ELECTRONIC DELIVERY OF RESEARCH INFORMATION

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Introduction

There is currently an upsurge of interest in electronic journals (1,2) — the publication of scholarly research information in computer-readable form. This has been a subject that has excited some academics for about fifteen years, since the first experiment by John Senders (3).

The term "electronic publishing" has sometimes been applied to material that is put together by electronic means but then typeset and published conventionally on paper. I do not use the term in this sense. Some journals are published in parallel printed and electronic versions with essentially the same content. This I regard as a legitimate use of the term "electronic publishing". Some journals appear electronically without any printed version. Other electronic periodicals are called "electronic journals", but have not been subjected to peer review; these I prefer to call "electronic newsletters". Finally, some of the electronic versions of printed journals consist of page images, with no, or very limited, searchable text attached. These can be better thought of as electronic document delivery systems, though I do discuss some of them later. A true electronic journal has a substantial amount of its text searchable as well as displayable.

The past

In the UK, the major initiatives were the BLEND (4) and Quartet (5) projects funded by the British Library Research and Development Department. Like Senders' work, BLEND suffered from the inadequacy of the technological infrastructure then available. The academic networks, nationally and internationally, were not sufficiently developed to be used, and BLEND participants had to dial up over the public switched telephone network to the machine holding the journal. This had three drawbacks: the poor quality of the dial-up telephone lines; telephone costs; and confinement to the closed BLEND community. Quartet produced a journal called *HyperBIT* (6), which enhanced the equivalent printed journal (*BIT*) with hypertext features - a valuable innovation which will no doubt be followed in electronic journals of the future.

The Commission of the European Communities (CEC) was not inactive in this area. In the early 1980s Directorate-General XIIIB financed DOCDEL (7,8), the Document Delivery and Electronic Publishing Initiative. This led to a variety of projects undertaken across the community. The majority were "document delivery" rather than "electronic publishing"schemes. They too often suffered from being conceptually ahead of the available technology. In particular, one DOCDEL project with which I was associated at the Royal Society of Chemistry (RSC) (9) suffered from having been conceived just before the IBM PC appeared; in that era, most inexpensive microcomputers were incompatible with each other and with mainframes, and the easy transfer of files from machine to machine, and from software package to software package, that we take for granted today, did not exist. Nonetheless, we did eventually produce an experimental service which addressed the key problem of graphics as well as text.

Networks

The past five years have seen an upsurge in the use of networks by UK academics. In its early days JANET was used almost exclusively by scientists for number-crunching work on large

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remote machines. More recently it has come into use by academics from most disciplines and academic librarians. Usually the entry is through electronic mail; this leads fairly seamlessly on to mailing lists, or listservers, which blend into discussion groups, computer conferences and bulletin boards. Taken collectively, they represent the high-technology equivalent of the well-documented "invisible college" (10).

Now that we have a fairly robust national academic network, linked to other networks throughout the Internet, it is quite natural that academics should think of extending its use to formal publications as well. To many of them, the exclusion of the information professionals from the communication chain may be seen as a positive advantage; academics always dream of having everything done by academics. A recent proposal by Sir Peter Swinnerton-Dyer (11), based on this kind of scenario, is currently being investigated by the Science and Engineering Policy Study Unit.

Some current projects

Ongoing services

ADONIS For a number of years a consortium of major scientific publishers led by Elsevier has been developing a document-delivery service for the supply of separates based on video-disk technology (12,13). The origins of this concept lay in the copyright-photocopying controversy. ADONIS was conceived as a means for publishers to supply separates inexpensively on demand. A workstation was designed comprising a PC with CD-ROM drive, a 300 dpi A4 screen and a laser printer. A total of 219 biomedical journals are scanned and stored on CD-ROM, yielding about one disk per week. ADONIS workstations are sited in several major libraries including BLDSC Boston Spa. Searching is by means of the usual bibliographic details; the full text cannot be searched, and can only be displayed as bit-mapped images.

Experiments have been made in allowing ADONIS to be used directly by end-users, but this has proved disappointing. Display of the bit-mapped pages is too slow, with frustrating waits when moving from one page to the next. Second, despite the 300 dpi screen and laser-printed output, the display of half-tones is not adequate for many biomedical illustrations. Third, 219 journals is the wrong size of database: not comprehensive across the whole of biomedicine, but not specialised in one area either.

CARL Uncover This service originated in a group of research libraries in Colorado and became a commercial service (14). Very recently, UnCover became a joint undertaking between CARL Systems Inc. and B.H. Blackwell Ltd. Member libraries send their journals to the CARL Systems offices in Denver, where staff check them in and create records corresponding to the tables of contents of each journal issue, supplemented by a brief abstract of each paper. The printed journals are then sent back to the member libraries within 24 hours. By that time their contents lists will have been added to the machine-readable index. At present over 10,000 journals are included and 3000 articles are added per day. The service is offered to participating libraries by means of private lines from Denver and to other libraries via gateways from other networks. Individuals or occasional users can also obtain access.

UnCover 2 provides the supporting document delivery. Users can order a copy of an article with a couple of keystrokes if a photocopy cannot be obtained locally. The order is sent from Denver to the participating library that holds the journal in question, where staff optically scan the required paper and send the page images online to CARL in Denver. They are retained there in case the same article is requested later by another customer. Page images are then sent out to the customer by computer-driven fax. It is recognised that the use of fax is a transitional technology, and eventually it is expected that electronic transmission of the full texts will replace it.

UMI University Microfilms Inc. run a service, ProQuest, which they call an electronic journal system, although this is arguable. It consists of a set of CD-ROMs, one of which contains digital title, abstracts and keyword information, while the remainder contain the full texts as page images. The user searches first on the digital files, retrieves hits and then inserts the appropriate page-image disk in order to view and/or print out the page facsimiles. This is somewhat cumbersome.

Chemical Journals Online The American Chemical Society (ACS) is part-owner of the international Scientific and Technical Network (STN), a commercial online information-service host. This carries mainly abstracts and index databases, notably CAS Online, the full machine-readable version of *Chemical Abstracts*. However, for a number of years now the ACS has also mounted the full texts of its scholarly primary journals on STN under the title of *Chemical Journals Online* (CJO) (15). More recently these have been joined by the journals of the RSC, some Wiley journals on polymers and the English-language edition of *Angewandte Chemie*. The files contain all the text, as ASCII characters, with the special characters written out with delimiters like &alpha&, *greaterthan*, etc. Captions of figures and tables are included but not the figures and tables themselves. Parts of the paper — title, authors' names, abstract, main text, references, etc. are explicitly tagged, and the paragraphs of the main text are numbered. Thus what is retrieved does not look like the printed journal — no page images are stored. The service is not intended to be a document delivery service. Rather, it is intended to provide a means by which every fact in a paper may be retrieved, even if it would never have been abstracted or indexed.

Network journals An increasing number of genuinely refereed journals are now appearing, and can be accessed over the Internet. Generally these are new publications; I do not know of any printed journals that have converted themselves into pure electronic journals on the Internet. They must of necessity be text-only, without graphics and without special characters, so as to be deliverable over the current narrow-bandwidth networks; thus most are in the humanities and social sciences. Typically, authors are encouraged to e-mail their submissions to the editor, who uses the same method to send them to referees. Once accepted in either its original or a revised form, the paper is published. In the case that I am familiar with (16), this has been done by establishing a list-server (an electronic mailing list) to which anyone can subscribe, and over which the contents list and abstracts of the papers in each issue are broadcast. On receipt of these the reader can request the full text of the papers by issuing a "get" command to the listserver. At present, these journals have an enormous advantage over traditional ones in that they are free. There is, of course, no such thing as a free journal really, but the costs of the academic networks are paid by "top-slicing" and these services are therefore free to the academic end-user. The administrative, clerical and copy-editing costs that commercial publishers of scholarly journals have to bear are in effect absorbed by the academic editors. Claims have been made for hundreds of electronic journals on the Internet, almost all of them American (17).

Another network activity described in *Science* last month is the distribution of preprints (18). This idea is not new; about twenty years ago an organised preprint exchange (using old-fashioned mail) grew up in the USA. It eventually foundered on two obstacles: US government agencies who had been paying for it found the cost too high, and many scientists objected to the circulation of (and often citation of) material not yet refereed. Now that preprints are circulated over the network, I predict that before very long the same objections will again be raised. There is no doubt that peer review is regarded by the majority of scholars as absolutely essential (19). Although some present proposals envisage distribution only after peer review, experience suggests that it will be difficult to prevent distribution before refereeing.

Current experiments

AAAS/OCLC Clinical Trials In July 1992, the American Association for the Advancement of Science and OCLC jointly launched *The Online Journal of Current Clinical Trials* (20). It is held on a machine at OCLC and can be accessed by direct dial to OCLC or by Compuserve or Internet. There is an annual subscription, for which you get free access and downloading; typeset-quality offprints can be sent to you by mail or fax at an extra charge. The files contain text and graphics, with the tables, figures and references linked to the main text by hypertext links; you can also link from the references to the Medline abstracts of the papers referenced. Only the text and simple graphics can be downloaded, with SGML and ASCII options available; complex graphics and tables and the Medline abstracts cannot be downloaded. The journal is peer-reviewed and

papers are made available continuously (not in batches like a printed journal), each one going online within 48 hours of acceptance. Research reports, reviews, meta-analyses, methodological papers, clinical alerts etc. are all encouraged. A facility for automatic selective-dissemination of information profiles is included. The subject field was selected because it was assumed that physicians would be likely to have access to a networked PC, because it was known that there is an enormous amount of clinical trials material needing to be published, and because such material needs to be published quickly.

So far this journal has not been a success. There have been technical difficulties. For example, the advertised "minimum configuration" of user hardware does not work. However, the most important failing has been the lack of content. From July 1992 until recently only 31 documents had been posted and most of them were in the launch batch, and only one real clinical research paper has so far appeared! The system was designed for end-user (physician) use, but the enthusiasm for it has come from the information professions, not the physicians. Papers were not originally going to be published in printed form, but shortly after the launch it was announced that the *Lancet* would carry shortened versions of its papers. Even this added inducement has not brought the articles in.

CORE The Chemistry Online Retrieval Experiment (21) aims to deliver a large majority of the journal literature needed by chemists in electronic form. Articles are held in both text and bit-map forms and a variety of interface options are being investigated. The library at Cornell University houses the project. The data used is a ten-year run of twenty ACS journals This is roughly the same database as the ACS journals in the CJO service, but here both ASCII files and microfilm page images are supplied. Furthermore, *Chemical Abstracts* indexing is directly appended, whereas on STN cross-file searching has to be used to link CAS Online with CJO. OCLC is involved in providing large-database expertise and BellCore contributes expertise on text and graphic conversion and transmission, as well as developing prototype user interfaces. The project derives its ASCII text files from typesetting tapes, and has developed ways of identifying and extracting figures automatically from the page images; a variety of page images and resynthesised text options have been explored on various interfaces.

Conclusions of the experiment are that technological problems are largely solved or soluble, but that human and economic issues remain. On any test where one has to discover what to read, electronic searching is better. Electronic searching finds "false drops", but manual searching misses good hits. Serendipity is as good in electronic journals as in paper ones, although browsing is slowest with an electronic page-image database.

ACS/POD Experiment This project at University College London (UCL) connected with CORE but not part of it - uses the same files as CORE: ten years of the ACS journals, with the tagged text file derived from typesetting tapes and the page-image file obtained by scanning the microfilm. The text files are held on magnetic hard disks for searching and the page images on optical disks for display. A conversion program takes the ACS's proprietary format and converts it into SGML. UCL has produced another program to convert SGML into Open Document Interchange Format (ODIF). Three different user interfaces are being tested. XpixLook runs under X-Windows, searches the SGML file but displays the bit-maps. It is a client-server system. A second, X-Wais, is a widely used X-Windows system, customised by Leck of the CORE project to display SGML and customised by UCL to display ODIF. It can be used remotely over networks. The third, SuperBook, is a hypertext system; the display in this case is scrolling, not page-based, and uses hypertext buttons to access figures, tables and references. In the view of the researchers involved, this last-named approach is the most satisfactory for electronic journals, because pages designed for print-on-paper are not easily displayed on a standard PC screen — which is too small, of landscape shape, and of inadequate resolution. The scrolling approach, without the concept of a "page" as such, seems to be preferred choice of users.

TULIP This is a three-year project running until the end of 1995 (22). Forty-two journals from the Elsevier-North Holland-Pergamon group (in materials science) will be delivered to fifteen

university libraries in the USA, yielding about 100,000 pages per year. The backfile for 1992 has already been distributed. Elsevier will send the database once a fortnight to Engineering Information (Ei) in the USA. Ei will customize it to the individual requirements of each of the participating universities, and then despatch it via the Internet. Each university will provide its own choice of hardware and software platforms and access tools for using the database. The file consists of bit-mapped page images of the entire journals, with indexes for retrieval, plus an ASCII file of the text which can be searched but not displayed. Initially the ASCII file will be derived by optical character recognition technology (OCR) from the printed journals, without spelling correction, and is therefore referred to as "dirty ASCII" (though this may change as various typesetting contractors transfer to PostScript systems). The purpose of the experiment is to investigate the technical problems, legal issues, economic models and user behaviour involved in publishing a substantial-sized database of journals in electronic form in parallel to the printed version. Three choices of subscription allow for the full file to be delivered, the index plus ASCII files to be delivered with the images sent from Ei on demand for a per-article fee, and a repeat of the second option when external users are to be served. This relatively low-tech approach has been chosen by TULIP because the main emphases of the project are on the economic and behaviourial investigations.

CAJUN Ironically, the journal *Electronic Publishing* has until now been an entirely conventional paper journal — a nice case of not practising what you preach. Not surprisingly Prof. Brailsford, the editor, was keen to produce an electronic version, and in a project based at Nottingham University this is now taking place. Another journal, *Optical Quantum Electronics,* is also involved in the same project. Prof. Brailsford established a series of criteria to which any system used for the electronic publication of these journals had to conform. A system must be full-text searchable, not just bit-mapped page images. The formats must be public-domain and resolution and device-independent. They need to be readily transferred to and from PostScript. Hypertext features are required (for links between the main text and the figures, tables and references). Viewing technology must be fast and machine-independent: specifically, users with IBM-compatibles, Apple Macintoshes and Unix machines must all be able to use the journal. It must be multimedia-ready — the "hooks" must be in place ready for the day when articles with video and audio sequences in them are published and the system must deal in ASCII-85, 7-bit, for network and e-mail dissemination.

The system chosen was Adobe Acrobat (23), which provides all of the above-mentioned requirements. It incorporates a Portable Document Format (PDF), based on level 2 PostScript with hypertext, and is due to be made public in late 1993. The journals will be published on CD-ROM, which is seen as a good intermediate solution. Site licences will be sold to universities, who will be able to mount them on their networks using juke-box or tower CD-ROM systems. The journals are currently being beta-tested at three sites.

SCONUL/IOPP/LUT The Institute of Physics Publishing Ltd (IOPP) and SCONUL jointly proposed an experiment designed to test a scenario in which both the publisher and the library remain in the system. The project is being undertaken at Loughborough University of Technology (LUT) by means of a grant from British Library Research and Development Department to Prof. Jack Meadows (24). I am currently engaged half-time on the project together with Dr Cliff McKnight of the Human Sciences and Advanced Technology (HUSAT) Research Institute at LUT and Mr Peter Such, an independent consultant. A newly-launched printed journal published by IOPP, *Modelling and Simulation in Materials Science and Engineering (MSMSE)* will be produced in electronic as well as printed form, and seven participating libraries will receive both versions free of charge during the experimental period. An unusual aspect of this project has been the predelivery phase, now almost completed, which has surveyed the views of librarians and materials scientists in each of the seven institutions. The design of the electronic version delivered to each site will reflect the wishes of the users and librarians at that university; the seven electronic versions will therefore be different in structure, though all of the text will be present in each.

The subsequent post-delivery phase will further survey user behaviour as they become used to the electronic version. At the same time the possible economic structures that might be applied to this publisher-library model of electronic publication will be investigated.

The problems

Human

As has been noted above, the AAAS/OCLC Clinical Trials journal has attracted very few papers. On the other hand there is no shortage of subscribers. A similar situation prevailed with an earlier and less radical innovation —synopsis journals (25). Several of these were launched in the 1970s but only the *Journal of Chemical Research* survives; that, too, has little difficulty attracting sufficient subscribers for commercial viability, but continues to find difficulty in attracting sufficient papers of good quality. Many of the earlier (3,4) electronic journal experiments also found this difficult even though they were based in fields like human-computer interaction where workers might be thought to be sympathetic to the concept of electronic publishing. Here the difficulty probably lay in the experimental nature of the journals; researchers were disinclined to publish in a journal that would probably not outlive the experimental period. In the SCONUL/IOPP/LUT project, although the electronic version is not yet up and running, we have encountered difficulty in engendering enthusiasm and active support amongst materials scientists.

Some of the network journals seem to be thriving, but most are rather new and some, as has been noted, are perhaps not really journals. Although there is widespread interest in the electronic journal concept among the publishing, library, information and computing communities, support from disciplines not closely related to information technology seems at best patchy.

Why is this? At an exchange-of-experience meeting held on the 26th of February this year at The Royal Society, the issue of academic promotion and tenure, and the related questions of the research selectivity exercises and consequent ratings of departments and entire universities, were widely discussed: people won't publish in electronic journals, participants said, because they do not believe that these publications (even if refereed) will count to their, or their departments', credit. Whilst I'm sure that this is true, I also believe that this is a superficial statement of a rather deeper truth. As Ziman (26) and Ravetz (27) noted long ago, the scholarly publishing system is at the heart of the scholarly enterprise. Geneticists have always noted that any feature that is strongly conserved during evolution is probably a function that is vital to the survival of the organism. The strongly conserved publication system is vital to the continued health of scholarship, and most scholars instinctively realise that this is so. Hence most innovations such as microfilms, synopsis journals and preprint circulation systems that have been tried in the past have been rejected, or at best marginalised. Will the electronic journal be different?

It is essential to recognise one key point — not, in my view, sufficiently recognised among librarians and information workers, though I think scholarly publishers understand it very well. The scholarly publication system is author-driven, not reader-driven. It is a system with two "markets" —authors and readers — and the author market is by far the more important. The prime purpose of the scholarly journal system is not the dissemination of information amongst scholars. Dissemination amongst active researchers and scholars takes place through conferences, personal contacts, and informal communications — the invisible college, often now facilitated by telecommunications — in which we as information professionals have perhaps only a minor part to play.

Journals are a source of information, to be sure, but mainly after the event — as the archival store of established knowledge and for people, such as undergraduates and schoolteachers, who are not connected to the invisible college. The same scientist who happily communicates with colleagues over the Internet for hours every day will still submit his formal papers to printed journals, because the function of the formal system is to validate, to control quality, and to award credit and priority. This is so engrained in the scholarly culture that formal statements by the HEFCs, or by individual university administrations, that they will now accept electronic publications when reviewing an individual's or a department's standing, do not convince. They may be a necessary but not a

sufficient condition for a bright future for electronic journals.

A further reason why decisions by the HEFCs may not be sufficient is the international nature of the scholarly enterprise; it is not enough to say to a scholar that the HEFC will recognise an electronic paper in the research ratings exercise; the scholar will want to be sure that subject colleagues in other parts of the world will recognise it too. They will be able to see it on the Internet, but will they value it?

While the human obstacle to the acceptance of electronic journals should not be underestimated it is not insurmountable. However there needs to be a recognition that it is more than an administrative matter, and cannot be overcome merely by the passing of resolutions by the HEFCs.

Technical

As has been noted, the early projects failed or had only limited success because of the fragility, or sheer unavailability, of the technical infrastructure. This problem, at least, is far smaller today. In the UK it is probably only in the past five years that an electronic journal has become a practical proposition for anyone other than the enthusiast to use. However, we do need to recognise that this statement is really only true for text and perhaps line-diagrams. Any kind of half-tone photograph or bit-mapped image is difficult to transmit over existing narrow-bandwidth networks at reasonable speed and with good resolution. Colour, animation and video are impossible. We know that wide bandwidth networks are coming, and SuperJANET is only months away. Electronic publication is cited as one of the justifications for it. But already, networking experts are suggesting that the extra capacity of SuperJANET may be taken up by more messages passing, rather than richer information in each message. Another point concerns the internal networks within campuses: SuperJANET may reach the Computer Centre, but for the electronic journal to reach the academic's own desk — which is clearly what the academic wants — similar bandwidth needs to exist within the campus. In the present financial straits of UK universities it not clear just how soon this can be provided.

As was noted earlier, there is diversity among existing electronic journals in precisely what they deliver. CJO delivers a tagged, searchable full text, transmittable over current networks since it is text only. TULIP has a "dirty ASCII" full text for search and bit-mapped page images for display. Other systems have limited searchable text linked to bit-mapped images for display. The network journals have text only, fully digital, but the search capability is defined by the resources of the network or the destination university rather than those of the individual product. ADONIS, CARL and UMI operate document delivery services linked to abstracts-and-indexes searching only. It remains unclear which technology will prevail or indeed whether any standardisation will emerge. Librarians certainly want to see a degree of standardisation rather than every publisher, or worse still every journal, doing things differently.

Economic

Another major topic of debate at the recent meeting at The Royal Society was the economic model of electronic scholarly publishing. For years it has been unclear how an electronic system of scholarly publication would be financed. Two current models can be taken as starting points.

The first model relates to present printed journals. Most printed scholarly journals are produced commercially — in that even those publishers which are not-for-profit are also supposed to be not-for-loss. Authors and referees receive no payment, though academic editors may sometimes receive an honorarium. Costs are involved in administration, in communication to and from editors and referees, in salaries for copy-editors and proof-readers, and in expenses for the offices in which these people are housed. The costs of typesetters, printers, binders and distribution agencies would presumably be avoided in a purely electronic journal, as would the postage bills for the final product. If the publisher is a for-profit company an element of profit also has to be included and if it is a learned society, the publishing arm is often expected to generate a surplus to help to pay for non-revenue-earning but worthwhile, activities of the society. Either way, interest payments on any borrowed capital have to be met.

The key feature of journal economics is that a substantial proportion of the costs of a journal are

independent of the circulation. As circulations fall, the fixed costs have to be spread across fewer subscribers, thus generating price increases greater than general inflation. Another source of above-inflation price increases is the growth of the literature; even if the price per page is constant, prices will rise if more pages are published. These increases above general inflation have caused grave problems for libraries whose budgets have not kept pace. The continued launch of new printed journals and fluctuating currency exchange rates have not helped either. Furthermore, storage space is a significant problem for some libraries. Many librarians are looking to the electronic journal to solve their financial and space problems, with "access" rather than "holdings" becoming the key concept.

The second model is the one used by online information services in the secondary (abstracts and indexes) sector. Here there is now experience stretching back a couple of decades in pricing for electronic access to information. *Chemical Abstracts* passed the crossover point several years ago where electronic sales now generate more revenue than printed. It must be said, however, that online information services, except in the financial-services sector, are not a way to get rich. Most such services started in the scholarly bibliographic database area, and many have now deserted it because of its unprofitability. Takeovers and mergers have also gone on apace, the latest being the recent merger of Dialog and DataStar. Originally, online services charged mainly on a connect-time basis, with a minor element of charge for offline prints mailed to the user. Nowadays a mixed time-and-hits basis is common, while some suppliers go for a charge based on the complexity of the search logic used.

Possible models that have been discussed for the electronic primary journal have included both of the two models mentioned. An annual subscription model would entitle users at a specified site to use the database as much as they want to for a year. A time-and-hits basis has the drawback for libraries and users that costs are not predictable (and therefore not easily budgetable). Many users expect a per-article-displayed basis, since this is the charging mechanism of document delivery services like BLDSC and CARL. If, however, first-copy costs had to be recovered from this source alone, users might find that the per-copy charge was much higher than they expected.

Finally, of course, there are the free of charge network journals. Historically many printed journals originated similarly, with editorial functions carried out by an academic, with clerical tasks performed by the editor's secretary. The price charged — often included in a society membership subscription — just covered printing and distribution costs. It is worth noting, however, that as they grew larger such journal operations had to bring in paid staff. The point here is that beyond a certain size a journal cannot be handled in an academic's spare time. In the UK academics have heavier workloads than ever before. Perhaps this is one reason why so few of the newly launched network journals are based here. In any event, there seems to be no obvious reason why this model should survive any better for electronic journals than it did for printed ones. We know that academics would like to do everything themselves, but reality suggests that they will not have the time and energy to do so for very long. Furthermore, the Funding Councils will presumably notice that networks, like libraries, have a high price-tag, and will eventually try to control expenditure on them.

The future

The electronic library

While there is clearly a symbiotic relationship between the scholarly periodical and the academic library, it is not total. Some copies of journals are sold to purchasers other than academic libraries, and academic libraries buy materials that are not scholarly journals. But there is no doubt that it is the academic libraries of the world that are the source of most of the revenue of the scholarly publishers. In consequence, it is necessary for scholarly publishers, both commercial and not-for-profit, to observe closely what is happening to academic libraries and to higher education generally (28). Public services, higher education among them, are being expected to do more work with fewer resources, and this trend is likely to continue. The widespread adoption of IT is seen by policy-makers as a principal tool in this

exercise. Rightly or wrongly computers are viewed as devices that can increase academic productivity.

That they can increase productivity in the research laboratory seems beyond doubt; automated laboratory instruments linked directly to microprocessors generate raw data at an enormous pace. And as we have seen, the Internet provides access to an enormous, if chaotic, wealth of information right on the researcher's desk.

In British universities there has been much discussion of the future of the University Library and especially its relationship with the University Computing Service. Several universities have experimented with the idea of putting these two central academic services under a single manager. Others, while keeping two separate professionals in managerial charge, have put both services under a single university committee. In some cases other units, such as Audio-Visual Services or Staff Training and Development, may be brought under the same umbrella as the library and the computing service. Some of the "new" old universities, such as Aston and Ulster, have gone down this road, but it is mainly in the former polytechnics, that these trends have gone furthest. De Montfort University is a good example of this (29).

At De Montfort, Collier (29) has been developing the idea of the electronic library, with particular application to the university's new campus at Milton Keynes, where information provision has been predominantly electronic from the start. The debate on "access" versus "acquisition", however, has been raging around the world (28), and there seems little doubt that "access" will win. Thinking seems to be moving within the HEFCs towards the concept of integrating the library within the university's teaching and learning resource — the trends to modular courses, transferability of credit, part-time or distance learning, student-centred learning and computer-assisted learning all seem to focus in on the library as an electronic learning resources centre, accessed remotely by the student at any time of the day or night. Where does this leave the library as a research resource, and specifically, where does it leave the scholarly journal?

SuperJANET

It has been announced that SuperJANET will reach a significant number of universities in the near future, and many more within a couple of years. However, the speed of transmission will not be as high as originally planned, and many universities, including mine, will be on "branch lines" at a yet lower speed — though still at least an order of magnitude faster than the best of today's JANET connections. The availability of a distribution network capable of handling graphics, colour, video, animation and sound in real time will provide an enormous fillip for electronic publishing. Prospects open up not only of replicating current journals in electronic form but also of enhancing them with multimedia features.

In all of this excitement, however, we need to remember that research is not undertaken solely for the benefit of closed research communities. Information needs to be exported to practitioners, to students, to schoolteachers and to the general public, and the vital work of collating and interpreting research findings needs to be done by people who can access the research information, are rewarded for their work, and publish their own results in user-friendly and accessible forms, which will be, in my view, still largely print-on-paper. Here at least there is still a role for the publisher and the library!

A brief research project, SPIRS (SuperJANET Project on Information Resources and Services), has been supported by the British Library Research and Development Department, to demonstrate the feasibility of storing and using text in a flexible way and of displaying colour and high-resolution images (30). It will move beyond viewing images of documents on screens to flexibly interacting with them. One might, for example, want to enlarge a colour or half-tone image to look at it more closely, or lay different sections of text alongside one another. In time, publishers will want to explore three-dimensional and moving images. Nine publishers from both the commercial and the not-for-profit sectors are collaborating in pre-competitive research with Institute of Physics Publishing (IOPP). In this demonstrator project the main aspects explored are:

1. Identifying an article through an hierarchic structure (journal, title, abstract, text); searching through free text; browsing by flicking through images, tables or sub-headings.
2. Manipulating and linking sub-article elements, both within and between articles, and between publications.
3. Exploring the transfer and display of colour images and half-tones
4. Exploring distributed storage of articles and distributed tools for viewing them.

The need for a large-scale project

It was agreed at the meeting at The Royal Society on 26 February that the time is now past for small demonstration projects. Small projects have the significant handicap that there is really no incentive for academics to use them: no authors want to publish their significant work in small, obscure and perhaps temporary journals, whatever medium they use, and readers see no point in learning to use a new software system just to access a dozen papers a quarter.

What is needed is a large-scale project. Only if a significant proportion of the information that academics need to publish and read is found in electronic-only form will this new sector take off in a big way. There is a need for agreement on standards; no-one will want to learn different search protocols for every journal. The difficulties will be considerable: already, after all, there are significant vested interests among the existing document-delivery competitors. Scholarly journal publishing has been very profitable over the past forty years — not, in my view, because the publishers are profiteers, as many librarians and academics believe, but because the journals are sold on advance subscription and therefore have a uniquely favourable cash-flow position. Proposals that expect the commercial journal publishers just to fold their tents and slip away are not realistic.

In essence, a prominent idea now circulating (11) is that the HEFCs might redirect much of the current academic library resources into an electronic publishing system based on the learned societies, and co-ordinated by The Royal Society and the British Academy. It remains to be seen what the present government would think of this proposal which seems perilously close to nationalisation of a profitable British industry! Academic libraries would remain, but their emphasis would shift towards the support of teaching rather than research, a concept already well established in many of the new universities, and they might well be renamed "learning resources centres". There is a perception that the shift of purchasing from books to journals has gone too far; and text-books, as well as videos, computer-assisted learning packages, audio cassettes etc. are perceived as supporting the teaching and learning function, whereas scholarly journals support research.

It seems to me that, if the academic publishers want to stay in business in Britain, and the academic librarians want to stay in the business of supporting research as well as teaching and learning, they need to join constructively in the current debate and find ways of co-operating to propose other organisational and economic models that will preserve their position. Time is short.

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