Current Perspectives and Preferred Practices for the Selection and Purchase of Electronic Infrastructure (http://www.library.yale.edu/consortia/statement.html). This is essentially a wish list which elicited responses from several publishers thus initiating dialogue which continues at annual meetings of the ICOLC.

The most recent (7th) draft of the NESLI model contract, published in September 1998 (http://www.nelsi.ac.uk/nesli7.html) addresses many of the issues raised by the ICOLC

and by writers on licensing such as Okerson (Okerson 1998). For example, terms dictate that access to licensed material will not be withdrawn when subscriptions are cancelled and that licensees will be given the opportunity to subscribe to electronic copy only. NESLI is also considering the type of usage data that it can feasibly provide and is working towards seamless access from OPAC entry to abstracts, Tables of Contents, and full text.

By offering standardised terms, NESLI aims to minimise negotiation costs for both parties but acknowledges that the terms in this contract will not be acceptable to all publishers. There are often stark differences between the commercial interests of publishers and the library mission and negotiation is not often straightforward. The US experience to date is that negotiation of terms of use of electronic journals is often adversarial and protracted, and the resulting licences are lengthy and complex (Okerson 1998) but clearly there is a willingness to simplify the licensing process and thus reduce costs for all parties.

2.10.2 User behaviour in the online environment

User acceptance is key to the success of digital library resources and services. A resource can be technically impressive but unless it is acceptable to the target audience it will not be used. Research on user needs should be practical rather than hypothetical as potential users' reported needs differ from those of experienced users (SuperJournal 1999). Thus, studies which provide access over a sufficient period to allow users to learn and repeatedly use a system are likely to be most useful. Research on user behaviour tends to focus on electronic journals but user needs and behaviour with reference to electronic texts and monographs have also been explored (see Summerfield 1997). There is a remarkable degree of consensus among researchers of user behaviour in the online

environment. It would appear that researchers consistently identify the same essential pre-requisites for a successful online resource and the same deterrents to use.

2.10.2.1 Core functionality

Identification of core functionality is important as journal readers use only those functions that meet their needs (Elsevier Science 1996). As additional functionality increases production costs and may impact on price, superfluous functions should be avoided.

Users consider the core functions to be the facility to browse, search and print from an electronic journals service (SuperJournal 1999). Research repeatedly emphasises the fact that users do not read on screen but prefer to use print copy (Edwards *et al.* 1998; Kingston *et al.* 1997; Summerfield 1997; SuperJournal 1999; Tuck and Grieves 1998). There are various reasons for this, including portability, the facility to annotate and guaranteed future access. Some users claim that a virtual filebox may reduce the need to print (SuperJournal 1999; Tuck and Grieves 1998). This would reduce anxiety about accessing materials in the future but does nothing to address the requirement for annotation and portability.

Although Butterworth reports that scientists' interest in electronic journals relates primarily to improved functionality and lists linking to references as one of the required functions (Butterworth 1998), the SuperJournal project found that users consider linking to be 'nice to have' rather than essential (SuperJournal 1999). Creating links to references can be expensive especially for journals that are published in PDF format (Hitchcock *et al.*1997*)* so it is essential that the importance of this feature to users be established.

2.10.2.2 Critical Mass and currency

Users consider it essential that any service should offer a critical mass of resources both in terms of breadth and depth (Jenkins 1997; McKnight 1997; Prior 1997; Rowland *et al.* 1997; Summerfield 1997; SuperJournal 1999). Access to a limited selection of journal titles, whether they be published by a single publisher or by a range of publishers, is not considered sufficient incentive to learn to use a new system. Users also expect an electronic journal service to offer a backfile of a minimum duration (Jenkins 1997; McKnight 1997; SuperJournal 1999). The SuperJournal Project found that users consider the minimum requirement for a journal service to be a backfile of 5–10 years (SuperJournal 1999). Others consider the minimum useful backfile to be 25 years (Jenkins 1997). Furthermore, many users expect an electronic journals service to offer a wider range of titles than is currently available in print from the library (SuperJournal 1999).

2.10.2.3 System performance

System performance is a necessary prerequisite if users are expected to use digital resources and services (Jenkins 1997). Both academics and students are subject to time constraints (McKnight 1997; CAPP 1998) and users are reluctant to learn to use new systems unless there are clear benefits (McKnight 1997; Petersen Bishop1998). Low-level problems demoralise users (Gomes and Meadows 1998) and it is difficult to entice them back if they have been disappointed (McKnight 1997). Time taken to download and print materials from a system is also important. At present many users consider the delay to be excessive and consequently, would not print (Edwards *et al.* 1998; Summerfield 1997).   Staff from the library at the University of Columbia have found that the online books system is used as a sophisticated catalogue. Users search for items of interest in the digital environment but when they have identified an item and wish to read

more than a few lines, they seek a print copy from the library shelf (Summerfield 1997). This finding echoes that, noted earlier, of the ELINOR project at De Montfort University (Anne Ramsden, personal communication, 1995; Charles Oppenheim, personal communication, 17 February 1999). It is no surprise that users consider the online books system to be an adjunct rather than a replacement for print (Summerfield 1997).

2.10.2.4 Convenient, fast desktop access to a one-stop shop

Desktop access is considered to be important (Edwards *et al.* 1998; SuperJournal 1999) as is speed and ease of use (Edwards *et al.* 1998; Jenkins 1997; McKnight 1997; Tuck and Grieves 1998). Users prefer not to have to login at all and complicated login procedures invariably deter use (Petersen 1998; SuperJournal 1999). The SuperJournal project found that when users experienced difficulty with the login procedures they did not attempt to use the system again (SuperJournal 1999). Furthermore, 90% of requests for user support from the SuperJournal helpdesk were from users who had forgotten their personal ID for logging in (SuperJournal 1999). Having accessed the system, the time taken to identify and retrieve material is important; users are not prepared to follow long chains of links to access relevant content (Kingston *et al.* 1997; Rowland *et al.* 1997). A single common interface is also an important feature (McKnight 1997; Prior 1997) and the interface should be familiar so frequent upgrading and redesign is unacceptable (McKnight 1997). Furthermore, users expect an electronic journals service to offer seamless discovery and access (Butterworth 1998; McKnight 1997; SuperJournal 1999). The user should have the facility first to identify material that she wishes to read by searching or browsing tables of contents, second to link to the abstract of any items that interests her, and third to link to the full-text of any article that she wishes to read in full.

2.10.2.5 Format

A significant proportion of electronic journals are delivered as portable document format (PDF) documents especially when the electronic format is produced as a parallel of the print format. It is claimed that PDF is cheap to produce in these circumstances but is inappropriate for electronic delivery especially when pages have two or more columns (Rowland *et al.* 1997). Nevertheless, PDF currently has advantages over HTML. Users of SuperJournal service claimed to prefer reading HTML on screen but when offered a document in either HTML or PDF format, the majority selected the latter. This may be related to the fact that users prefer not to read on screen and print material if they intend to read more than a few lines. SuperJournal users claim to prefer prints from PDF because they look like printed journal pages and, unlike HTML documents, they have page numbers (SuperJournal 1999).

2.10.2.6 Benefits of an electronic service

Access to digital library resources tends not to be restricted to library opening hours and generally, two or more users may access an item simultaneously. Improved access is considered to be a benefit of digital library services (Summerfield 1997; SuperJournal 1999). However, although SuperJournal users claimed that access outside library opening hours is important, most use occurred during office hours (SuperJournal 1999). Users also believe that the digital medium should facilitate faster publication; where items are published in both print and digital formats, users expect the latter to be published before or at the same time as the former.

2.10.2.7 Benefits of print and photocopies

Generally, studies of user needs and behaviour in the digital library have revealed a range of different functions associated with print and photocopies that users consider to be

important. Until equivalent or improved features are available in an electronic
environment many users will remain attached to print. These features include ease of
browsing and reading (SuperJournal 1999); most current users have been familiar with
print since childhood and are skilled in its use (McKnight 1997). A ubiquitous equivalent
level of familiarity and skill is likely to be available to future users who are currently in
the primary education system. Studies also report an emotional attachment to print
(McKnight 1997; Summerfield 1997; Elsevier Science 1996). Whether or not this
attachment will remain among future lifelong users of electronic media remains to be
seen. Another feature of print that currently give it an edge is its portability
(Summerfield 1997; SuperJournal 1999). Users tend not to read at their computers
(Summerfield 1997) and often read journal papers at home or when travelling (McKnight
1997; Tuck and Grieves 1998). The facility to annotate a print copy is also important as
is the fact that they can legally cache materials for future use (Butterworth 1998; Mandel
et al. 1997; McKnight 1997; SuperJournal 1999). Finally, some users consider
presentation in print resources to be superior to that in digital resources. For example,
high-quality graphics cannot be satisfactorily reproduced on prints from electronic
resources. This is particularly important with regard to colour images (SuperJournal
1999).

2.10.2.8 Disciplines

Although many research findings apply to all users, differences between disciplines
should be recognised (Butterworth 1998; SuperJournal 1999). The Los-Alamos pre-print
archive is commonly cited as an example of discipline-specific behaviour which has
contributed to the success of a digital library resource. There has long been a culture
among physicists of distributing preprints. Physicists differ from other sciences in this
respect and it is argued that the success of the Los Alamos archive derives in part from

this culture (Wilkinson 1998). It is reported also that electronic journals are embraced more readily by those in disciplines that have not been adequately catered for in a print environment, for example musicology and other disciples to which non-printable elements are important (Tuck and Grieves 1998). Future research on user behaviour in the online environment should differentiate between users from different disciplines. Unfortunately, initiatives such as ATHENS which are designed to streamline delivery of digital resources can subvert attempts to gather data on different types of user.

2.10.3 Measurement of use and performance indicators in the digital library

2.10.3.1 International standards for performance measurement

The ability to monitor use and interpret the results is essential if any information resource or service is to be deemed a success or otherwise. Internationally standardised performance indicators have been developed for traditional library services. However, recent studies of usage measurement and performance indicators for digital libraries have found no evidence of standardisation and continue to recommend that international standards be developed and applied (Brophy *et al.* 1997; Petersen Bishop 1998). An initiative in this direction has been taken by the ICOLC who have published guidelines for statistical measures of usage of electronic resources (ICOLC 1998b).

An eLib supporting study published in 1997 investigated Management Information Systems and Performance Measurement for the Electronic Library (Brophy and Wynne 1997). The authors described a three-fold approach to library management with regard to performance measurement: (1) the day-to-day needs of library managers; (2) the need for information that can be used by planners for forecasting; and (3) the need for indicators of value for strategic review (Brophy and Wynne 1997). Although they found that some indicators used in traditional libraries can be adapted, it was necessary to devise other

new indicators. For example, the number of documents accessed was considered not to be important in an electronic environment; the range and depth of resources available was deemed far more important. Furthermore, Brophy and Wynne identified a number of issues which must be addressed if progress is to be made in this area. While acknowledging the significant contribution of the eLib programme in this regard, they called for a clearer definition and understanding of what is meant by the term 'electronic library'.

2.10.3.2 Non-standard usage measurement

A requirement for international standards is clear but development of such standards is a lengthy process. While this process is ongoing, each individual digital library initiative requires feedback to inform development and, thus, must unilaterally adopt an approach to performance measurement. Electronic library projects in the UK, Europe and the USA have used a variety of different definitions and methods of usage measurement and analysis. Thus, neither analyses nor data from different projects can be compared (Petersen Bishop 1998).

Most Internet usage analysis tools are applicable to digital library activities and WWW server log file analysis programs still predominate (M. Hamilton, personal communication, 14 January 1999). In 1997 the eLib supporting study referred to above found that most work in the electronic library field relied on transaction logging for management information (Brophy and Wynne 1997). If users are authenticated (i.e. have usernames and passwords), it is possible using these tools, to monitor individual use by logging the username alongside the URL. Hits can also be time stamped. In this way, an individual's progress can be tracked from page to page. It is possible also, using cookies, for a service supplier to track an individual's movements on the Internet beyond that supplier's site. However, this is likely to be considered a breach of privacy and librarians

make it an issue in negotiation with content suppliers (see ICOLC 1998b). To comply with the library ethos, performance indicators should not rely on information about individuals' reading habits.

Many academic subscription services authenticate whole sites by registering and restricting access a list of IP addresses. Not only does this overcome privacy issues related to individual users as names and time stamps cannot be recorded on accesses, but it also removes the need for costly password management. An alternative means of reducing the cost of authentication in the UK is use of the ATHENS service which provides an individual with a username and password which may be used to access a variety of services. Unfortunately, use of ATHENS greatly reduces the management information that can be gathered by individual service suppliers. This is deliberate to protect the privacy of individual users. For example, it is not possible for a supplier to monitor use of her service within a specific discipline if neither individuals nor even whole classes are identifiable by user ID.

2.10.3.3 Limitations of current usage measurement tools

It is important when designing performance measurement activities that they be justified in terms of the benefits derived (CERLIM 1998). Because it is automatic, transaction logging is a cheap way of gathering data in an electronic environment. Unfortunately, the type of data that can be collected is often restricted by the delivery format. In 1996, when Michigan University intended to test economic models during the TULIP Project, it was unable to do so because 'the Web does not support the kind of data collection required to test economic models' (Elsevier Science 1996). Project MUSE is still unable to distinguish between downloading/printing and browsing as the Web is a stateless environment (MUSE 1999). SuperJournal know that although users claim to prefer HTML documents for onscreen viewing, given a choice of formats, a large majority

chooses PDF over HTML. As most users print documents if they intend to read more than a few lines, it can be assumed that they select PDF as a superior format for printing. Unfortunately, SuperJournal cannot verify this assumption by monitoring use as it is not possible to differentiate downloading from printing (D. Pullinger, personal communication, 21 April 1999).

Thus, although data gathering is cheap, as yet, it is also limited. Furthermore, analysis of such data tends to be time consuming and thus expensive and interpretation is not always straightforward.

For example, it may be assumed that more hits indicate a better service, as a high number suggests that users return and that they recommend a site to others but, of course, this may not always be the case. A subject-based gateway which generates search results that closely match a users needs will record very few hits before that user leaves the site satisfied with the result. If the search results supplied are poor and include a number of extraneous links or if the user is required to conduct several searches before she retrieves useful links, the gateway will record many more hits before the user leaves. However, if a subject-based gateway offers not only access to a database of catalogue records but also holds a local archive, it should record a larger number of hits as users are likely both to search the database and to retrieve local resources (J. Knight, personal communication, 14 January 1999). Furthermore, attempts to make more efficient use of internet bandwidth by caching and mirroring can subvert attempts to monitor use. Access to resources from site A from a cache or mirror held at site B will not be included in usage measurement unless site B informs site A about the cache and agrees to supply site A with use data. This type of shortfall makes WWW statistics unreliable or, worse, misleading (Goldberg 1995).

2.10.3.4 Inferring user behaviour from transaction logs

Use of transaction logs for performance measurement requires digital library practitioners to infer meaning from specific types of user act in a digital environment.   For example, A. Dawson of the BUBL service (http://www.bubl.ac.uk) suggests that to view a list of journal issues with dates and contents is the equivalent of browsing a library shelf . He also asserts that searching is a deliberate activity which is not easily mistaken and that to access full-text is a likely indication that the user is reading the article. The latter assertion is qualified by the acknowledgement that the reader may access text to scan for relevance rather than, necessarily, to read the article. However, Dawson argues that this ambiguity need not influence the accuracy of any performance measure as it applies to all journals (Dawson 1998). This type of inference helps digital library practitioners to make sense of quantitative data. However, knowledge of user behaviour in the digital environment is limited and it can be dangerous to base inference entirely on assumptions and prior experience. For example, Dawson's assumption that the frequency with which a reader accessing full text is in fact scanning for relevance will apply equally to all journals is contradicted by the findings of the SuperJournal project. SuperJournal found evidence that the way in which scientists and social scientists use journal elements differs. For example, scientists are more likely than social scientists to identify a relevant article from its title and to print it on that basis. Social scientists more often read the abstract to establish relevance because article titles in the social sciences can be more ambiguous. (D. Pullinger, personal communication, 21 April 1999). There may be similar differences in the way that scientists and social scientists approach full text.

It is clearly difficult to derive qualitative research findings from quantitative information (Mabe 1998; Petersen Bishop 1998). Qualitative methods such as interviews and

observation should be used to inform assumptions about the meaning of quantitative information and for triangulation.

2.10.4 Training and awareness

Some of the eLib projects in the Training and Awareness programme area have now migrated to a service model and offer training courses in the use of new technologies for teaching and learning. HEIs are likely to continue to pay for this type of training from staff development budgets. Training of users in the use of IT is unlikely to fall within the remit of libraries although libraries will probably continue to offer training in information skills and the use of specific resources. It is beyond the scope of this project to explore the economics of this activity and compare the costs and benefits of training academics and students in the use of electronic and print resources.

Clearly, the transition from a traditional to a digital or hybrid library involves dramatic changes in the infrastructure that supports the production and use of information resources. At present people prefer not to read on screen (Mabe 1998; McKnight 1997; Summerfield 1997; Woodward *et al.* 1998) so they print articles from electronic journals. As resources for teaching, learning and research are increasingly delivered in electronic form there is likely to be a mass shift from photocopying to printing; the latter is more expensive than the former but the total opportunity cost of an individual operating a photocopier is not incurred so costs are probably very similar. As people become more familiar with technology, users may no longer need print copies. This could lead to a net reduction in the cost of using information. The report of a recent study on the impact of electronic journals on networked printing suggested that one of the reasons for printing material from the Internet is to ensure future access; networked access is not always reliable. In effect users create a personal print cache of networked resources (Tuck and Grieves 1998). The report predicted that improved access to networked resources would

reduce the need to print but suggested that it may also increase use of the network, which in turn would increase the print load. The net effect of a combination of such changes is virtually impossible to predict (Tuck and Grieves 1998). Another factor impacting on the economics of digital information is the pace of technological change; new technologies become obsolete at an alarming rate, making it expensive for organisations to meet the changing needs of users. However, technological advances are reducing some costs, for example the cost of storing digital resources. It is not possible within the scope of this project to estimate the infrastructure costs associated with delivering electronic resources in such an unstable and unpredictable climate. Investment in infrastructure that effectively enables all stakeholders to conduct much of their business electronically will be required. The models described here will be based on the assumption that the HE sector will invest in sufficient infrastructure to support digital/hybrid library activities.

2.11 Conclusions

At present there is no coherent model of the digital library, nor is there yet any developed model of the hybrid library (Oppenheim and Smithson 1999). Furthermore, economic issues tend to be tested after solutions have been found to the more pressing technical, cultural and legal issues. Many specific digital library activities are insufficiently mature to have generated economic models. Where a model exists it has been evaluated and where alternatives exist these have been compared. It is clear that a great deal of progress has been made over the last decade towards a greater understanding of how digital library activities may be integrated in HE. Nevertheless, a considerable amount of work remains, specifically in the areas of preservation and archiving and in standardisation of usage measurement and performance indicators. Conclusions regarding specific issues relating to digital library activities are outlined in the remainder of this report.

3 Methodology

For this research, the authors used Ithink modelling software. Ithink uses a mapping language designed to facilitate visualisation of the 'interrelationships which constitute a process, a strategy or an issue' (High Performance Systems Inc. 1997). The key elements in an Ithink model are described below. Ithink was used to represent graphically the interrelationships that characterise each system modelled. The elements in the models then had numbers or ranges of numbers added and simulations were run. The models were deliberately made simple and aim to capture the essential features of the systems modelled. They are intended as generic rather than specific examples. Many of the model elements are defined by equations which describe the relationship of that element with one or other elements in the same model. The relationships represented by the equations are generally informed by the literature. However, some assumptions are inherent in these relationships. The bases of the equations and the assumptions in each model are described in 'documents'. These documents may be viewed by double-clicking the element and selecting from the dialogue box a button labelled 'document*'. The asterisk indicates that a document exists. Some elements are self-explanatory and so are not documented within the model. As these assumptions inform the results of the 'what if' scenarios and sensitivity analyses, they are most appropriately presented alongside those results. Thus, the assumptions are documented in the Results and Discussion section of this report.

Copies of the models described here are available from the authors and can be examined by using the free runtime version of the Ithink software package. This is available at the following URL: http://www.cognitus.co.uk/IS/IS.htm. The runtime version of the software can be used to view and manipulate our models, but any changes that the user

makes cannot be saved. A brief guide for users of this modelling software is appended to this report.

The models were designed to facilitate greater understanding of the economic factors and the economic relationships between different stakeholders in each of the processes modelled. Model variables can be manipulated using so-called 'sliders', and the effects can then be monitored. For example, in a model of electronic journal production and delivery any of the following elements could be varied using sliders: the number of subscriptions; the number of manuscripts submitted; the overhead rate applied to staff costs; the journal acceptance/rejection rate; or the profit margin applied by the publisher. Holding all other variables equal, a user might, for example, vary the number of subscriptions and observe the effect on subscription price or individual article price. Similarly, in the model of an ER system, the user could vary the number and size of classes to establish how this would affect, for example, total cost, the institution fee, and the fee per student.

3.1 Model elements

3.1.1 Stock

Stock

A stock represents an accumulation. For example, in the model of an electronic reserve system the repository of digitised materials is represented by a stock. The items accumulate by flowing into and/or out of the stock (see description of the 'flow' below). The total content amounts to the inflow minus the outflow at each time period in a model simulation. In many of the stocks represented in the models described here the inflow and outflow are equal. For example, a journal editor receives a number of manuscripts

every year. Of those, she rejects a very small percentage and the remainder are sent for

peer review. However, the repository in the ER system has no outflow as items must be

stored for possible future use. Thus, its content increases annually.
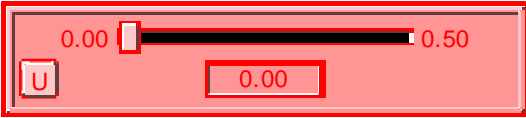
3.1.2 Flow
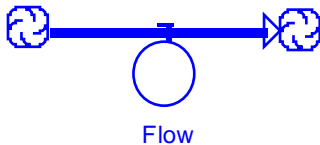
Flow

A flow is like a pipe. It either fills or drains a stock in the direction of the flow arrow. A

cloud at either end of a flow indicates an infinite source or destination of the 'stuff'

flowing to or from a stock. If the flow source were a stock and that stock were empty,

the value of the flow equation would not flow into the destination stock. Thus, a cloud is

a device which indicates that the source of 'stuff' passing through the flow is beyond the

scope of the model. For example, where the flow 'journal acquisitions receipts' flowing

into the stock 'journal acquisitions budget' originates with a cloud, this means that the

entire library or institutional budget is not represented. It is assumed that the library or

institution provides funding to acquire journals.

3.1.3 Converter

A converter informs other elements in the model. It may contain a constant value, for

example, VAT which is 17.5%, or a variable value which may be manipulated by the

model user by means of a slider. Alternatively, it may represent an algebraic relationship

between other elements in the model or it may represent an external input such as the rate

at which items selected for digitisation in the ER model are duplicates of items already

held in the repository. The latter may be a ramp, i.e. the initial value is X% and it rises

annually by Y%. A converter may also be the repository for a graphical function which

sketches the relationship between an input and an output. For example, the output may be

the price of a subscription and the input the number of items in a database. A graphical

functions can also be used to sketch non-linear relationships. Table 1 shows the

graphical representations of converters in these roles and an example of a slider which

may be manipulated by a user.

Table 1: Different roles of a converter.

Graphical representation	
Converter	This is a simple converter which may represent a constant value or the value of an algebraic relationship
slider	This is the graphical representation of a slider as it appears in a model.
profit margin 0.00 0.50 U 0.00	This is the slider which is represented in the model as above. The user slides the button to determine the value of the profit margin before running the model to monitor the effect of this change.
graphical function	This converter represents a graphical function, i.e. a sketch of the relationship between and input and an output.

3.1.4 Connector

○ ⟶
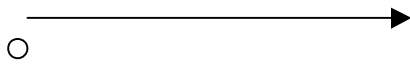
A connector is like a wire which transmits information between elements in a model, e.g. in Figure 1, the value of the flow labelled 'RDN staff' is determined by the product of the values of the two converters. The value of the converters is conveyed to the flow by connectors. A connector can connect out of a stock and it can flow into or out of a flow or converter. It cannot connect into a stock as the value of the latter can be altered only by a flow.

Figure 1: The relationship between the flow value RDN staff (costs), the converter whose value is the number of employees and the cost of employing an individual.
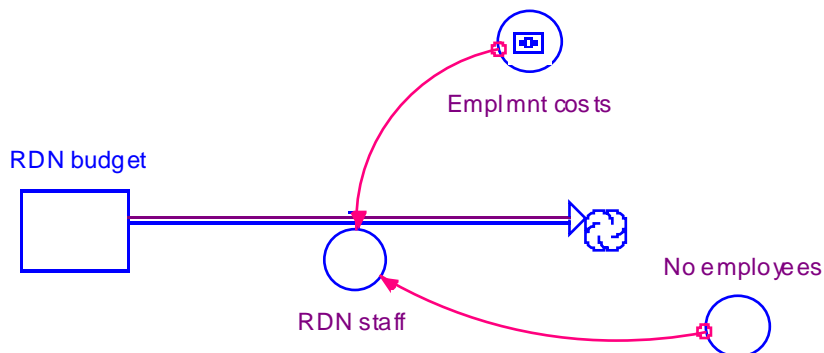
3.2 Evaluation of Ithink modelling software

Ithink was an effective tool for the research described here. It allowed the authors to map the interrelationships in a system before numbers were introduced. The documentation supplied with the software is clear and comprehensive. Two versions of the software are available: Ithink Strategy and Ithink Analyst. The latter includes additional modelling features. These features were not required to build the models described in this report. Ithink software is available for educational use at half of the full price. The educational

rate for Ithink Strategy is available for $299 and Ithink Analyst for £479 (see http://www.cognitus.co.uk/IS/IS.htm). The price includes documentation.

There were a few drawbacks. Among them were the fact that the software prohibits circular relationships. For example, in the model of a non-commercial journal, we wished to define the overhead applied when calculating total publication costs as a percentage of sales income. However, as total publication cost is one factor determining price and price is one factor determining sales income, this relationship would have been circular and was prohibited. Another drawback for this project is the difficulty of printing the models. The software is designed as a learning tool. To be most effective models should be manipulated by users. Thus, prints of the models are considered to be of limited value. Nevertheless, the output of this research project had to be documented and published. Although the authors expect interested parties to request copies of the models, they also believe that illustrations would contribute to understanding of written reports and papers. Unfortunately, several of the models would be illegible on anything smaller than an A2 sheet of paper. It is for this reason that we recommend that interested readers should download the runtime version of Ithink software and request copies of our models. Requests for discs with the models should be addressed to either of the authors of this report (l.l.halliday@lboro.ac.uk or c.oppenheim@lboro.ac.uk).

4 Results and discussion

The authors built six Ithink models based on economic models of different aspects of the digital library. These include four economic models of electronic journal production and delivery. Development of electronic journals is more advanced than most other areas of the digital library. The selection of models evaluated here reflects this. The other two models evaluated are a resource discovery network and a National Electronic Reserve

Service (NERS). The former is based on a recent eLib supporting study of subject-based gateways (Haynes *et al.* 1998) and is informed by the JISC call for proposals to develop a Resource Discovery Network Centre (JISC circular 10/98). The latter model is based on the eLib-funded national electronic resource service, HERON and is informed by relevant eLib publications and by publications of other stakeholders such as the CLA and the PLS.

4.1 Electronic journals models

There are four Ithink models of electronic journal production and delivery. The first is a model of a non-commercial electronic journal with traditional economic characteristics. In this model, costs are recovered from sales of subscriptions and individual articles. A "Traditional model" is presented first to facilitate easy comparison with journal production and delivery in a print environment. The second model is based on the economic model proposed by Harnad and Hemus (Harnad and Hemus1997) and is hereinafter described as the "Harnad model". . The third is a 'market' model based on Fishwick *et al.*'s eLib supporting study on the economic implications of different models of publishing scholarly electronic journals and is hereinafter referred to as the "Fishwick model". The fourth model is an alternative model, proposed by the authors, which is informed by the other three models. The Traditional model is presented first and assumptions informing different elements in the model are explained. The Harnad model, the Fishwick model, and the authors' alternative model are then described. Where elements and assumptions in these models differ from those in the Traditional model these are documented. The values of several elements in each of these models were varied and the models run to monitor the effects. The costs and benefits for different stakeholders of manipulating model elements was established and model sensitivities were identified. The results are described.

4.1.1 Non-commercial electronic journal with traditional economic characteristics

The characteristics of this model are very similar to those of the scholarly print information delivery chain. Editors and referees are unpaid other than a contribution from the publisher towards editorial office costs. A traditional pricing mechanism is applied, i.e. costs are recovered through sales of subscriptions and of individual articles. The model differs from the print system in that the entire editorial process is conducted electronically and the product is delivered in electronic form to libraries. Libraries are free to obtain subscriptions/individual articles directly from publishers or to obtain them from an information broker. It is assumed, if a library chooses the former, that terms will be negotiated between the library and the publisher. The model consists of four interconnected sectors: content origination, publication, information brokerage, and the library function.

4.1.1.1 Content origination

In this sector, manuscripts are first submitted to the editorial office for review. The number of incoming manuscripts is specified so that the number of papers published was limited to a realistic level. The model simulates production of a single journal. We assumed that the journal publishes approximately 120 papers per annum. Theoretically, an electronic journal need not be constrained by a pre-determined limit on the number of papers that it can publish annually because distribution and storage costs are low. However, other resources required for production are related to journal size and these are likely to restricts growth in the short to medium term. For the purpose of the modelling exercise, the authors assumed that the number of papers published per annum in an electronic journal is similar to the number published in a print journal.

The rate at which manuscripts are submitted to any journal fluctuates. However, if an excess of manuscripts is accepted and, in turn, the publication delay is unacceptable, it is reasonable to assume that potential authors will be discouraged from submitting to that journal. The editors also would regulate the number of papers accepted by increasing the rejection rate to maintain an acceptable publication delay. In the model, the number of papers submitted was specified with reference to the rejection rate to ensure that 120 papers were produced per annum.

Most manuscripts submitted for publication are refereed but a small percentage is rejected immediately usually because the subject matter is unsuitable for publication in that journal. The immediate rejection rate wan this model is 2% and is based on an established print peer reviewed journal (A. Gilchrist, personal communication, 16 March 1999). The total rejection rate in the model is varied to monitor the effect. Rejection rates vary between journals, and vary significantly between disciplines (i.e. in the humanities 90% is not uncommon whilst in the pure sciences 10% is common).

It is assumed that the editor spends a total of 30 minutes per paper. This represents time spent scanning the manuscript content, deciding whether or not to have the paper refereed, selecting referees, and considering revisions and whether or not to return the paper to the referees.

We assumed that all but 2% of manuscripts are refereed, each of them by two peers. The average paper is revised once. It was assumed that each referee spends two hours reviewing the manuscript in the first instance and that revision takes one hour. Thus, each referee spends three hours per paper and therefore, each paper takes six referee hours to process.

It was assumed that one hour of an average editor or referee costs £50 including full employment costs and overhead. This is a conservative estimate which does not vary with overhead rate. The total cost to HE is calculated as the cost of editorial and refereeing work minus the contribution from the publisher towards the costs of the editorial office. This cost to HE is an opportunity cost as it is not accounted for in the financial transactions between different stakeholders. It was assumed that the publisher contributes £160 per accepted manuscript towards the costs of the editorial office. This assumption is based on figures given in (Page *et al.* 1997).

The model includes no clerical administration cost, as most of the clerical administrative tasks are automated and journal production staff undertake what remains. Thus, the editorial and production functions are interlinked. This organisational model is based on that of the *Conservation Ecology* Project (Pope and Miller 1998).

4.1.1.2 Publication

Production costs in the model vary with the overhead rate applied. It was assumed that overheads cost 120% of production costs, but a rate of 60% was also tested. The authors would have preferred to calculate overhead as a percentage of sales income because distribution incurs additional administration costs and thus costs vary with the size of the subscription base. However, calculation of the overhead in this way would have required a circular connection between elements in the model which is prohibited by the software package (see Methods section).

As the model is non-commercial, it was assumed that the publisher does not seek to make substantial profits. However, some profit margin is required to develop the journal. We applied margins in the model at a rate varying from 0% to 20%.

The journal is produced by a half-time production editor and a half-time systems administrator (Pope and Miller 1998). The cost per paper was estimated at £275. This is based on a part-time journal production editor and a part-time systems administrator each earning, pro rata, £25 000 who also cost an additional 20% of that figure in national insurance contributions (NIC) and pension contributions. This gives a total employment cost of £30 000. An overhead was not applied to staff costs in this instance. Assuming that these staff members can produce a journal consisting of 120 papers per volume (per year), the cost per paper is £250. An additional £25 was added to this figure to cover any other expenses.

Subscription fees in the model vary with the level of use. The price increases as the user base decreases because there are fewer subscribers or purchasers of individual documents to share the costs. The price of an individual paper is double that of a paper sold as part of a subscription to reflect the increased risk to the publisher when she sells papers individually rather than in volume sized bundles. This price may be calculated by dividing the subscription price by 120 to generate a per-paper price and multiplying the resulting figure by two. All subscription and article prices include VAT at 17.5%. HEIs in the UK are currently required to pay VAT on purchases of electronic information, but not on print information.

The authors acknowledge that it can take several years for journal start-up costs to be amortized and the duration varies considerably. In the interests of simplicity, the journal modeled here is assumed to be an on-going concern, i.e. start-up costs are not included.

The flow element 'other publisher income' represents sources of income derived from the journal publication other than sales of subscriptions and individual articles. Other source of income may include, for example, advertising or sponsored supplements. This figure

is calculated at 4% of subscription and individual article income. This figure was derived from the journal costing form referred to above (Page *et al.* 1997).

4.1.1.2.1 COST OF STORING DIGITAL JOURNALS

The cost of storing digital journals is currently very low and is falling. It is assumed that this cost is incurred by the publisher and that the work related to storage would be undertaken by the Systems administrator in the normal course of her duties. The cost of storage space itself is based on a rough estimate that it costs £100 per gigabyte per annum to store digital content. It is estimated that an HTML journal volume occupies approximately 30 Mb. This is a liberal estimate based on figures supplied by Stuart Peters with reference to the electronic journal *Sociology Online* (S. Peters, 22 March 1999, personal communication). Thus, a volume costs £2.93 per annum to store. After 13 years the cost of storing that journal is £26 per annum. Storage costs are likely to decrease significantly over the period but no attempt is made to predict the degree of this decrease.

4.1.1.3 *Information broker function*

The information broker (subscription agent) undertakes administrative work that saves time and money for both the library and the publisher. The various tasks involved are not represented. The information broker also generates management information which she supplies to both the publisher and the library as appropriate. As the type of information and thus its value and the cost of processing it are unknown as yet, this function is not represented. It is assumed that the information broker negotiates favorable licence terms for libraries. Libraries pay an annual fee to the information broker. In the model, this is based on the fee charged by NESLI. NESLI charges institutions a fee to use SwetsNet which amounts to £1 per title subscription up to a maximum of £560 (A. Prior, personal

communication, 17 March 1999). In the model, the fee paid by an institution is determined by the amount of service delivered to the institution as determined by number of subscriptions and number of individual articles delivered; the latter is divided by 120 as a proxy for a single journal title. It is assumed in the model that when an individual at an HEI has received a document electronically, the document will then be available to other researchers at the institution free of charge. This assumption is based on the practice of Elsevier Science with regard to institutions participating in the PEAK project (Kiernan 1998). Publishers pay for the services of information broker by supplying publications at a discounted rate. Generally, discounts from publishers to subscription agents are in the region of 7% (A. Prior, personal communication, 9 March 1999). This figure is used in the model.

It was beyond the scope of this study to explore the costs to information brokers of the variety of services that they provide. It was assumed that the discount from the publisher and the fee from the library is sufficient remuneration.

4.1.1.4 HE library function

The cost to the library of negotiating the licence terms on which journals and/or individual electronic articles are supplied is represented by a negotiation fraction for each of these resources. This fraction is based on the cost of an individual, professional negotiator working at full capacity plus the cost of 1 hour per week to five other senior staff members in HE. This is a modest estimate of the cost based on current practice in the US where licence negotiation often involves a team of senior staff who sometimes meet as frequently as every week (Brennan *et al.* 1997). The hourly rate for employing a senior staff member (including employment costs and overhead) is £50. Electronic Individual Article Supply (EIAS) directly from the publisher is likely to be negotiated based on access to a bundle of titles, perhaps within a single subject area or perhaps the

publisher's entire list. The negotiation process itself is likely to take longer than negotiation for a single title as both parties have more at stake. However, the cost of the negotiation may be spread across all EIAS acquisitions for, at least, a single year. In the model, the cost of negotiation for EIAS directly from the publisher is based on 33 senior staff hours at £50 an hour (representing three 1-hour meetings attended by the negotiator and five other participants and 15 hours of negotiation and related tasks by the negotiator). It is assumed that negotiation reduces the subscription cost and the EIAS cost to the library to 10% less than the standard price.

It was assumed also that the library acquisitions budget is £505 per active researcher. This figure is based on SCONUL figures for an average academic library acquisitions budget (SCONUL 1998) and on the number of active researchers. It was assumed that an average institution has 1174 active researchers. This is a rough estimate based on SCONUL figures (SCONUL 1998). It includes the total mean number of teaching and research staff which is (arbitrarily) divided in half, the mean number of research only staff, and the mean number of postgraduate research students.

In the model, the cost of licence negotiation is deducted from the library acquisitions budget. This does not reflect reality. However, the cost of licence negotiation is directly related to the acquisition of journals and it is deducted from the acquisitions budget in the model so that the total cost of acquiring journals directly from the publisher may be compared with the cost of acquiring them from via an information broker. It was assumed that the publisher commits as much time and effort to negotiating licences as the library. Thus, the negotiation fraction deducted from the library journals acquisitions budget is also deducted from the publisher gross income to indicate publisher spend.

4.1.1.4.1 COSTS OF PROCESSING, STORING AND ISSUING PRINT JOURNALS

The cost of processing, storing, issuing and other tasks related to print journals is included in the model for comparison. Odlyzko claims that these costs are the cause of the serials crisis and suggests that for every $1 that a library spends on journal acquisitions, it spends another $2 on these related activities (Odlyzko 1999). He based this assertion on the fact that Association of Research Libraries (ARL) statistics consistently show that acquisitions represent approximately 30% of the budgets of research libraries in the US and Canada (Odlyzko 1999). The assumption is that if this material is acquired in digital form, these additional library costs can be eliminated. This assumption is, it must said, contentious. The cost of storing digital journals is likely to be much lower than the cost of storing print but the cost of maintaining that store and of technical migration to ensure that the content is available in the future will be significant. Furthermore, it is likely that in a digital library, the tasks currently undertaken by librarians will be as important as they are now. These tasks may be undertaken by other stakeholders and the nature of the tasks will change to some degree. Nevertheless, the costs of undertaking them will be incurred and will be included in the price of scholarly literature.

Figures used for calculating these costs are based on those calculated for use in planning the JSTOR project (Bowen 1996). The cost of storing a single volume of the journal *Ecology* for 1 year is $3.07. This figure is used here as a basis for calculating storage costs for journals. It has been inflated and converted at the current rate (26 March 1999) to give £2 per volume. Bowen estimated that circulation costs for current issues of journals amount to a total of $45 (currently £29) and that circulation costs for past issues also cost $45. In the model, the term 'current issue' refers to the current year and two previous years. After that period has elapsed, the cost of circulating back issues will be

added to library costs at the same rate as circulation of current issues. Bowen estimated that binding of current issues costs $20 (currently £13) and processing and check in a further $20 (currently £13). Finally, he estimated that the cost of conserving and preserving backruns is $5 (£3). The total cost per title per annum ranges from £60 in year 1 to £113 in year 13. As a percentage of the current mean journal subscription fee in the UK (£103.71; LISU 1998) this represents 58–109%. These figures are lower than Odlyzko suggested, but are still significant when scaled up for a whole journal collection. For example, the cost of processing, storing and issuing a collection of only 1000 titles ranges from £60 000 in Year 1 to £11 3000 in Year 13. The mean number of titles held by a library is 4880 (SCONUL 1998). The cost to the library of processing, storing and issuing a print collection of this size ranges from £292 800 in Year 1 to £551 440 in Year 13. As a percentage of total gross library expenditure (£3 137 558; SCONUL 1998), this represents 9–18%.

4.1.1.4.2 COST TO THE LIBRARY OF USERS PRINTING FROM JOURNALS

At present, researchers use the library to browse but photocopy papers that they intend to read. In an electronic environment, they will print from a laser printer. A photocopy costs about 2.5p/page. A laser print costs approximately double. However, printing from a laser printer does not require the researcher to stand at the machine and photocopy each page of the journal in turn. When this opportunity cost is taken into account the difference in price between photocopying and laser printing is likely to be negligible. However, were researchers to begin to read on screen rather from than from printed copy, this cost would be saved. For this reason, the model calculates a very approximate print cost as follows.

It is estimated that each active researcher prints 2160 pages per annum. This figure is based on a rough calculation of the number of pages per paper multiplied by the number

of papers read by an active researcher per annum. A selection of 36 papers printed from a variety of electronic journals was sampled and the average number of pages was found to be 10. The number of papers read by each active researcher is based on figures derived from a citation analysis conducted for the FIDDO project. On average, each of 1500 authors cited 18 papers (J. Woodfield, personal communication, 24 March 1999). It has been estimated that one third of all influences is cited (McRoberts and McRoberts 1996) so it is assumed that each author reads 54 papers when preparing a paper for publication. As many academic departments in the UK currently require research-active staff to publish four papers per year, this is taken as a standard and it is assumed that researchers read a total of 216 papers per year. If each paper consists of 10 printed pages, in an electronic environment, each researcher will print 2160 pages. Thus, an institution with only 200 research-active staff will incur print costs of £21 600. It is assumed that an average institution has 1174 active researchers as calculated above. Based on this figure, the cost to an institution for printing is £126 792.

The size of the fund supplied to the library for acquisitions is based on the number of active researchers multiplied by a financial sum per active researcher. The sum per active researcher is based on SCONUL 1996/97 figures and reflects mean subscription costs plus mean binding costs plus mean ILL transaction costs divided by mean number of active researchers.

4.1.1.5 Model simulations

The overhead rate, the profit margin applied by the publisher, and the number of subscriptions were varied and the effect on subscription fees monitored. The results are recorded below.

At an overhead rate of 120% and a profit margin of 20%, subscription fees for 200, 500, 1000, 2000, and 20 000 subscriptions are £809.62, £323.84 £161.92, £80.96, and £8.10 respectively.

If the overhead is maintained at 120% and the profit margin is reduced to 10%, the subscription fees for 200, 500, 1000, 2000, and 20 000 subscriptions are £742.15, £296.86, £148.43, £74.22, and £7.42 respectively.

If the overhead is maintained at 120% and the profit margin is reduced to zero, the subscription fees for 200,500, 1000, 2000, and 20 000 subscriptions are £674.69, £269.88, £134.94, £67.47, and £6.75 respectively.

If the overhead is reduced to 60%, at a profit margin of 20%, the subscription fees for 200, 500, 1000, 2000, and 20 000 subscriptions are £588.82, £235.52, £117.76, £58.88, and £5.89 respectively.

If the overhead is maintained at 60% and the profit margin reduced to 10%, the subscription fees for 200, 500, 1000, 2000, and 20 000 subscriptions are £539.75, £215.90, £107.95, £53.97, and £5.40 respectively.

If the overhead is maintained at 60% and the profit margin reduced to zero, the subscription fees for 200, 500, 1000, 2000, and 20 000 subscriptions are £490.68, £196.28, £98.14, £49.07, and £4.91 respectively.

It is clear from these figures that a non-commercial journal making a modest profit and recovering full costs (120% overhead) can be supplied to users for a modest fee as long as the subscription base consists of at least 500 subscribers.

4.1.2 Harnad model

The Harnad model differs from the traditional model in that all costs are recovered through author submission fees. Again the entire editorial process is conducted electronically. Journals are available on the Internet free of charge to any user. However, as delivery through a common, familiar interface is important to users and one function of the information broker is to deliver material through a common interface it is assumed that the library pays to use an information broker to deliver Harnad-modelled journals. Even if all journals were produced on a Harnad-type model, the library would seek to obtain such a service. It is beyond the scope of this project to determine the feasibility of the latter scenario for the information broker.

4.1.2.1 Content origination and publication

Manuscripts are submitted to the editorial office for review. The model simulates production of a single journal consisting of 120 papers per annum. Only authors of papers which are refereed are charged a submission fee. Thus, the 2% of authors whose papers are rejected immediately do not contribute to publication costs. The contribution of editors and referees is the same in this model as in the traditional model and again, the cost of this contribution is an opportunity cost as this work is unpaid. The total publication cost is calculated based on journal production staff costs which are the same as those in the traditional model, overhead and storage of the back list as it accumulates. Overhead is applied at a rate of 120% and of 60%. Clearly, the alternative method of calculating overhead referred to above could not have been used in this model as there is no sales income. The submission fee is calculated as the total production cost divided by the number of papers refereed.   No profit margin is applied. Harnad's is a model in which publication is conducted by, and for the benefit of, HE. It is assumed that future

development would be funded by HE grant or other HE sources of income. The cost of storing the journal back list is calculated as above.

4.1.2.2 Information brokerage and HE library function

In the model, the cost to the library of obtaining information brokerage services is based on the charges levied by NESLI. There is no requirement for the information broker to negotiate with a publisher on behalf of the library. This would represent a significant proportion of the cost of NESLI services. However, it is assumed that the information broker in this model provides the other services offered by NESLI such as management information and catalogue records as well as the common interface for delivering journals. The fee charged by NESLI for using SwetsNet is £1 per title subscription up to a maximum of £560. The NESLI pricing mechanism would appear to be based on a traditional model, i.e. one in which publishers charge subscription fees, as NESLI also plans to seek fees in the form of a discount on subscriptions from publishers. This is likely to be at a rate of approximately 7%. Where subscriptions are free of charge, the library would be expected to pay for that part of the NESLI fee that, otherwise, would be recovered from publishers. The rate applied in the model is based on the average cost of a journal subscription and the fee per institution is based on the amount of service delivered, i.e. the number of subscriptions. The average subscription fee used is the mean subscription fee paid by UK libraries for journal subscriptions in 1997 as indicated by the LISU Library and Information Statistics Tables 1998 (£103.71; LISU 1998). NESLI would seek 7% of the subscription price from the publisher (£7.26). In this model, the library pays 20% of that figure, £1.45, up to a maximum of £812. Thus, the total figure paid by the library is £2.45 per title up to a maximum of £1372.

In this model, the library incurs no costs from negotiating journal licences with publishers. It is assumed that the library acquisitions budget consists of £505 per active

researcher. The costs of processing, storing and issuing print journals calculated above are unaffected by differences in the journal models as is the cost of printing from electronic journals.

4.1.2.3 Model simulations

The overhead rate applied to production costs and the journal rejection rate are varied and the effect on submission fees is monitored. The results are recorded below.

If the overhead on production costs is 120%, at a 10% rejection rate the submission fee is £878.90. This figure falls to £97.66 for a 90% rejection rate.

If the overhead on production costs is reduced from 120% to 60% the submission fee is reduced and ranges from £639.21 for a rejection rate of 10% to £71.02 for a rejection rate of 90%. For a 10-page article, a fee of £639.21 represents a page charge of £63.92. If the submission fee were £639.21 the page charge for a 20-page article would be £31.96 but for each of those 20-page papers the model requires two corresponding 5-page articles, submitted at a cost of £127.84 per page.

If the overhead on production costs is reduced to 30%, the submission fee is further reduced and ranges from £519.36 at a rejection rate of 10% to £57.71 for a rejection rate of 90%.

Clearly, submission fees are reduced in line with reductions in the overhead rate applied to production costs. We argue that an overhead rate of 120% is realistic. Thus, if the overhead rate is reduced, the remaining overhead must be covered by the host institution as a subsidy. Presumably, this could be justified with reference to the kudos gained from producing a reputable peer reviewed journal and only if journal production

responsibilities were spread across the HE sector. However, even at an overhead rate of just 30% , fees are not reduced to within the range that Harnad would expect.

He suggests that fees of tens of dollars a page rather than hundreds of dollars a page would be acceptable and estimates that it would cost approximately $400 to produce a 20-page article. This converts as approximately £250 for 20 pages, i.e. a page charge of £12.50. In the model, a page charge of £12.50 would not cover the production costs of any journal with a rejection rate below 80%. If an overhead of 120% were applied, a page charge of £12.50 would cover publication only if the rejection rate were 88% or more. If an overhead of 60% were applied, a page charge of £12.50 would cover publication only if the rejection rate were 84% or more. If an overhead rate of 30% were applied, a page charge of £12.50 would cover publication costs only if the rejection rate were 80% or more.

Nevertheless, fees are reduced to a level close to that charged for submission to many US journals. The latter also charge subscription fees which the Harnad model avoids. Thus, although costs are not reduced to the level anticipated by Harnad, cost recovery by author submission fees is a viable model.

Clearly, in this model, rejection rate is a key factor determining viability as submission fees are much higher for papers submitted to journals with high rejection rates. This effect would make submission fees in the natural sciences much more expensive than those in the humanities. In the former, rejection rates tend to be around 10–20% and in the latter, they tend to be around 80–90%. This may appear to be reasonable as research in the natural sciences is more likely to be funded by substantial grants, so it may be argued that natural scientists can better afford to pay high submission fees. However, the difference between disciplines of the cost of submitting a paper for publication is

misleading. Most academic papers are published even if they are rejected by the first or second choice of journal. In disciplines where the rejection rate is high, presumably authors often have to submit the same paper to several journals before it is eventually accepted for publication and thus, they would be required to pay several submission fees. Ultimately, the total cost to scientists and humanities scholars would be similar. It may, however, be argued that in these circumstances cost would regulate quality.   In other words, authors would not go to the expense of constantly submitting (and paying submission fees) a paper they knew to be inferior.   This argument, whilst valid, is countered by the argument that rejection rates in the humanities do not simply reflect an abundance of poor-quality material. Humanities subjects are characterised by debate rather than the scientific method. Quality assessment in these subjects is more subjective than in the sciences. Thus, material that is rejected by referees selected by the editor of one journal may be commended by referees selected by the editor of another journal.   It is likely, therefore, that the majority of authors will persist with their articles.

As expected, in this model the cost to users of journals is very low. Thus, any HE subsidy for journal production and development could be offset by savings in acquisitions costs. A library providing 4880 Harnad-modelled titles to its users could expect to pay only £11 956 in fees to an information broker. Compared with subscribing to an average journals collection (4880 titles; SCONUL 1998) at the average price (£103.71) for a total cost of £506 104 this represents a huge saving for the library.

4.1.2.4 New Journal of Physics

Working examples of the journals modelled by those who seek to change the economic characteristics of the scholarly information delivery chain are rare. Many journals available in electronic form are published in parallel with print and the price mechanism is traditional. Many other journals that are produced only in electronic form are grant

funded and recover costs neither from authors nor from users. A new electronic journal, *The New Journal of Physics (NJP)* is published by an established publisher of peer-reviewed scholarly journals, the Institute of Physics Publishing (IoPP). The *NJP* is published only in electronic form and is no doubt intended to cover its costs; this it does from its authors. Thus, to a degree, it exemplifies the Harnad model. However, whereas Harnad suggests that costs be recovered through submission fees, the IoPP seeks to recover the cost of publishing the *NJP* through acceptance fees. Presumably, fees paid by authors of papers that are accepted for publication must cover the cost of all papers submitted.

The IoPP charges $500 for production of an accepted paper in the *NJP* and the journal is available to access free of charge over the Internet. This suggests that the *NJP* can be published for $60 000 (£37 267.08 on 31 March 1999) per volume (based on a volume of 120 accepted papers). The IoPP encourages authors to submit only papers that are of the highest quality and of wide appeal which suggests that they wish to keep the rejection rate as low as possible. It is common for physics journals to have rejection rates of approximately 10%.

The Ithink model produced to test Harnad's theory was revised to simulate the characteristics of the *NJP*. This revised model was run and the results show that if the overhead rate on production costs is 120%, the total production cost for a volume of the *NJP* consisting of 120 10-page papers ranges from £114 000 at 2% rejection rate to £115 000 at 10% rejection rate. If overhead is applied at a rate of 60%, the cost is approximately £84 000. If the journal were to recover these costs through a submission fee then, at an overhead rate of 120% the fee would range from £958 to £882 for rejection rates of 2% and 10% respectively. If an overhead of 60% were applied, the fee would range from £697 to £641 for rejection rates of 2% and 10% respectively. The submission

fee decreases as the rejection rate increases. However, if costs are recovered through an acceptance fee, as proposed by the IoPP, then at an overhead of 120%, fees range from £958 to £960 for rejection rates of 2% and 10% respectively. If an overhead rate of 60% is applied, fees range from £697 to £698 for rejection rates of 2% and 10% respectively. The fee increases with the rejection rate. Hence the desire of the IoPP to keep the rejection rate of the *NJP* low.

 These figures suggest that production of an electronic journal costs a great deal more than a sum that can be recovered from acceptance fees of about $500 (£311). Presumably, over the longer term, the IoPP expects to recover costs from some other sources. It will be interesting to monitor the success of this new journal.

4.1.3 Fishwick model

The Fishwick model is significantly different from either of the other models in that it introduces 'normal' market feedback mechanisms into the academic information delivery chain. Both submission fees and subscription fees are used to recover costs as Fishwick argues that both users' requirement for reading material and authors' requirement for publication create demand. The financial cost of producing a Fishwick journal is much higher than the cost of the other journals modelled because the editor and referees are paid for their contributions. Again, the entire editorial process is conducted electronically and journals are delivered in electronic form. Libraries are free to obtain subscriptions/individual articles directly from publishers or to obtain them from an information broker. It is assumed, if the library chooses the former, that terms will be negotiated between the library and the publisher.

4.1.3.1 Content origination

In this sector manuscripts are submitted to the editorial office for publication and authors are required to pay a submission fee. Only authors of papers which are refereed are charged a submission fee. Thus, the 2% of authors whose papers are rejected immediately do not contribute to publication costs. Fishwick *et al.* propose that a submission fee should contribute to refereeing, editorial and production costs. Thus, all authors submitting a paper for publication contribute to production costs regardless of whether or not the paper is accepted. The alternative would be to charge a submission fee which covers only editorial and refereeing costs and, on acceptance, charge an additional publication cost. However, this would incur an additional administration cost.

The contribution of editors and referees is the same in this model as in the traditional model. However, both referees and editors are paid for their work at an hourly rate of £50 including overhead and any other related employment costs. The submission fee consists of the total cost of editorial, refereeing and editorial office work on the manuscript plus a contribution to publisher costs. Fishwick *et al.* do not suggest an appropriate rate at which authors should contribute to publication costs nor do they suggest a suitable rate at which authors should be paid royalties on sales of their papers. In the model, authors contribute 10% of the production cost and receive royalties at a rate of 5% of usage fees. Generally, authors, their employers, or their funding sources will pay the fee but a small number of papers will be submitted by authors who cannot pay the fee. In these cases, the editorial office will apply, on behalf of the author, for publication assistance from public/charitable bodies. Any royalties accumulated from publication of these papers will be paid to the body which funded publication.

4.1.3.2 Publication

Production costs in the model vary with the overhead rate applied. It is assumed that overheads cost 120% but a rate of 60% is also tested. As in the traditional model, a profit margin varying from zero to 20% is applied.

Fishwick *et al.* suggests that the basic product be simple unedited text and that a more sophisticated product be available at a higher price. Research suggests that users and librarians expect electronic journals to have additional functionality and would not consider it worthwhile learning how to use a system simply to access text which they would then print. It is assumed in this model that users would subscribe only to a more sophisticated product, i.e. that the minimum requirement would be hotlinks to cited papers. Production costs are based on this assumption and consist of the two part-time staff members described above with reference to the Traditional model. Authors contribute 10% towards production costs and the remaining 90% is recovered through subscription/individual article fees.

This journal would be more expensive than the others to administer because of the additional tasks associated with unfunded papers. As well as manuscript management administration, the cost of the following tasks would be incurred: (1) receiving applications for assisted publication; (2) applying to funding bodies on behalf of those applying for assistance; (3) administering receipt of submission fees; and (4) administering royalty payments. It would cost £19 500 to employ a part-time secretary on a pro-rata salary of £15 000 if the overhead applied were 120%. If the overhead were 60%, it would cost £14 400. A cost per-paper is required for the model. It is assumed that the cost of applying for assistance with publication costs would be spread across all papers and that the secretary could administer 600 papers per annum. This would be the number received by a journal with an 80% rejection rate. Thus, the cost per paper is

£32.50 (£19 500/600) if the overhead rate is 120% and £24 (£14 400/600) if the overhead rate is 60%.

Fishwick *et al.* suggest that published papers be sold to users either by subscription to the publisher's whole list, by subscription to specific parts (e.g. within a specific subject areas), by a two-part tariff which consists of a reduced subscription price combined with reduced transaction costs relating to individual articles, or simply on a pay-per-use basis. These different pricing mechanisms are different risk-sharing schemes. When the publisher shoulders most of the risk in a pay-per-document model the price is higher but when the library shoulders most of the risk by subscribing to a whole database from which users may select only a small proportion of the content, the price per paper is lower. These different pricing mechanisms were not modelled. To include them in the model would be to introduce too many variables and thus, simulations would reveal economic factors that apply only in very specific circumstances. Only subscription and individual article fees are included in the model. Subscription fees vary with level of use as in the Traditional model.

It is assumed that the journal is an ongoing concern, i.e. that journal start-up costs need not be amortised.

4.1.3.3 Information brokerage

Assumptions informing the role of the information broker were the same in this model as in the Traditional model.

4.1.3.4 HE library function

Assumptions informing the HE library function were the same in this model as in the Traditional model.

4.1.3.5 Model simulations

4.1.3.5.1 SUBMISSION FEES

The submission fee covers the cost of the editorial process and contributes to publisher income for use in the production process. However, it is not informed by subscription price or any of the elements affecting price and thus, it is not affected by the profit margin applied by the publisher. It varies only with rejection rate and the rate at which overhead is applied. The latter alters the submission fee because the fee includes the cost of administering the manuscript which is not insignificant in this model (see notes above).

If the overhead is applied at a rate of 120% , submission fees will range between £446.56 for a journal with a 10% rejection rate to £368.44 for a journal with a 90% rejection rate.

If the overhead is applied at a rate of 60%, submission fees will range between £413.92 for a journal with a 10% rejection rate to £357.10 for a journal with a 90% rejection rate.

These fees fall within the range charged by many US journals and thus, are not entirely unacceptable. Unlike the Harnad model however, they contribute little to a reduction in costs for the user.

4.1.3.5.2 SUBSCRIPTION PRICE

The subscription price does not vary with rejection rate because it is determined by the cost of producing the 120 papers published in the journal. It does not include the editorial process which is covered by the submission fee.

If the overhead is applied at a rate of 120% and the profit margin is 20%, the subscription price if 200 subscriptions are sold is £728.66. The subscription price if 500 subscriptions

are sold is £291.46. The subscription price if 1000 subscriptions are sold is £145.73. The subscription price if 2000 subscriptions are sold is £72.87 and the subscription price if 20 000 subscriptions are sold is £7.29.

If the overhead is applied at a rate of 60% and the profit margin is 20%, the subscription price if 200 subscriptions are sold is£529.93. The subscription price if 500 subscriptions are sold is £211.98. The subscription price if 1000 subscriptions are sold is £105.99. The subscription price if 2000 subscriptions are sold is £52.99 and the subscription price if 20 000 subscriptions are sold is £5.30.

If the overhead is applied at a rate of 120% and the profit margin is 10%, the subscription price if 200 subscriptions are sold is £667.94. The subscription price if 500 subscriptions are sold is £267.18. The subscription price if 1000 subscriptions are sold is £133.59. The subscription price if 2000 subscriptions are sold is £66.79 and the subscription if 20 000 subscriptions are sold is £6.68.

If the overhead is applied at a rate of 60% and the profit margin is 10%, the subscription price if 200 subscriptions are sold is £485.77. The subscription price if 500 subscriptions are sold is ££194.30. The subscription price if 1000 subscriptions are sold is £97.15. The subscription price if 2000 subscriptions are sold is £48.58 and the subscription if 20 000 subscriptions are sold is £4.86.

If the overhead is applied at a rate of 120% and the profit margin is zero, the subscription price if 200 subscriptions are sold is £607.22. The subscription price if 500 subscriptions are sold is ££242.88. The subscription price if 1000 subscriptions are sold is £121.44. The subscription price if 2000 subscriptions are sold is ££60.72 and the subscription price if 20 000 subscriptions are sold is £6.07.

If the overhead is applied at a rate of 60% and the profit margin is zero, the subscription price if 200 subscriptions are sold is £441.61. The subscription price if 500 subscriptions are sold is ££176.64. The subscription if 1000 subscriptions are sold is £88.32. The subscription if 2000 subscriptions are sold is £44.16 and the subscription price if 20 000 subscriptions are sold is £4.42.

4.1.3.5.3 AUTHOR ROYALTIES

Author royalty is based on income from subscriptions and sales of individual articles, i.e. it is based on the price of subscriptions and individual articles. It is not affected by the rejection rate because editorial and associated administrative costs are covered separately by submission fees. Nor is author royalty affected by the number of subscriptions sold. Subscription price varies with the number of subscriptions sold so that journals/individual articles may be delivered to users at the cheapest rate possible; this a non-profit initiative. The royalty is affected, however, by the overhead applied to production costs and by the profit margin applied by the publisher as both of these things vary the price of the product.

If overhead is applied at a rate of 120%, a profit margin of 20% is applied, the mean royalty received is £24.03.

If overhead is applied at a rate of 60%, a profit margin of 20% is applied, the mean royalty received is £17.48.

If overhead is applied at a rate of 120%, a profit margin of 10% is applied, the mean royalty received is £22.03.

If overhead is applied at a rate of 60%, a profit margin of 10% is applied, the mean royalty received is £16.02.

If overhead is applied at a rate of 120%, a profit margin of zero is applied, the mean royalty received is £20.03.

If overhead is applied at a rate of 60%, a profit margin of zero is applied, the mean royalty received is £14.56.

Individual articles are priced at double the rate of a paper sold as part of a subscription. However, prices of papers and subscriptions vary with the number of subscriptions and individual articles sold, i.e. with income from sales. Thus, although a single paper may sell well on an individual article basis, the mean author royalty will be static. The royalty is included in Fishwick's model as an incentive to publish only high-quality material. A very successful paper could recover the submission fee through royalties such as these. For example, the royalty for a journal produced when an overhead of 120% and a profit margin of 10% are applied is £16.02. In this case the submission fee is £413.92. To recover the submission fee, the author would be required to attract 22% of the royalty funds available for that title in a single year.

4.1.3.6 Conclusion

The Fishwick model is expensive. Submission fees are not insignificant and, primarily, they pay for work that is unpaid in other models. Furthermore, although authors contribute 10% to production costs, the effect on subscription fees is small. Thus, in financial terms the model does not compare well with the others. Nevertheless, like the other models, subscription fees generated for this model are modest compared with fees of commercial publishers.

4.1.4 Alternative model proposed by authors

Like the Fishwick model, the alternative model proposed here recovers costs through a submission fee and a subscription fee in recognition that both authors and users create

demand for publication of scholarly articles. However, this is not a market model and does not introduce payment for editors and referees. The model differs from the standard non-commercial model only in that a proportion of the production cost is recovered from submission fees.

4.1.4.1 Content origination

In this sector manuscripts are submitted for publication and authors pay a submission fee. Only authors of papers which are refereed are charged a submission fee. Thus, the 2% of authors whose papers are rejected immediately do not contribute to publication costs. The authors attempted to establish an acceptable rate at which page charges may be levied. Figures charged for publication in some leading US journals were compared. These tend to fall within the range $25–$75 per page (1997 figures; Page *et al.* 1997). At current UK prices, these charges represent £15.53–£46.58 per page which, for a 10-page article, amounts to £155.30–£465.80. The model is used to explore the effect on subscription costs of varying submission fees from £200–£50. The former falls comfortably within the lower end of the scale of charges common in the US and the latter is a fraction of those charges.

The contribution of editors and referees is the same in this model as in the traditional model. It was assumed that clerical and administrative tasks are undertaken by journal production staff.

4.1.4.2 Publication

Other than that authors contribute to production costs, the assumptions informing the publication sector were the same as in the Traditional model.

4.1.4.3 Information brokerage

Assumptions informing the role of the information broker were the same in this model as in the Traditional model.

4.1.4.4 HE library function

Assumptions informing the HE library function were the same in this model as in the Traditional model.

4.1.4.5 Model simulations

The effect of variations in overhead rate applied, profit margin, rejection rate and submission fee were explored. The results follow.

If the submission fee is set at £200 per paper, the overhead is 120%, the profit margin 20% and the rejection rate 10%, subscription prices range from £6.25 to £625.38 for 20 000 and 200 subscriptions respectively. The subscription price if 500 subscriptions are sold is £250.16, if 100 subscriptions are sold, £125.08 and, if 2000 subscriptions are sold, £62.54.

If the submission fee is £200 per paper, the overhead is 120%, the profit margin 10% and the rejection rate 10%, subscription prices range from £5.73 to £573.27 for 20 000 and 200 subscriptions respectively. If 500 subscriptions are sold the price is £229.30, if 1000 subscriptions are sold, £114.65, and if 2000 subscriptions are sold the price is £57.33.

If the submission fee is £200 per paper, the overhead is 120%, the profit margin is zero and the rejection rate 10%, subscription prices range from £5.21 to £521.15 for 20 000 to 200 subscriptions sold respectively. If 500 subscriptions are sold the price is £208.46, if 1000 subscriptions are sold, £104.23, and if 2000 subscriptions are sold the price is £52.12.

If the submission fee is £200 per paper, the overhead is reduced to 60%, the profit margin is 20% and the rejection rate 10%, subscription prices range from £3.71 to £370.86 for 20 000 to 200 subscriptions sold respectively. If 500 subscriptions are sold the price is £148.34, if 1000 subscriptions are sold, £74.17, and if 2000 subscriptions are sold the price is £37.09.

If the submission fee is £200 per paper, the overhead is 60%, the profit margin is 10% and the rejection rate 10%, subscription prices range from £4.05 to £404.58 for 20 000 to 200 subscriptions sold respectively. If 500 subscriptions are sold the price is £161.84, if 1000 subscriptions are sold, £80.92, and if 2000 subscriptions are sold the price is £40.46.

If the submission fee is £200 per paper, the overhead is 60%, the profit margin is zero and the rejection rate 10%, subscription prices range from £3.37 to £337.15 for 20 000 to 200 subscriptions sold respectively. If 500 subscriptions are sold the price is £134.86, if 1000 subscriptions are sold, £67.43, and if 2000 subscriptions are sold the price is £33.71.

If the submission fee is reduced to £100 per paper, the overhead is 120%, the profit margin is 20% and the rejection rate 10%, subscription prices range from £7.18 to £717.50 for 20 000 to 200 subscriptions sold respectively. If 500 subscriptions are sold the price is £287, if 1000 subscriptions are sold, £143.50, and if 2000 subscriptions are sold the price is £71.75.

If the submission fee is £100 per paper, the overhead is 120%, the profit margin is 10% and the rejection rate 10%, subscription prices range from £6.58 to £657.71 for 20 000 to 200 subscriptions sold respectively. If 500 subscriptions are sold the price is £263.08, if

1000 subscriptions are sold, £131.54, and if 2000 subscriptions are sold the price is £65.77.

If the submission fee is £100 per paper, the overhead is 120%, the profit margin is zero and the rejection rate 10%, subscription prices range from £5.98 to £597.92 for 20 000 to 200 subscriptions sold respectively. If 500 subscriptions are sold the price is £80.12, if 1000 subscriptions are sold, £40.06, and if 1000 subscriptions are sold the price is £59.79.

If the submission fee is £100 per paper, the overhead is reduced to 60%, the profit margin is 20% and the rejection rate 10%, subscription prices range from £4.97 to £496.70 for 20 000 to 200 subscriptions sold respectively. If 500 subscriptions are sold the price is £198.68, if 1000 subscriptions are sold, £99.34, and if 2000 subscriptions are sold the price is £49.67.

If the submission fee is £100 per paper, the overhead is reduced to 60%, the profit margin is 10% and the rejection rate 10%, subscription prices range from £4.55 to £455.30 for 20 000 to 200 subscriptions sold respectively. If 500 subscriptions are sold the price is £182.12, if 1000 subscriptions are sold, £91.06, and if 2000 subscriptions are sold the price is £45.53.

If the submission fee is £100 per paper, the overhead is reduced to 60%, the profit margin is 0% and the rejection rate 10%, subscription prices range from £4.14 to £413.91 for 20 000 to 200 subscriptions sold respectively. If 500 subscriptions are sold the price is £165.56, if 1000 subscriptions are sold, £82.78, and if 2000 subscriptions are sold the price is £41.39.

It is clear that if the rejection rate is low, i.e. close to those common in the pure sciences, it would be possible to recover full costs (i.e. 120% overhead) and make a modest profit (i.e. 10%) by charging a submission fee of only £100 whilst reducing subscription fees well below the current level. If these conditions applied, then with a subscription base of 500–1000 a publisher could afford to set the subscription fee at £131-£263. A larger subscription base would reduce the price.

When the rejection rate is much higher, i.e. close to those common in humanities subjects, both the submission fee and the subscription fee can be lower. If the overhead rate applied is 120%, the profit margin is 20% and the rejection rate is 90% then a submission fee of £200 would more than cover the costs so no subscription fee need be charged.

If the submission fee is £100 per paper, the overhead is 120% the profit margin is 20% and the rejection rate 80%, subscription prices range from £1.74 to £174.28 for 20 000 to 200 subscriptions sold respectively. If 500 subscriptions are sold the price is £69.72, if 1000 subscriptions are sold, £34.86, and if 2000 subscriptions are sold the price is £17.43. An even lower submission fee may be preferable however, given that an author has an 80% chance of having her paper rejected and may need to pay another fee to submit the paper for publication in another journal.

If the submission fee is £50 per paper, the overhead is 120%, the profit margin is 20% and the rejection rate 80%, subscription prices range from £3.82 to £381.55 for 20 000 to 200 subscriptions sold respectively. If 500 subscriptions are sold the price is £152.62, if 1000 subscriptions are sold, £76.31, and if 2000 subscriptions are sold the price is £38.15.

If the submission fee is £50 per paper, the overhead is 120%, the profit margin is reduced to 10% and the rejection rate 80%, subscription prices range from £3.50 to £349.75 for 20 000 to 200 subscriptions sold respectively. If 500 subscriptions are sold the price is £139.90, if 1000 subscriptions are sold, £69.95, and if 2000 subscriptions are sold the price is £34.98.

At a 90% rejection rate, if the submission fee is £50 per paper, the overhead is 120%, the profit margin is 20%, subscription prices range from £1.74 to £174.28 for 20 000 to 200 subscriptions sold respectively. If 500 subscriptions are sold the price is £69.72, if 1000 subscriptions are sold, £34.86, and if 2000 subscriptions are sold the price is £17.43.

At a 90% rejection rate, if the submission fee is £50 per paper, the overhead is 120%, the profit margin is 10%, subscription prices range from £1.6 to £159.75 for 20 000 to 200 subscriptions sold respectively. If 500 subscriptions are sold the price is £63.90, if 1000 subscriptions are sold, £31.95, and if 2000 subscriptions are sold the price is £15.98.

It is clear that in disciplines with high rejection rates, i.e. close to those common in the humanities, it is possible to recover full costs (i.e. 120% overhead) and make a modest profit (i.e. 10%) by charging a submission fee of only £50 whilst reducing subscription fees well below the current level. If these conditions applied, then with a subscription base of 500–1000 a publisher could afford to set the subscription fee at £32–64. A larger subscription base would reduce the price. It is possible to reduce the submission fee even further if a higher subscription fee is acceptable. If the submission fee were £25 and the rejection rate 90% subscription fees could be set at £110.43 and £220.86 for 1000 and 500 subscriptions respectively. If the submission fee were £25 and the rejection rate 80% subscription fees could be set at £64.72 and £129.44 for 1000 and 500 subscriptions respectively.

4.1.5 Journal submission fees subscription fees

It is clear that the rate of overhead paid on production costs is more important than any modest profit margin. A journal recovering full costs is much more expensive than one that is subsidised by its host institution in the form of a reduced overhead on production costs regardless of whether it seeks to make a small profit or not. Nevertheless, although a reduction in costs predicted by Harnad and others is unlikely to be realised in an electronic environment, it is clear that prices of non-commercial journals which recover full costs (i.e. 120% overhead) and make a small profit (10%) can be sold at reasonable subscription prices as long as there is a subscription base of at least 500. A journal recovering costs through subscription only can sell 500 subscriptions at £148.43 and 1000 subscriptions at £74.22. A modest submission fee reduces the subscription fee even further.

4.1.6 Net benefit to libraries of negotiating licence terms with publishers

It is assumed that negotiation will be sufficient to secure a reduction in price of 10%. If a non-commercial journal recovering full costs and making a profit of 20% on a subscription base of 1000 costs £120.38 (exc. VAT), the library can expect to reduce the price to £108.34, a saving of £12.04. The cost of negotiating this saving would be £550. The net loss for the library is £537.96. Even for a journal costing 10 times as much as the one described above, i.e. £1203.80, the saving would be only £120.38 and the net loss would be £429.62.

It is clear that some rationalisation of negotiation activity is required. Consortia may find that they can efficiently negotiate licences on behalf of their members. It is beyond the scope of this project to investigate this. It is clear, however, that use of information brokers such as NESLI is very efficient. Furthermore, these organisations understand the business and have established relationships with all other parties, i.e. with libraries and

publishers. It is likely that in an electronic environment information brokers will continue to be useful to both libraries and publishers. It may be difficult for them to survive, however, if all journal prices are significantly reduced. At present, an information broker's income tends to be derived from publisher discounts. If prices are reduced and publisher operations are necessarily leaner, the current discount rate of 7% will be insufficient and the information broker may find it difficult to negotiate a viable rate.

4.2 Resource Discovery Network

This model is based on the eLib supporting study titled *Comparative Evaluation of the Subject Based Gateways Approach to Providing Access to Network Resources* (Haynes *et al.* 1998) and is informed also by the JISC Circular (JISC 10/98) which called for proposals for a Resource Discovery Network. The report explores a number of alternative models for the continuation of subject-based gateways and, finally, recommends one of those models. The selected model involves: (1) rationalisation of non-cataloguing tasks such as marketing and training; (2) employment of a Managing Director (MD) with responsibility for finding sponsors to fund SBGs; (3) and 50% matched funding from the JISC over a 3-year period. The report states that 'until a market for these services has been fully developed it will be difficult to predict the long-term viability of fully self-supporting services'. The model developed here explores the financial viability of a resource discovery network which is part-funded by the JISC or is self-supporting. The model consists of the RDN centre, the hubs and the RDN income.

4.2.1 Staff costs

All staff costs in the model include salary plus 20% for national insurance contributions (NIC) and pension payments, plus overhead. The overhead is not broken down into

accommodation, consumables, equipment etc. but the authors aim to reflect the true cost to the institution so overhead is calculated at 120% (V. Bruce, Vice Principal (Research), Stirling University, personal communication, August 1997). The authors are aware that some critics may argue that a lower rate would be applied by University Finance Departments so an alternative rate of 60% is applied and figures generated by the model on that basis are recorded.

4.2.2 The hubs

It is assumed that the RDN will consist of eight hubs. Development of these hubs will vary. Some of the hubs will be developed from existing subject-based gateways and thus, will have a database of catalogue records from Year 1. As existing Subject Based Gateways (SBGs) vary in size, the databases of hubs developed from SBGs will also vary in size. It is assumed that some hubs will be developed anew and thus will have no existing catalogue records.

The model developed by the authors would become overly complex if each of eight hubs were included. Thus, although equations within the model will generate figures for eight hubs, only three different-sized hubs are modelled. One is a new hub with no existing records. The second begins with 2000 records and thus corresponds with a small SBG such as RUDI or ADAM. The third begins with 7000 records, and thus corresponds with a large SBG such as SOSIG.

4.2.2.1 Hub income

It is assumed that each hub receives from the RDN a sufficient sum to employ one full-time individual who catalogues resources and develops and maintains the hub. This individual is paid within the range cited by Haynes et al., i.e. £16 000 - £23 000 (a mean figure of £19 500 each is used). Employment costs consist of a salary of £19 500 plus

20% NIC and pension payments, plus overhead. Thus, the total cost is either £37 440 or £51 480 if overhead is applied at a rate of 60% and 120% respectively.

In addition to funding an individual employee, the centre contributes start-up (SU) costs to any new hub at a rate of £20 000 in the first year.

It is assumed that each hub benefits from its own success in that is receives a percentage of the HE subscription income received by the RDN for access to that hub and it attracts more sponsorship. The latter is difficult to predict and to model because other variables will affect the likelihood that any specific hub receives sponsorship, e.g. it can be assumed that OMNI, like any other medical publishing outlets, is more likely to attract sponsors than an arts and humanities hub. The total sum required from sponsors for the whole RDN is calculated on an annual basis.

It is assumed that the hubs will invest their income in development. Thus, hubs that receive larger sums as a proportion of subscription income will develop at a faster rate than those that do not. Each hub passes 28% of its work to the RDN centre. The centre pays for hub employee and infrastructure costs and requires the bulk of any income to do so. It is assumed that although the centre uses a majority share of any income to pay for hub and centre costs, a percentage of subscription income is passed directly back to the hub to invest in development. It is estimated that 12% of current JISC spending on SBGs could be saved through rationalisation such as that represented in this model. It is assumed, arbitrarily, that 12% of the hub subscription income is returned directly to the hub to invest in development. The rest of the hub income is routed through the RDN centre which pays for hub employee and infrastructure costs.

The number of subscriptions to each type of hub in the model is a variable and is controlled by a slider. Subscription price varies from £100 for a database with 5000

records (those with fewer records are available free of charge) to a maximum of £500 for databases of 25000 records or more. The effect of doubling these prices is also explored. In reality subscription price may vary with institution size but, for example, the influences determining subscription numbers across different institution sizes are unknown so this additional complexity is not modelled.

4.2.2.2 *Hub spend*

Each hub spends its funds on development of the hub, on creating catalogue records and on maintenance of the database.

It is estimated that the cost of a record produced by an individual earning £16 000--£23 000 lies between £13.80 and £19, depending on the overhead rate applied. These figures were calculated as follows from information supplied by Haynes et al.: during a six-month study period, five SBG providers added between 350 and 3057 records to their databases and three of the five producers added between 948 and 1326. It is fair to assume that one provider added 350 records, one added 3057 records and each of the other three added ~ 1137 (i.e. ((948 + 1326)/2) x 3) records. Thus, the mean number of records added over the six-month period was 1363 ((350 + 3057 + (1137 x 3))/5). Thus, in one year, a provider may be expected to add 2726 records. It is assumed that an individual works for approximately 1628 hours per annum (52 weeks minus 8 weeks holiday at 37 hours per week). Thus, the individual produces 1.67 records per hour. Her hourly rate is calculated as follows: she is paid within the range cited by Haynes *et al*., i.e. £16 000–£23 000 (a mean figure of £19 500 each is used). Her employment cost, including NIC, pension contributions and overhead at a rate of 120% or 60% is £51 480 or £37 440 respectively. Thus, if she works for 1628 hours per annum, her hourly rate is £31.62 or £23 at overhead rates of 120% or 60% respectively. If she produces 1.67 records per hour, the cost per record is £19 or £13.80.

Gateway development costs are assumed to amount to 10% of one full-time employee per annum per hub.

Haynes *et al.* estimate that as much as 30% of the time of a hub employee will be spent maintaining current records. Presumably, this is based on the SBGs at the time of the study and thus, it must be based on databases of approximately 2000–7000 records. As 30% is cited as a high figure, it is assumed that 30% time relates to a larger database of e.g. 7000 records. This rate is divided to generate an indication of how many records could be maintained per 1% of an individual's time. The result is that 233 records (7000/30) can be maintained per 1% of a hub employee's time. This figure is used to relate directly the employee's time spent on maintenance to the number of records in the hub database.

4.2.3 RDN Centre

The RDN centre is modelled as a budget which has four outgoing flows and one incoming flow. The outgoing flows represent RDN staff costs, RDN infrastructure costs, hub income, and Managing Director salary and bonuses. The incoming flow represents RDN funds and is informed by two converters: non-grant funds and JISC funds. The former consists of HE subscription income and of sponsorship and the latter consists of JISC start-up funds plus and ongoing allowance as described by Haynes *et al.* However, the JISC will probably not continue grant-funding this enterprise indefinitely, so simulations were run also on the assumption that the JISC provides start-up funding over the first four years as described by Haynes *et al.* , but that there was no further funding beyond that period.

The element in the model determining the number of subscriptions represents the number of subscriptions per hub and is controlled by a slider. The model represents only three

hubs but model elements representing the financial figures for the system are based on the existence of eight hubs. Thus, figures calculated for, e.g. sponsorship income required, refer to an RDN with eight hubs.

Subscriptions income is determined by the subscription price of each type of hub multiplied by the number of subscriptions. Total subscription funding from the three hubs is multiplied by 8/3 to generate the total figure paid to the centre for subscriptions to eight hubs.

It is difficult to predict uptake. There are 174 HEIs in the UK. However, the subject area covered by some hubs will not be relevant at many of these institutions. Uptake of JISC datasets varies from 23 to 131 subscription according to the dataset (figures based on JISC 1997) and most commonly falls between 30 and 50. Price is not the only factor affecting uptake. Many institutions do not subscribe to datasets even when they are free of charge (JISC 1997). The effect of varying uptake is explored but the authors acknowledge that subscription may not be a viable income stream for the RDN. The financial effect of relying more heavily on sponsorship is explored as is the effect of varying subscription rates from 30 up to 120 per hub.

It was assumed that sponsorship would not be received until Year 2. The MD will spend Year 1 seeking sponsorship. The converter representing funding from 'sponsorship' is a slider which is varied to monitor the effect during model simulations. Sponsorship income attracted by the three hubs is multiplied by 8/3 to reflect the income derived from eight hubs of varying sizes.

The JISC contributes £950 000 in Year 1. This represents current spending on SBGs, plus £50 000 for a Managing Director, plus £50 000 for managing change. In Year 2, this is reduced to £650 000. This reflects a saving of £100 000 as a result of rationalisation, a

reduction in the cost of managing change to £30 000 a reduction in the MD's salary to £25 000 but with an additional marketing bonus of £10 000. It is assumed that the MD will have attracted matched funding, i.e. non-grant of £165 000. In Year 3, the JISC contribution is reduced by £265 000 to £385 000. Matched funding is assumed to have increased by £215 000 to £380 000 while the saving from rationalisation has remained at £100 000. The MD's bonus has increased by £5000 to £15 000 but she no longer receives a salary from the JISC which saves £25 000 and funds for managing change are no longer contributed by the JISC which saves £30 000. In Year 4, JISC funding is reduced by a further £15 000 to £370 000 as the JISC will no longer contribute a marketing bonus. This is the sum contributed by the JISC in all future years but the assumption that JISC funding is withdrawn entirely after 3 years is also tested.

RDN costs include staff costs, infrastructure and hub income. (Haynes *et al* 1998) suggested that rationalisation of certain aspects of the work of subject-based gateways could save £100 000 from a budget of £850 000. This is a 12% saving. Such a saving would be achieved were each hub to pass 28% of its work to the centre and for the work to be undertaken by two full-time employees. RDN salaries are the salaries of these two individuals. It is assumed that they each earn salaries in the same range as the hub employees who catalogue resources, i.e. £16 000–£23 000 (a mean figure of £19 500 each is used). A further 20% is added to reflect NIC and pension payments (£23 400 each) and overhead is calculated at 120% (total £51 480 each) and 60% (£37 440).

As there is no breakdown of costs in Haynes *et al.*'s report the cost of infrastructure is unclear. In the model, it was assumed that the RDN centre meets infrastructure costs at a rate of 25% of all staff costs. The latter includes hub employee costs, RDN staff costs and MD costs. Hub income consists of 12% of subscriptions income (see above), plus the cost of employing an individual for each of eight hubs, plus start-up costs for the new

hubs. As there are only three hubs in the model, it is assumed that 8/3 of the eight hubs is a start-up hub.

Haynes *et al.*'s report suggests that the MD should be employed for 18 months and that she would cost £50 000 in Year 1 and £25 000 in Year 2. Employment costs of £50 000 would pay a salary of approximately £19 000 or £26 000 assuming that the employment cost also covers NIC and pension contributions (20% of salary) and that overhead is applied at a rate of 120% or 60% respectively. Haynes *et al.* state that 'we envisage a package with a competitive salary for 18 months and additional incentives in the form of a bonus based on the level of matched funding obtained and payable in the two years after the funding has been secured'. As the model is based on the Haynes *et al.* report, the effect of paying the MD at that rate is explored. However, the authors of this report would suggest that an MD of the calibre required would expect to be paid at least double that rate and more probably, would expect a salary of around £60 000. The effect of paying the MD a basic salary of £60 000 is explored. The total cost of such a salary including 20% for NIC and pension contribution would be either £115 200 or £158 400 if overheads are applied at 60% or 120% respectively.

Haynes *et al.* propose that the MD would receive a bonus of £15 000 in Year 2 for attracting matched funding of £380 000. This corresponds to a bonus of 4% of non-grant funding. Thus, it is assumed that the MD receives an annual bonus of 4% of non-grant funding.

4.2.4 Model simulations

It is assumed in these model simulations that the RDN is expected to be self sustaining within 10 years of starting up. Thus, the RDN budget must always be in the black and, before the end of the 10-year period, the RDN must make a surplus, however small. The simulations were run with a view to determining the level of sponsorship required if the

RDN is to be viable. The sponsorship required is rounded up to the nearest hundred pounds.

Table 1 documents the results of the model simulations by listing the level of sponsorship required in each instance. Simulations include those that assume that the JISC continues to fund the RDN at a rate of £370 000 per annum after the initial 3-year period when higher sums are granted, and those that assume that JISC funding ends after the initial 3-year period. The subscription price of resources from each hub varies as described above and two rates of prices are tested: those that begin at £100 for a database of 5000 records and increase to £500 for a database of 25 000 records or more and those that begin at £200 for a database of 5000 records and increase to £1000 for a database of 25 000 records or more. The other variable is the MD's salary. Either she earns £60 000 and overhead is applied at a rate of 120% or 60% or she costs £50 000. If the latter, her salary is £19 000 or £26 000 at overhead rates of 120% and 60% respectively. Simulations are run assuming that the following number of subscriptions is secured per hub: 0, 30, 50, 70, and 120.

Table 1: Sponsorship required for the RDN to break even within a 10-year period. Where no sponsorship is required the year in which the RDN breaks even is indicated in parentheses, e.g. Y7 indicates that this occurs in year 7 after the initial 3-year grant-funded period.

	Number of subscriptions				
	0	**30**	**50**	**70**	**120**
	Sponsorship required (£)				
JISC funded after 3 years					
Sub price ranges £100–£500					
MD earns £60K, o/h 120%	424 100	361 200	319 200	277 300	172 500
MD earns £60K, o/h 60%	202 200	139 300	97 400	55 400	0 (Y8)
MD costs £50K, o/h 120%	281 400	218 500	176 600	134 700	29 800

MD costs £50K, o/h 60%	116 400	53 500	11 600	0 (Y8)	0(Y3)
Sub price ranges £200–£1000					
MD earns £60K, o/h 120%	424 100	298 300	214 400	130 500	0 (Y7)
MD earns £60K, o/h 60%	202 200	76 400	0 (Y8)	0 (Y5)	0 (Y1)
MD costs £50K, o/h 120%	281 400	155 600	71 800	0 (Y8)	0 (Y1)
MD costs £50K, o/h 60%	116 400	0 (Y9)	0 (Y4)	0 (Y1)	0 (Y1)
Non-JISC funded after 3 years					
Sub price ranges £100–£500					
MD earns £60K, o/h 120%	813 600	750 700	708 700	666 800	561 900
MD earns £60K, o/h 60%	591 700	528 800	486 800	444 900	340 100
MD costs £50K, o/h 120%	670 900	608 000	566 100	524 200	419 300
MD costs £50K, o/h 60%	505 900	443 000	401 100	359 100	254 300
Sub price ranges £200–£1000					
MD earns £60K, o/h 120%	813 600	687 700	603 900	520 000	310 300
MD earns £60K, o/h 60%	591 700	465 900	382 000	298 100	32 900
MD costs £50K, o/h 120%	670 900	545 100	461 200	377 400	167 700
MD costs £50K, o/h 60%	505 900	380 400	296 600	212 700	0 (Y9)

These figures are encouraging. Haynes *et al.* suggest that matched funding, i.e. sponsorship, could be secured at a rate of £365 000 within 4 years. If the JISC continues to fund the RDN beyond the initial 3-year period, all but the most expensive alternative modelled here would be sustained by sponsorship of less than £281 000. The most expensive alternative would be sustainable for £361 000 if it could also secure a modest income from subscriptions. If JISC funding ends, the RDN will be required to attract much more funding from sponsors. Sale of subscriptions is considered by the authors to be viable as a constituent income source. However, if RDN resources are restricted to the UK HE community, this source will be limited and must be complemented by other sources such as sponsorship. In this model, as in the others, variation in the overhead rate applied to staff costs has a marked effect. Clearly, staff are a very expensive resources. Nevertheless, if an HEI hosts an initiative such as the RDN and fails to recover full

costs, it effectively subsidises the RDN activity. In the present climate, few HEIs can afford to do this.

4.3 National Electronic Reserve Service (NERS)

The model of a national electronic reserve service is based on information and assumptions about the HERON project and is informed by an eLib supporting study of ODP/ER services (Halliday *et al* 1998) and by cost and charge developments such as those published by the CLA and the PLS. Figures cited here are for a NERS which has migrated from grant-funded status. It is assumed that development during the project phase lasted for 3 years.

Three functions of the NERS are represented: copyright clearance, digitisation, and the repository function. It is assumed that course materials change every 4 years (Halliday *et al* 1998) i.e. that there is an annual change of 25%. Thus, in a print environment publishers could expect libraries to have replaced all books for a class by the end of every 4-year period. This should be a basis for comparison of publisher income in a print environment and in an electronic environment such as the one modelled here.
Costs are not inflated over the 13-year period.

4.3.1 Copyright clearance

The copyright clearance procedure in the model has been simplified. For example, where an item selected by a lecturer cannot be used because copyright permission cannot be obtained, the reserve service would be required to liaise with the lecturer to select an alternative. This process is not represented. Instead, it is assumed that ultimately, if a list of 14 items is selected by a lecturer, then the ER service will provide the lecturer with 14 items. Furthermore, although the lead time between receipt of lists of items by the library

and the availability of an item in the reserve collection may be longer in an electronic environment due to the time required to clear copyright this would have no financial effect and so is not included in the model.

In the Ithink model described here, the number of items for which copyright permission is required is represented by the flow element 'clearance'. This is defined as the number of items in a class multiplied by the number of classes. The average size of a reading list supplied to the library at Stirling University in 1997 was 15 items (Halliday *et al* 1998). Presumably, there is a degree of overlap between courses especially those in the same department. This is reflected by a reduction in the average list size of one item thus reducing list size to 14. The number of classes is variable and is manipulated by a slider.

The cost of providing a class with materials included in the NERS is determined by the cost of obtaining copyright permissions, the frequency with which a course changes, and the ratio of 'library substitution' to 'text substitution' materials on a reading list. When seeking copyright permission the Copyright Officer sends details of items required to the relevant Reprographic Rights Organisation (RROs; e.g. CLA in UK or CCC in USA). She receives permission from the RRO and forwards details to the NERS digitisation staff. The RRO will not have a mandate from all publishers and so the NERS will be required to seek some permissions directly from publishers. When the NERS first approaches a publisher the parties negotiate licence terms. This is a skilled task and costs more than a straightforward request from an RRO. However, the number of negotiations per list received reduces as the content of the repository increases because the NERS already has agreements with some publishers and can readily identify other publishers which are unwilling to grant permission for digitisation and electronic delivery.

It is assumed that only 10% of requests require negotiation and thus the skills of a more expensive staff member. It is estimated that negotiation takes approximately 3.25 hours work. This includes identification of the rights holder (15 minutes) and negotiation (3 hours) (Halliday *et al* 1998). A negotiation such as this will cost £133 or £99 if overhead is applied at a rate of 120% and 60% respectively. This cost is based on a full-time negotiator on a salary of £25K for whom national insurance contributions and employer pension contributions cost an additional 20%, i.e. £5000. The total cost to the employer is £66 000 if overhead is applied at 120% and £48 000 if overhead is applied at a rate of 60%. If the negotiator is given 8 week's holiday, and works for 37 hours per week, her hourly rate is £41 or £29 if overhead is applied at a rate of 120% or 60% respectively. Thus, a negotiation lasting a total of 3 hours and 15 minutes costs £133 or £99 if overhead is applied at a rate of 120% or 60% respectively.

The cost of processing a request that can be granted by an RRO is estimated as £2 or £1.50 if overhead is applied at a rate of 120% or 60% respectively. It is estimated that an individual can process 12 requests (including receipt and processing of the permission) in 1 hour. If the individual processing these requests earns £15 000 per annum and the employer pays an additional 20% in national insurance and pension contributions plus overhead at a rate of 120% or 60%, the total cost is £39 600 or £28800 respectively. If the individual is given 8 week's holiday, and works for 37 hours per week, her hourly rate is £24 or £18 at overhead rates of 120% and 60% respectively. Thus, the cost of processing a single request is £2 or £1.50.

The average cost for a permission is calculated based on the premise that 9 out of 10 permissions are secured from the RRO and one out of ten requests requires negotiation. Thus, the total cost of 10 permissions is £151 (2 £2 x 9 + £133) or £113 (£1.50 x 9 + £99) if overhead is applied at a rate of 120% or 60% respectively and, for one permission, it is

£15 (£151/10) or £11 (£113/10). This is reduced by 1% for every 1000 items added to the repository to reflect the reduction in the number of negotiations required as the stock of publisher agreements grows.

4.3.1.1 *'Pricing mechanism: Text substitution' vs 'library substitution' models*

The cost to a library of providing electronic reserve materials for a class will be determined largely by the ratio of 'text substitution' materials to 'library substitution' materials required as the former are much more expensive than the latter. 'Text substitution' is a pricing model for high-use materials and 'library substitution' is intended for materials that would be used for further reading (Bide *et al.* 1997). Clearly, as a reserve collection is effectively a means of rationing access to high-demand materials, the prevailing model in an electronic reserve collection is likely to be the 'text substitution' model. Any item not required by large numbers of students at the same time is likely to be placed on open shelves. In a print environment, materials in a reserve collection tend to be borrowed, photocopied and returned within a short period as the loan period is often too short to allow a student to read the item. In an electronic environment, high-demand materials made available electronically can be printed by each student. However, publishers wish fair compensation for this type of use as they consider it a threat to their core business, i.e. text sales. In the 'text substitution' model copyright fees are charged based on numbers of students in a class rather than on use. This model, referred to as the 'Bookshop Material' model by the Publishers Licensing Society is the default for publishers mandating the PLS to license their copyright material through the Copyright Licensing Agency (CLA) (PLS 1999). As very few items will be read by all students in a class, this is likely to be a very inefficient way for a library to provide reading materials to users. The 'library substitution' model proposed by (Bide *et al* 1997) and described in the CLA Higher Education Digitisation White Paper (CLA 1998)

requires the library to pay a one-off fee to the publisher for unlimited use of the material. The model referred to by the Publishers Licensing Society (PLS 1999) as the 'Library Materials' model is based on the 'library substitution' model but restricts the license to a period of five years rather than granting it in perpetuity.

The difficulty of establishing a fair rate for 'library substitution' fees makes this a difficult model to adopt. In the Ithink model described here it is assumed that 'library substitution' prices will be pitched at a level that compensates for loss of library sales. For the purpose of the model, a mean figure of £29.40 is adopted for all 'library substitution' materials. This figure is based on an estimate of the number of copies of a text that any library would buy to provide for an average class. In 1997, among six universities participating in an eLib supporting study on the impact of electronic reserve services on teaching, students and libraries found that most of the libraries have 'no formal policy dictating that a specific number of copies of a high-demand text should be purchases for every student in a class. One of the libraries holds a copy per 25 students in the reserve collection while one of the larger libraries with a smaller space available for reserve materials, and supplying much larger classes, aims to hold approximately one copy per 100 students.' (Halliday *et al* 1998). For the purposes of this model, it was assumed that the library holds seven copies of each title in its print reserve collection. This figure is the mean of the 6–8 copies held by many libraries and, at the library which provides one copy per 25 students, it would provide for a class of 175 students. It was assumed that a standard text costs approximately £30. This is lower than the average cost of an academic book; £41 in 1997/98 (LISU 1998). However, since academic books include monographs and texts, the latter is likely to be less expensive than the average of both.

If the electronic text were to substitute for the sale of seven copies and thus the licence were to be set at a price that compensates for those lost sales, the price per title would be £210. However, as a printed text is estimated to cost £30 and the publisher is not required to incur print and distribution fees for ER use of the material, this figure is reduced by 30% to £147. The electronic reserve collection is likely to require extracts rather than whole books. It is assumed that an extract typically consists of 20 pages, i.e. 10% of a 200-page book. It is reasonable to assume that on a page-for-page basis, an extract would be more expensive than a whole book as the publisher's risk is increased. For the purposes of the model, it is assumed that an extract is charged at 20% of the £147 referred to above, i.e. an extract of 10% of the whole title, charged at double the price of the whole work. Thus, each extract costs £29.40.

4.3.2 Digitisation

In the model, the NERS digitises every item which is not already held in the digital repository and for which copyright has been cleared. Every item that has been digitised is then stored in the repository. It is assumed that a lecturer selecting materials for her class will be supplied with details of materials held in the repository and will select any available materials that suit her requirements. The degree to which requested items duplicate those held in the repository is an important variable in the model and may determine its success as the rationale behind a NERS is that economies of scale may be realised in the digitisation and copyright clearance functions. The total cost of a digitised item includes the cost of acquiring a legitimate, clean original and the cost of capturing the material in digital form. The cost of a clean original scanned and supplied to the NERS by the British Library Document Supply Service and the copyright fee required by BLDSS for each scanned item supplied is £14 plus VAT (£16.45). The cost of capturing pages in the manner described by the eCLA in their Higher Education Digitisation White

Paper (CLA 1998) varies. The HERON project has been quoted a figure of 15 pence per page (G. Pitcher, personal communication, 29 March 1999). It is assumed that a typical extract consists of 20 pages (as above).

4.3.3 Repository

The repository function is related to a single institution. The cost to an institution for this function is related to the number of items that the institution has placed in the repository. The figures supplied here refer to the post grant-funded period when the repository will already contain resources gathered over the 3-year grant-funded period. Clearly, overlap between institutions with regard to the material required will reduce costs. Research on overlap in reading lists in UK HEIs is limited but suggests that overlap is low (Halliday *et al* 1998). Nevertheless, it is assumed that academics will have access to the contents of the repository when compiling reading lists and that they will in a small proportion of cases select items already held in the repository if these suit their teaching purposes.   It is reasonable to assume that the resulting duplication of use of a single item (hereinafter simply referred to as "duplication") will increase as the number of items in the repository grows. In the model, duplication between items requested and items in the repository was varied and the results are documented below. Three different patterns of duplication were tested. The first pattern assumes that duplication between requests and materials held in the repository occurs at a rate of 0.5% in the first project year and increases by 0.5% per annum. Thus, in the first post-project year, duplication occurs at a rate of 2%.

In the second pattern, duplication occurs at a rate of 0.5% in the first project year and this figure increases by 50% beyond each year. Thus, in the second year there is 0.75% duplication, and in the first post-project year, duplication occurs at a rate of 1.69%.

In the third pattern, duplication occurs at a rate of 1% in the first project year and increases arithmetically at a rate of 1% per annum, i.e. duplication is 2% in year 2, 3% in year 3 and so on. The authors of this report consider the first scenario to be the most realistic. Duplication would be efficient in economic terms, and if suitable materials are available lecturers will select them. Nevertheless, the degree of overlap between courses throughout the country is believed to be very low at present. Furthermore, academic freedom and the individual character of courses offered is an issue. The authors doubt that lecturers will select more than one or two items from a repository of existing materials and will prefer to select the items they think are best for their students, whether or not already held in a repository.

High duplication would obviously produce cost savings. The more material lecturers use that is already available in machine readable form and copyright cleared, the more efficient the system would be in economic terms. Of course, this requires that suitable materials are available; only then will lecturers select them. Nevertheless, we believe the degree of duplication between courses throughout the country is very low at present. Furthermore, academic freedom and the individual character of courses offered are relevant issues. We therefore doubt that lecturers will select more than one or two items from a repository of existing machine readable copyright cleared materials, and will in general prefer to select the items they think most suit their students, even if such materials are not in the repository yet.   However, in the absence of clear data regarding the current rate of duplication, our models can only be tentative at this stage.

The cost of storing a single item in the repository is estimated at £1.27. This is based on figures supplied for the JSTOR project (Guthrie 1997). JSTOR estimate that $2.5M is required for storage, maintenance and technical migration of a database consisting of backruns of 100 journal titles. Assuming that backruns consist of 100 years and that the

average journal volume consists of 120 papers, this is $2.5M for 1 200 000 items, which divides as $2.08 (£1.27) per item. It is assumed here that an average journal paper is approximately equal to an average volume of text held by the NERS.

4.3.4 Staffing the NERS

It is beyond the scope of this project to explore and compare the costs of staffing a traditional and an electronic reserve service but the cost of the latter is estimated. Anecdotal evidence from those operating ER services (generally in the US) suggests that electronic reserve services require more staff than traditional services (see the archives of the electronic mailing list arl-ereserve@arl.org at http://www.cni.org/Hforums/arl-ereserve/). The negotiation and copyright clearance function has been included in the model but not additional computing costs such as troubleshooting network printer problems have not. An ER service such as HERON will have considerable staffing costs beyond the Copyright Officer. As these cannot be directly related to specific elements of the model and as they would be covered by all subscribing institutions rather than the single institution represented in the model it is assumed that staffing costs would be covered by the annual access fee.   The HERON service employs, in addition to the Copyright Officer, a Technical Manager, a Marketing Officer, a part-time Project Co-ordinator, and a part-time secretary. The estimated cost of this body of staff is presented in Tables 1a and 1b. Costs include salary payments, NIC and pension contributions plus overhead. The overhead is not broken down into accommodation, consumables, equipment etc. but the authors aim to reflect the true cost to the institution so overhead is calculated at 120% (V. Bruce, Vice Principal (Research), Stirling University, personal communication, August 1997). The authors are aware that some critics may argue that a lower rate would be applied by University Finance Departments so an alternative rate of

60% is applied to generate and the results are recorded. A rough estimate of the staffing costs is presented in Table 1.

Table 1a: estimated staffing costs for an ER service (overhead rate of 120%).

Post	Salary (estimate)	NIC and Pension	Overhead @ 120%	Total
Technical Manager	£25 000	£5000	£36 000	£66 000
Project Co-ordinator	£25 000 (50% time)	£2500	£18 000	£33 000
Marketing Officer	£19 500	£3900	£28 080	£51 480
Secretary	£14 000 (50% time)	£1400	£10 080	£18 480
Total	*£64000*	*£12 800*	*£92 160*	*£168 960*

Table 1b: estimated staffing costs for an ER service (overhead rate of 60%).

Post	Salary (estimate)	NIC and pension	Overhead @ 60%	Total
Technical Manager	£25 000	£5000	£18 000	£48 000
Project Co-ordinator	£25 000 (50% time)	£2500	£9000	£24 000
Marketing Officer	£19 500	£3900	£14 040	£37 440
Secretary	£14 000 (50% time)	£1400	£5040	£13 440
Total	*£64000*	*£12 800*	*£46 080*	*£122 880*

If these staff costs (not including Copyright Officer) were to be recovered through the annual access fee, at a mean fee of £1200, 141 or 102 subscribers respectively would be required where overhead is applied at 120% and 60% respectively. At a fee of £1500, 113 or 82 subscribers respectively would be required where overhead is applied at 120% and 60% respectively. The model includes an annual access fee of £1200 to cover staff costs.

4.3.5 Role of booksellers in the provision of high-demand reading materials

The effect of the introduction of ER on booksellers is not explored in this model. Clearly, the interests of booksellers are closely tied to those of publishers. Students buy

their texts through the bookseller and thus, library provision on a 'text substitution' basis is a threat as it bypasses the bookseller. The bookseller is threatened by a 'library substitution' model only if the library acquires print texts from the bookseller. A comparator print model would reveal the extent to which booksellers would lose as a result of libraries delivering 'text substitution' materials through an ER service. It is beyond the scope of this project to explore such a model.

4.3.6 Comparing cost of content for print and electronic reserve collections

An example of the level of funding made available within the library to provide a print reserve collection at a Scottish University was detailed in a recent eLib supporting study (Halliday *et al* 1998). At Stirling University, 1440 books were purchased every year for the short loan collection at a cost of £28 800. The collection was expected to provide access to high-demand materials for 5544 students. This represents £5.19 per student per annum. This is a useful comparator for the figures generated during model simulations.

In the model, the number of classes affects the total cost of resources by determining the total number of items digitised and stored in the repository, i.e. 14 per class. As student numbers per class decrease, the cost per student of digitising and storing materials for that class increases. If the number of students remains the same, a change in the number of classes affects copyright costs only for 'library substitution' materials. The NERS incurs a copyright fee per page per student for 'text substitution' materials so the copyright fee per class depends not on the number of titles but on the total number of pages per student.

The cost of storage to be shared between institutions participating in the ER scheme will increase every year as more items are added to the repository. In a print reserve collection materials are weeded as well as added to the collection but the NERS is responsible for storing digital copy of items used by HEIs to prevent re-digitisation of

122

materials. It would be interesting to monitor the percentage of items in the HERON repository that are reused and to determine whether redigitisation might be more efficient than long-term storage of a large collection much of which may never be reused.

The effect of varying the ratio of items on reading lists that are categorised as 'text substitution' and those categorised as 'library substitution' is explored. One of the scenarios explored is intended to be compared with the Stirling University print reserve collection referred to above which services 5544 students for a book spend of £28 800 (£5.19 per student). If Stirling University meets the needs of 5544 students, divided into 28 classes of 198, by spending £28 800 on books, the book trade receives £28 800. An ER system such as the one modelled here and providing material to 5544 students (divided into 28 classes of 198) would generate publisher income of £36 739 if all of the materials in each 14-item list were categorised as 'text substitution'. Thus, without incurring the cost of print and distribution, the publisher would actually increase her income. The figure would fall below the print receipt only at 70% 'text substitution'.

4.3.7 Model simulations

4.3.7.1 100% text substitution

4.3.7.1.1 OVERHEAD ON STAFF COSTS APPLIED AT 120%

In the model, assuming that the ER collection consists of 14 items per class, there are 100 classes, and duplication occurs at the default rate of 0.5% in year 1 increasing at 0.5% per annum thereafter, spend per student in a class of 50 ranges from £27.38 to £30.17 in (post grant-funded) years 1 to 10 respectively. Spend per student in a class of 200 ranges from £19.18 to £19.88 in years 1 to 10 and spend per student in a class of 400 ranges from £17.82 to £18.16 in years 1 to 10.

If there are 400 classes, spend per student in a class of 50 ranges from £27.33 to £30.02 in years 1 to 10. Spend per student in a class of 200 ranges from £19.17 to £19.84 in years 1 to 10. Spend per student in a class of 400 ranges from £17.81 to £18.15 in years 1 to 10.

4.3.7.1.2 OVERHEAD ON STAFF COSTS APPLIED AT 60%

In the model, assuming that the ER collection consists of 14 items per class, there are 100 classes, and duplication occurs at the default rate, spend per student in a class of 50 ranges from £26.26 to £29.05 in (post grant-funded) years 1 to 10 respectively. Spend per student in a class of 200 ranges from £18.90 to £19.60 in years 1 to 10 and spend per student in a class of 400 ranges from £17.68 to £18.02 in years 1 to 10.

If there are 400 classes, spend per student in a class of 50 ranges from £26.21 to £28.90 in years 1 to 10. Spend per student in a class of 200 ranges from £18.59 to £19.56 in years 1 to 10. Spend per student in a class of 400 ranges from £17.67 to £18.01 in years 1 to 10.

4.3.7.2 90% text substitution to library substitution

4.3.7.2.1 OVERHEAD ON STAFF COSTS APPLIED AT 120%

If 90% of items in each 14-item list are categorised as 'text substitution' and the other 10% as 'library substitution', if there are 100 classes and duplication occurs at the default rate then in a class of 50 students, the spend per student ranges from £25.98 to £28.76 in years 1 to 10. In a class of 200 students, spend per student ranges from £17.60 to £18.29 in years 1 to 10. In a class of 400 students, spend per student ranges from £16.20 to £16.55 in years 1 to 10.

If there are 400 classes, spend per student in a class of 50 would range from £25.93 to £28.62 in years 1 to 10. In a class of 200 students, spend per student would range from £17.59 to £18.26 in years 1 to 10. In a class of 400 students, spend per student would range from £16.20 to £16.55 in years 1 to 10.

4.3.7.2.2 OVERHEAD ON STAFF COSTS APPLIED AT 60%

If 90% of items in each 14-item list are categorised as 'text substitution' and the other 10% as 'library substitution', if there are 100 classes and duplication occurs at the default rate, spend per student in a class of 50 would range from £24.86 to £27.64 in years 1 to 10. In a class of 200 students, spend per student would range from £17.32 to £18.01 in years 1 to 10. In a class of 400 students, spend per student would range from £16.06 to £16.41 in years 1 to 10.

If there are 400 classes then in a class of 50 students, the spend per student ranges from £24.81 to £27.50 in years 1 to 10. In a class of 200 students, spend per student ranges from £17.31 to £17.98 in years 1 to 10. In a class of 400 students, spend per student ranges from £16.06 to £16.39 in years 1 to 10.

4.3.7.3 50% text substitution to library substitution

4.3.7.3.1 OVERHEAD ON STAFF COSTS APPLIED AT 120%

If 50% of the items on each 14-item list are categorised as 'text substitution' and the other 50% as 'library substitution', there are 100 classes and duplication occurs at the default rate, in a class of 50, spend per student would range from £20.36 to £23.15 in years 1 to 10. In a class of 200, spend per student would range from £11.26 to £11.96 in years 1 to 10. In a class of 400, spend per student would range from £9.74 to £10.09 in years 1 to 10.

If there were 400 classes, in a class of 50, spend per student would range from £20.32 to £23.00 in years 1 to 10. In a class of 200 students, spend per student would range from £11.25 to £11.92 in years 1 to 10. In a class of 400 students, spend per student would range from £9.74 to £10.07 in years 1 to 10.

4.3.7.3.2 OVERHEAD ON STAFF COSTS APPLIED AT 60%

If 50% of the items on each 14-item list are categorised as 'text substitution' and the other 50% as 'library substitution', there are 100 classes, in a class of 50, spend per student ranges from £19.24 to £22.03 in years 1 to 10. In a class of 200, spend per student ranges from £10.98 to £11.68 in years 1 to 10. In a class of 400, spend per student ranges from £9.60 to £9.95 in years 1 to 10.

If there are 400 classes, in a class of 50, spend per student ranges from £19.20 to £21.88 in years 1 to 10. In a class of 200 students, spend per student ranges from £10.97 to £11.64 in years 1 to 10. In a class of 400 students, spend per student ranges from £9.60 to £9.93 in years 1 to 10.

4.3.7.4 10% text substitution to library substitution

4.3.7.4.1 OVERHEAD ON STAFF COSTS APPLIED AT 120%

If only 10% of items on each 14-item list are categorised as 'text substitution' and 90% as 'library substitution', there are 100 classes and duplication occurs at the default rate, spend per student in a class of 50 ranges from £14.75 to £17.54 in years 1 to 10. In a class of 200, spend per student ranges from £4.92 to £5.62 in years 1 to 10 and in a class of 400, spend per student ranges from £3.28 to £3.63 in years 1 to 10.

If there are 400 classes, in a class of 50 spend per student ranges from £14.70 to £17.39 in years 1 to 10. In a class of 200 spend per student ranges from £4.91 to £5.58 in years 1 to 10. In a class of 400, spend per student ranges from £3.28 to £3.61 in years 1 to 10.

4.3.7.4.2 OVERHEAD ON STAFF COSTS APPLIED AT 60%

If only 10% of items on each 14-item list are categorised as 'text substitution' and 90% as 'library substitution', there are 100 classes and duplication occurs at the default rate, spend per student in a class of 50 ranges from £13.63 to £16.42 in years 1 to 10. In a class of 200, spend per student ranges from £4.64 to £5.34 in years 1 to 10 and in a class of 400, spend per student ranges from £3.14 to £3.49 in years 1 to 10.

If there are 400 classes, in a class of 50 spend per student ranges from £13.58 to £16.27 in years 1 to 10. In a class of 200 spend per student ranges from £4.63 to £5.30 in years 1 to 10. In a class of 400, spend per student ranges from £3.14 to £3.47 in years 1 to 10.

4.3.7.5 0% 'text substitution' and 100% 'library substitution'

4.3.7.5.1 OVERHEAD ON STAFF COSTS APPLIED AT 120%

If all items on every 14-item list are categorised as 'library substitution', there are 100 classes and duplication occurs at the default rate, in a class of 50, spend per student ranges from £13.35 to £16.14 in years 1 to 10. In a class of 200, spend per student ranges from £3.34 to £4.03 in years 1 to 10. In a class of 400, spend per student ranges from £1.67 to £2.02 in years 1 to 10.

If there are 400 classes, in a class of 50, spend per student ranges from £13.30 to £15.99 in years 1 to 10. If there are 200 classes, spend per student ranges from £3.33 to £4.00 in years 1 to 10. If there are 400 students, spend per student ranges from £1.66 to £2.00 in years 1 to 10.

4.3.7.5.2 OVERHEAD ON STAFF COSTS APPLIED AT 60%

If all items on every 14-item list are categorised as 'library substitution', there are 100 classes and duplication occurs at the default rate, in a class of 50, spend per student ranges from £12.23 to £15.02 in years 1 to 10. In a class of 200, spend per student ranges from £3.06 to £3.75 in years 1 to 10. In a class of 400, spend per student ranges from £1.53 to £1.88 in years 1 to 10.

If there are 400 classes, in a class of 50, spend per student ranges from £12.18 to £14.87 in years 1 to 10. If there are 200 classes, spend per student ranges from £3.05 to £3.72 in years 1 to 10. If there are 400 students, spend per student ranges from £1.52 to £1.86 in years 1 to 10.

Thus, for a class of between 150 and 200 people, the cost to the library of supplying high-demand materials electronically only approaches current cost levels if the ratio of 'text substitution' to 'library substitution' materials on the reading list is as low as 1:9.

4.3.7.6 Additional simulations on an ER service designed to provide for a specific user-base

A variety of simulations were run using figures that correspond with those of a real print reserve service. The example used is the print reserve service at Stirling University as described in a recent eLib supporting study (Halliday *et al* 1998). This service spends £28 800 per annum to provide a print reserve collection for 5544 students. It is assumed that this total student number is divided into classes of ~200 (198 divides cleanly by 28 classes).

4.3.7.6.1 OVERHEAD IS APPLIED TO STAFF COSTS AT 120%

If 100% of items on a list are categorised as 'text substitution' the cost to the library ranges from £106 235 to £110185 in Years 1 to 10 respectively.

If 90% of items on a list are categorised as 'text substitution' and the remainder are categorised as 'library substitution' the cost to the library ranges from £97 453 to £101 404 in Years 1 to 10 respectively.

If 50% of items on a list are categorised as 'text substitution' and the remainder are categorised as 'library substitution' the cost to the library ranges from £62 328 to £66 279 in Years 1 to 10 respectively.

If 10% of items on a list are categorised as 'text substitution' and the remainder are categorised as 'library substitution' the cost to the library ranges from £27 203 to £31 153 in Years 1 to 10 respectively.

If 100% of items on a list are categorised as 'library substitution' the cost to the library ranges from £18 421 to £22 372 in Years 1 to 10 respectively.

4.3.7.6.2 OVERHEAD IS APPLIED TO STAFF COSTS AT 60%

If 100% of items on a list are categorised as 'text substitution' the cost to the library ranges from £104 667 to £108 617 in Years 1 to 10 respectively.

If 90% of items on a list are categorised as 'text substitution' and the remainder are categorised as 'library substitution' the cost to the library ranges from £95 885 to £99 836 in Years 1 to 10 respectively.

If 50% of items on a list are categorised as 'text substitution' and the remainder are categorised as 'library substitution' the cost to the library ranges from £60 760 to £64 711 in Years 1 to 10 respectively.

If 10% of items on a list are categorised as 'text substitution' and the remainder are categorised as 'library substitution' the cost to the library ranges from £25 635 to £29 585 in Years 1 to 10 respectively.

If 100% of items on a list are categorised as 'library substitution' the cost to the library ranges from £16 853 to £20 804 in Years 1 to 10 respectively.

4.3.7.6.3 VARYING THE RATE OF OCCURRENCE OF DUPLICATION BETWEEN LECTURER SELECTION AND CONTENT OF THE REPOSITORY

In each of the simulations described there are 28 classes of 198 students and each class is provided in electronic form with materials on a 14-item reading list.

4.3.7.6.3.1 *Default occurrence of duplication: 0.5% in Year 1, increasing annually by 0.5%*

If overhead is 120%, and all materials are categorised as 'text substitution', the cost per student ranges from £19.21 to £19. 92 in post-grant funded Years 1 to 10 respectively.

If overhead is 60%, and all materials are categorised as 'text substitution', the cost per student ranges from £18.93 to £19. 64 in post-grant funded Years 1 to 10 respectively.

If overhead is 120%, and the ratio of 'text substitution' to 'library substitution' materials on the reading list is 9:1, the cost per student ranges from £17.63 to £18.34 in post-grant funded Years 1 to 10 respectively.
If overhead is 60%, and the ratio of 'text substitution' to 'library substitution' materials on the reading list is 9:1, the cost per student ranges from £17.35 to £18.06 in post-grant funded Years 1 to 10 respectively.

If overhead is 120%, and the ratio of 'text substitution' to 'library substitution' materials on the reading list is 5:5, the cost per student ranges from £11.29 to £12.00 in post-grant funded Years 1 to 10 respectively.

If overhead is 60%, and the ratio of 'text substitution' to 'library substitution' materials on the reading list is 5:5, the cost per student ranges from £11.01 to £11.72 in post-grant funded Years 1 to 10 respectively.

If overhead is 120%, and the ratio of 'text substitution' to 'library substitution' materials on the reading list is 1:9, the cost per student ranges from £4.96 to £5.67 in post-grant funded Years 1 to 10 respectively.

If overhead is 60%, and the ratio of 'text substitution' to 'library substitution' materials on the reading list is 1:9, the cost per student ranges from £4.67 to £5.38 in post-grant funded Years 1 to 10 respectively.

If overhead is 120%, and all materials on the reading list are categorised as 'library substitution', the cost per student ranges from £3.37 to £4.08 in post-grant funded Years 1 to 10 respectively.

If overhead is 60%, and all of the materials on the reading list are categorised as 'library substitution', the cost per student ranges from £3.09 to £3.80 in post-grant funded Years 1 to 10 respectively.

4.3.7.6.3.2   Duplication occurs at a rate of 1% in Year 1 and increases annually by 1%
If overhead is 120%, and all materials are categorised as 'text substitution', the cost per student ranges from £19.18 to £19. 80 in post-grant funded Years 1 to 10 respectively.

If overhead is 60%, and all materials are categorised as 'text substitution', the cost per student ranges from £18.90 to £19. 51 in post-grant funded Years 1 to 10 respectively.

If overhead is 120%, and the ratio of 'text substitution' to 'library substitution' materials on the reading list is 9:1, the cost per student ranges from £17.60 to £18.21 in post-grant funded Years 1 to 10 respectively.

If overhead is 60%, and the ratio of 'text substitution' to 'library substitution' materials on the reading list is 9:1, the cost per student ranges from £17.31 to £17.93 in post-grant funded Years 1 to 10 respectively.

If overhead is 120%, and the ratio of 'text substitution' to 'library substitution' materials on the reading list is 5:5, the cost per student ranges from £11.26 to £11.88 in post-grant funded Years 1 to 10 respectively.

If overhead is 60%, and the ratio of 'text substitution' to 'library substitution' materials on the reading list is 5:5, the cost per student ranges from £10.98 to £11.59 in post-grant funded Years 1 to 10 respectively.

If overhead is 120%, and the ratio of 'text substitution' to 'library substitution' materials on the reading list is 1:9, the cost per student ranges from £4.93 to £5.54 in post-grant funded Years 1 to 10 respectively.

If overhead is 60%, and the ratio of 'text substitution' to 'library substitution' materials on the reading list is 1:9, the cost per student ranges from £4.64 to £5.26 in post-grant funded Years 1 to 10 respectively.

If overhead is 120%, and all materials on the reading list are categorised as 'library substitution', the cost per student ranges from £3.34 to £3.96 in post-grant funded Years 1 to 10 respectively.

If overhead is 60%, and all of the materials on the reading list are categorised as 'library substitution', the cost per student ranges from £3.06 to £3.67 in post-grant funded Years 1 to 10 respectively.

4.3.7.6.3.3 Duplication occurs at a rate of 0.5% in Year 1 and increases annually by 50% of its current rate

The result of this duplication pattern is that in Year 10 post grant-funding, duplication between materials selected by lecturers and material already held in the repository occurs at a rate of 65%. The authors consider this to be unfeasibly high but have tested this scenario to demonstrate the effect of duplication at an extreme level.

If overhead is 120%, and all materials are categorised as 'text substitution', the cost per student ranges from £17.91 to £17.84 in post-grant funded Years 1 to 10 respectively.

If overhead is 60%, and all materials are categorised as 'text substitution', the cost per student ranges from £17.63 to £17.55 in post-grant funded Years 1 to 10 respectively.

If overhead is 120%, and the ratio of 'text substitution' to 'library substitution' materials on the reading list is 9:1, the cost per student ranges from £16.32 to £16.25 in post-grant funded Years 1 to 10 respectively.

If overhead is 60%, and the ratio of 'text substitution' to 'library substitution' materials on the reading list is 9:1, the cost per student ranges from £16.04 to £15.97 in post-grant funded Years 1 to 10 respectively.

If overhead is 120%, and the ratio of 'text substitution' to 'library substitution' materials on the reading list is 5:5, the cost per student ranges from £9.99 to £9.92 in post-grant funded Years 1 to 10 respectively.

If overhead is 60%, and the ratio of 'text substitution' to 'library substitution' materials on the reading list is 5:5, the cost per student ranges from £9.71 to £9.64 in post-grant funded Years 1 to 10 respectively.

If overhead is 120%, and the ratio of 'text substitution' to 'library substitution' materials on the reading list is 1:9, the cost per student ranges from £3.65 to £3.58 in post-grant funded Years 1 to 10 respectively.

If overhead is 60%, and the ratio of 'text substitution' to 'library substitution' materials on the reading list is 1:9, the cost per student ranges from £3.37 to £3.30 in post-grant funded Years 1 to 10 respectively.

If overhead is 120%, and all materials on the reading list are categorised as 'library substitution', the cost per student ranges from £2.07 to £2.00 in post-grant funded Years 1 to 10 respectively.

If overhead is 60%, and all of the materials on the reading list are categorised as 'library substitution', the cost per student ranges from £1.79 to £1.72 in post-grant funded Years 1 to 10 respectively.

The results of simulations designed to test the level of duplication between materials selected by lecturers and materials held in the repository are not encouraging. They suggest that even when duplication occurs at a high rate, NERS resources are still expensive compared with equivalent print resources. If 50% of materials on a list were categorised as 'text substitution' the cost per student would be double that of the print collection.

4.3.7.6.4 EFFECT ON PUBLISHER INCOME OF VARYING THE RATIO OF 'TEXT SUBSTITUTION' TO 'LIBRARY SUBSSTITUTION MATERIALS IN THE ER COLLECTION

These figures are unaffected by the rate at which overhead is applied to staff costs as they represent only publisher income. Clearly, if the cost to the publisher of negotiation were deducted from these figures the net income would be smaller.

If all materials on a list are categorised as 'text substitution', the publisher income would be £48 985. If 90% of materials on the list were 'text substitution' materials and the remainder were 'library substitution' materials, the publisher income would be £44 269. If 'text substitution' materials and 'library substitution' materials each represented 50% of the materials on a list, the publisher income would be £25 402. If only 10% of materials on the list were 'text substitution' and remainder were 'library substitution' the publisher income would be £6535. If all of the items on the list were categorised as 'library substitution' the publisher income would be £1818.

In the equivalent print reserve collection, the book trade would receive £28 000 and the publisher would receive £21 000–£28 000. To recover the same income from an ER, 'text substitution' would have to represent approximately 57% of materials on a reading list. This would make a list too expensive for the library. It may be argued that as the publisher income is received simply for copyright clearance it is reasonable to expect a reduction in cost when compared to printed books. However, even if the sum required by the publisher were reduced by 30% to £20 160, 'text substitution' would still have to represent nearly 39% of materials on the list and the cost would still be well beyond the means of the library at £51 640 to £56 496 in Years 1 to 10 respectively.

Unfortunately, the library could barely afford to pay for a list whose contents exceed 10% of items categorised as 'text substitution'.

4.3.8 Payment for copyright fees

It is clear that, in economic terms, ER does not compare favourably with a print reserve collection even if only 10% of materials included on a class reading list are categorised as 'text substitution'. 'Text substitution' would appear to be inappropriate as a payment mechanism for ER. It may be argued that this model is designed to be applied to material that, in a print environment, students would buy. It has never been the library mission to supply a copy of a text to every student in a class. On the contrary, 20–30 years ago, some key texts that students were expected to buy would not be stocked by the library (C. Rowlinson, personal communication, 23 April 1999). The 'text substitution' model is likely to be perceived as too expensive by libraries unless they pass copyright fees on to students.

The effect of passing either print costs and/or copyright costs to students has been explored previously (Halliday *et al* 1998). Although many in the library community would consider it reasonable that students pay print costs just as, at present, they pay for photocopies, passing the cost of content to students would be contentious. It is argued that students pay for library provision when they pay their fees. Furthermore, a proposal to pass copyright fees on to students calls into question the role of the library in providing resources for teaching and learning. It could be argued that it would render the library equal to and thus a competitor of other, more competitive, information providers. Even if libraries were to pass copyright fees on to students, the 'text substitution' model would probably incur costs well beyond what could be recovered from students. This model requires payment from every student in a class but some students will choose not to read some of the selected items. The number of students in a class who actually choose to read every item on a reading list is low. In the present environment, many students find that time is at a premium as they must take paid employment to supplement other sources of

income (CAPP 1998). As a result, they read only the bare minimum necessary to meet course requirements. Evaluation work conducted by the SCOPE project found that fewer than 18% of students who actually purchased a course pack of core readings read more than 50% of the material contained therein (SCOPE 1998). Furthermore, some students will refuse to print specifically to avoid payment of a copyright fee. Students are reluctant to pay for prints from library resources if the cost exceeds that charged for photocopies (Kingston *et al.* 1997; SCOPE 1998; Summerfield 1997). Thus, if the copyright fee is included in the cost of a print the number of students who choose not to print is likely to be high (Halliday *et al* 1998) even among students who wish to read a specific item. For many students this would appear to be related to student perceptions of the library role rather than willingness to pay for required reading materials as a recent study of student book-purchasing trends suggests that booksellers benefit through increased sales when required reading material is not obtainable from the library (CAPP 1998). Nevertheless, some students simply cannot afford to pay for learning materials (Halliday *et al* 1998). They depend on the library and thus, the introduction of fees for library resources is, justifiably, resisted by students and librarians alike.

It would appear that by taking on production and repository functions, the ER service increases library costs while depriving publishers of sufficient income to sustain a publishing business. The inherent inefficiency in this system is clear: the publisher must incur a significant proportion of production costs to produce hard copy which the ER service then uses to incur further production costs in creating a duplicate. When publishers are in a position to supply electronic copy directly, this inefficiency may be avoided but it is not clear then what the function of an ER service would be in those circumstances, or indeed whether such a service would be needed at all. When publishers supply their materials directly to the library in electronic form, resources,

perhaps with finer granularity than books and journal, could be acquired in electronic form by the libraries acquisitions department and integrated into a digital library. There may be a role for an intermediary which co-ordinates acquisitions and delivers resources seamlessly through a standard interface just as NESLI does for journals. The repository function would be part of the routine archiving function. It is not clear at present which body will have responsibility for archiving electronic copy but if it resembles the system in print, all material will be archived and a repository of extracts will be redundant.

As it stands the NERS does not appear to be economically viable at the levels of duplication we anticipate. To become viable, various actions or assumptions appear to be required. One is that a much higher level of duplication than we expect occurs. Another is that alternative income streams are created. A third is to reduce costs. One possibility is that materials academics have produced for teaching purposes at a single institution is supplied to the NERS for wider distribution. HERON aims to include this type of material in the repository. Such material would be supplied directly by the academic who would also grant copyright permission, presumably at a viable rate. HERON would not be required to acquire and pay a copyright fee for a clean original from the British Library thus eliminating an expensive element of the digitisation cost for published materials.

5 Conclusions and recommendations

5.1 Journals

1) Although the reduction in costs predicted by Harnad and others is unlikely to be realised in an electronic environment, it is clear that prices of non-commercial journals which recover full costs (120%) and make a small profit (10%) can be sold at reasonable subscription prices as

long as there is a subscription base of at least 500. Collecting submission fees from authors reduces this fee. **Our models suggest that electronic journals can both make a profit for the publisher and be reasonably charged.**

2) **The cost to libraries and publishers of negotiating the terms on which journals are licensed is excessive.** Negotiations at this early stage have progressed development of acceptable licence terms. Nevertheless, it is clear that rationalisation of negotiation activity is required. It was beyond the scope of this project to investigate how efficient consortia may be in this regard. Consortia are common in the USA but, in the UK, national initiatives are possible. Rationalisation of negotiation by a body such as NESLI is likely to be more efficient for both libraries and publishers than unilateral negotiation even if standard licences such as the JISC/PA recommended licence is regularly employed in the individual negotiations. However, if journal prices are reduced, the current rate of discount on prices commanded by subscription agents is likely to be insufficient to fund an organisation like NESLI. Further work is required to explore these issues. Publishers should be considering whether they should create their own central negotiating body to save themselves costs as well.

5.2 Electronic reserve

3) The results of our modelling work suggest that, in economic terms, electronic reserve does not compare favourably with print reserve as a means of delivering high-demand teaching and learning resources. **The 'text substitution' model for copyright payment that is favoured by the CLA is prohibitively expensive. We do not believe that this model of charging is viable.**   Furthermore, it would appear that by taking on production and repository functions, the electronic reserve service increases library costs while depriving publishers of sufficient income to sustain their businesses. **The authors recommend that alternative models for delivering teaching and learning materials in an electronic**

environment be explored. We also recommend that alternative revenue streams need to be considered.

4) Negotiation on the terms of journals licences is prohibitively expensive. Negotiation on the terms of licences for use of non-journal literature such as that handled by a national electronic reserve service such as HERON is also likely to be expensive. Thus, although certain aspects of a National Electronic Reserve Service appear not to be viable, it is likely that economies of scale can be realised with regard to copyright negotiation. The authors recommend that the viability of an initiative similar to NESLI be investigated for teaching and learning materials.

5) We note that our results depend critically upon the level of duplication achieved. We would welcome comments on the duplication rates we have assumed will occur. **We recommend that further research be funded to establish the current level of duplication of reserve materials across UK HEIs.**

6) It has been observed many times that the issue of electronic reserves is a medium term one. In the longer term, everything that might be needed will be routinely available from publishers in machine readable form in any case.

5.3 General

7) The authors recommend that further research be undertaken to delineate the cost of different functions of electronic publications and services. One variable with a very significant impact on costs for electronic journal production is the degree of functionality required by users. Odlyzko estimates that the last 20% of functionality will incur 80% of the total cost (Odlyzko 1998). Research on what functions users require is inconclusive at present. Further work in this area is required. Production decisions regarding additional features must also be informed by the cost of those features.

8) The authors recommend that further work be undertaken to cost specific activities related to the production and delivery of digital library services and resources. The capacity of staff

involved in various digital library initiatives is unclear as yet. Digital library work to date tends to have been undertaken on a project basis and staff have been involved in various associated tasks such as reporting to funding bodies. The cost of actually conducting the business of the project remains unclear. Any attempt to cost a digital library resource or service must be informed by details of what an individual staff member on a certain salary scale can be expected to achieve. Staff costs are significant in all of the models so any significant increase or reduction in staff costs would have a marked effect on the cost of providing a service or resource. For example, if an electronic journal could be produced by one half-time staff member or the equivalent rather than the two half-time staff members included in the models, production costs would be significantly lower.

9) There is a clear and recognised need for standards in usage measurement and performance indicators. Clearly, the establishment of standards is a lengthy process and can lag behind digital library developments. Nevertheless, staff of all digital library initiatives should be aware of developments in this area and should informed by them. Without standardisation in this area neither analyses nor data from different projects can be compared. The authors are aware that a working group has been formed to revise the international standard on library statistics (ISO 2789) and that collection of statistics related to digital resources will be covered by this standard. We are also aware of the work of the ICOLC is developing standards for reporting usage of digital materials. All this work will progress one area of this field. Further work is required also in establishing performance measures. **We recommend that the JISC/PA Committee keeps a watching brief on these matters and initiates further work in the field as needed.**

10) A great deal of work is currently devoted to development of archiving and preservation policies with regard to digital resources. Other than JSTOR, the authors are not aware of economic modelling on this topic. The CEDARS Project may address this issue in the future. Nevertheless, the economics of archiving and preservation are key to the success of

the digital library and the cost of undertaking these activities must be established if the viability of digital library activities is to be evaluated. **We recommend that JISC funds research in this area.**

11) Although a great deal of work on user behaviour has been undertaken by electronic journals developers, other areas of the digital library have neglected this area. Without patrons using the services, development work is redundant. Furthermore, research has revealed differences in the way that users in different disciplines behave. This may have implications regarding how appropriate a specific resource or service is to different user groups. **Studies of the behaviour of users of all other digital library resources and services should be funded.**

12) The authors ran various model simulations based on variation in the value of specific model elements. The results are recorded. It was beyond the scope of the project to manipulate all variables and record the effect on all other variables. However, details of all elements in the models are documented in this report. Users who wish to explore additional scenarios should obtain copies of the models from the authors. A brief guide to using the models is appended to this report.

13) The output of this research project is this report and six Ithink models of digital library activities. The models are simple and imperfect. The value of a modelling exercise such as this is to initiate feedback on the models and on the model assumptions. The authors view this project as a starting point and hope to receive feedback from all stakeholder groups. This feedback will be valuable in that it will inform future modelling, and will progress thinking in the area of economic factors related to digital library activities. Much economic data and business models are held by publishers.. Whilst confidentiality issues clearly prevent them from publishing such materials, we would particularly welcome comments from publishers regarding the assumptions we have made in our models.

14) **The authors recommend that future modelling work which focuses on specific areas of the digital library be funded.** As noted earlier, much of our work has focussed on UK

initiatives such as HERON or NESLI. We would be interested to learn of any similar

modelling that has been applied to other initiatives elsewhere.

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146

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Appendix 1: using the models

Floppy disc copies of the models described in the report are available from the authors. Any user may view a model, manipulate model variables and monitor the results. To do so, the user must first install on her machine the free runtime version of Ithink software. This is available at the following URL: http://www.cognitus.co.uk/IS/IS.htm.

On opening a model using this software package, the user is presented with the model control panel. The control panel has a toolbar on the top border and a downward arrow on the border at the left-hand side. On the panel itself are a number of mapping elements. The mapping elements include sliders, a button to take the user to the modelling elements, a table and a graph.

Viewing a model

To view the model, the user must go the modelling layer. To do so, she must either press the downward arrow on the border at the left-hand side of the mapping layer or press the button labelled 'To centre of the model'. On the modelling layer, the user can move around as she would in any other windows package, using the arrows or sliders on the borders at the bottom and right-hand side of the screen.   The elements of the model are described in the Methodology section of the research report. To view the value or equation determining the value of a model element, the user should double click on that element. She will be presented with the element window. The assumptions and information informing the value given to each element are documented. The element 'document' may or may not be displayed. If it is not displayed, the user should click on the button labelled 'document*' at the bottom of the element window.

Manipulating a model

To manipulate the model, a user should use sliders to alter the values of variables and should view the results on a table or graph.

Sliders are rectangular and each is labelled with the name of the corresponding element. The control panel reproduced below controls elements in the model of an electronic reserve service. The slider labelled 'classes' controls the number of classes to be provided with resources by the electronic reserve service. The default number is 664. The default on some sliders is controlled by an equation. To change the value of the slider the user can either click on the slider button and drag it to the left or right as appropriate or she may click on the value itself and type a new value into the box. The range within which that value must fall is indicated by numbers at the top of the slider.

When a user has specified values for each variable that she wishes to manipulate, she should run the model and monitor the effect. The effect will be evident in the changing values of specific model variables. For example, the user may wish to change the number of students in each class whilst holding all other variables constant and monitor the effect on the cost per student of providing electronic reserve materials which is recorded by the model element 'spend per student'.

To monitor the effect on 'spend per student' the user must create a table or graph that includes the value for this element. She can do so within the modelling layer by selecting the green table icon or pink graph icon from the toolbar at the top or she can return to the mapping layer and use the table or graph there. It is assumed here that the user will use the graph or table on the mapping layer. The user can return to the mapping element by pressing the upward pointing arrow on the border at the left-hand side of the model or by pressing any one of the buttons on the modelling layer labelled 'to control sliders'.

The instructions on using tables and graphs are the same so, for simplicity, it is assumed that the user will select a table. To view the table, the user should double click on the green table icon which is placed on the mapping layer. To select the model elements whose values are shown in the table, the user should double-click the table itself. She will be presented with a window containing two boxes labelled 'allowable' and 'selected'. To select an element, she should highlight the name of that element by clicking it in the 'allowable' box and then click the right-pointing arrow to place that element in the 'selected' box. The user can include several elements in the selected box. When she has selected all of the elements that interest her she should click the button labelled 'OK'.

To run the model, the user should select the pull-down menu labelled 'Run' and select 'run'. Values for a 13-year simulation will fill the table. To change the variables in the model again, the user must close the table and use the sliders.

The mapping layer of the model of a national electronic reserve service

ts: 'text substitution' materials. ls: 'library substitution' materials. CO: copyright officer

classes

0 ▬▬▬▬▬ 1000

? 664

To centre of model

Table 1   Graph 1

items per class

5.00 ▬▬▬▬▬ 30.00

? 14.00

ratio ts to ls

0.000 ▬▬▬▬▬ 1.000

? 0.900

students in class

0 ▬▬▬▬▬ 6000

? 100

clearance cost per item

11 ▬▬▬▬▬ 15

? 15