Dealing with Diversity: hybrid libraries and the Distributed National Electronic Resource

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Abstract

Over the past 5 years or so the Joint Information Systems Committee (JISC) working on behalf of UK Higher Education has sponsored a series of initiatives in the field of electronic information. The main aim of the paper is to illustrate how this has led through successive refinements via the idea of the hybrid library, and through this to the Distributed National Electronic Resource (the DNER). Some links with related work in Australia are mentioned.

Introduction and summary

The real world in which information professionals struggle to provide high quality services is not the simple world of most so-called "digital library" services, but rather is characterised by complexity and diversity in almost all aspects of the information access chain. Dealing with diversity is the real problem for providers interested in providing quality services, and for users interested in accessing the relevant sources to answer their information problems.

This paper outlines JISC's efforts to help UK HEIs deal with this growing diversity of information resources. These efforts are based on two strands of effort: the Electronic Libraries Programme and the development of the JISC Collections. These efforts are now coming together as JISC concentrates on developing the DNER.

Follett report

This work in the UK had a somewhat unlikely start. The abolition in 1992 of the "binary divide" between the older universities and the polytechnics (paralleling the similar abolition in Australia a few years previously), approximately doubled the number of universities. Library provision in the old polytechnics had been chronically under-funded, and there was serious concern at the potential impact of having to upgrade all these libraries to "research quality".

This issue spawned the Joint Funding Councils' Libraries Review Group, which in November 1993 produced its findings in the "Follett report", as it is colloquially referred to after the Chair of the Committee, Prof. Sir Brian Follett. This Report was one of the most influential of recent years, if measured by the amount of spending on its recommendations. Chapter 7 of the Report related to the use of IT to alleviate library problems. The implementation of this part of the Report was delegated to the HE Funding Councils' Joint Information Systems Committee (JISC), with a budget of £15 million over 3 years.

Within JISC, this implementation was handed to a newly created sub-committee, the Follett Implementation Group for IT, with the splendid acronym of FIGIT. The recommendations of chapter 7 were accepted almost un-changed as the basis of further work (not entirely surprising since so many of the authors of chapter 7 became members of FIGIT).

Some of the key propositions of chapter 7 were

- improved document delivery can reduce the need to build up holdings, and improve access to our resources (para 277)

- digitisation of long back runs of older journals can save shelf space which can be re-used for study space (para 279)

- moving towards electronic rather than print-based journals, and expanding support for pre-prints had advantages, although the group was not sure this would produce sufficient savings to break the journals price spiral (para 283)

- provision of extracts on demand can reduce the need for multiple holdings for teaching purposes (para 290)

- the JISC Data Centres are valuable and should be consolidated, and should be extended to cover the arts and humanities, and a limited union catalogue covering the CURL libraries (para 297)

- the ability of librarians to cope with a major shift to new technology had to be improved through significant training and awareness programs (para 305).

Key results in other areas were

- library provision was found to be inadequate in many areas, and a building expansion programme with a leaning towards IT provision was begun (cost around £30 million; para 166)

- a major 5-year program of cataloguing and preserving special collections and archives in the humanities was initiated (cost around £50 million; paras 228 and 232).

In parallel, the Pilot Site Licence Initiative (PSLI, costing around £4 million) attempted to test whether bulk buying could substantially reduce the cost of print journals, testing with 4 major publishers. This deal was aimed at paper, but in the small print were clauses encouraging provision of electronic versions. Between this and FIGIT's work through the eLib program, at least 400 journals acquired electronic versions by about 1996. Much later, PSLI's successor was the National Electronic Site Licence Initiative (NESLI). This has a strong orientation to electronic versions, although some publishers are still insisting on linkage to print.

eLib Phases 1 and 2

FIGIT's response to the agenda laid out in Chapter 7 of the Follett report was to call for proposals for what became the Electronic Libraries Programme, or eLib. Two calls were made, and the resulting Phases 1 and 2 of eLib comprised almost 60 projects (see the eLib web site at UKOLN).

It is worth noting at this point that the work in the document delivery area involved co-operation with the AV-CC's Integrated Information Infrastructure program, through the joint project JEDDS which resulted in the development of ARIEL 2. In addition, eLib's EDDIS document delivery project abandoned its attempt to construct systems on its own, in favour of a partnership with Fretwell-Downing, resulting in the VDX system. This was further enhanced for use in Australia through the LIDDAS and NILLU projects. These international synergies are particularly pleasing to this author as a citizen of both countries.

It is impossible to sum up the results of 60 projects in a few sentences, but a few points are worth noting here in view of later developments:

- A low technology, distributed document delivery co-operative was set up by the LAMDA project, providing both price and performance competition with BLDSC, without however challenging the latter's entrenched position. Our ambitions for user-initiated document delivery remain un-realised as yet due to a variety of factors including delays in software delivery. So far, it has proved impossible to import the Australian distributed model of document delivery; perhaps it would be inappropriate to attempt to do so.

- Non-destructive digitisation is extremely expensive, particularly for older material (especially pre-19th century). It is not easy to justify on space-saving grounds, although it can be eminently justifiable in terms of accessibility. Copyright material, particularly when including many pictorial images, remains a serious problem.

- Providing extracts of key texts on demand in print or especially electronic form is a valuable support for learners. Publishers became more aware of and accepting of this practice, and some economic factors are better understood. However, without support in copyright law for fair use in this area, the acts of copyright clearance and then digitisation (especially when OCR is used to convert to text, because of the proof-reading overhead) introduced such delays into a time-critical process, that the system is unlikely to work for institutions acting alone.

- The change towards producing parallel print and digital versions of journals *increases* costs in the short term. While new journals with no print equivalent can be created, those which make full and effective use of the new medium (eg *Internet Archaeology*) are also very expensive. Meanwhile the economic models for freely accessible electronic journals remain unclear, while the technology for subscription-based electronic journals is much more intrusive than in the print world.

- Librarians respond extremely positively to the pressure for change, driven by a strong service ethic. Some academics also grasp the opportunities for change, but careful co-ordination with the academic cycle is essential (and often difficult to achieve). Many academics do not have the time to experiment in their use of technological change. Some academics are distinctly techno-phobic, at least in their teaching practice. Cultural change by retirement may be an important factor!

- Dissemination is therefore a major issue, and one which is too often insufficiently stressed. If the goals of a program include cultural change in a community, it is not enough to report on results via web pages, conference papers or journal articles. There needs to be a sustained dissemination program; Colin Harris of Manchester Metropolitan University talks of dissemination as intensive "supported and assisted take-up and use" of the new technologies and practices which are advocated. We can see such dissemination programs in areas such as primary education where the government has a strong agenda for change.

- Human factors are probably the most important in deciding whether technologies are taken up and deployed in practice. They are the least easy to plan for and the most difficult to influence.

The first two phases of eLib are currently undergoing summative evaluation by independent consultants. The comments above do not reflect that evaluation, but are reflections of this author. They read perhaps rather negatively, but in fact I believe the program had enormous impact and influence in changing the direction of library provision towards the digital domain.

Some of the more positive results we could identify include

- A sea-change in attitudes in and towards the LIS community.

- Major impacts on publishers and others in the supply change, who have been forced to confront difficult issues relating to the digital domain.

- An interest in Information Strategies bringing the attention of senior academic managers to bear.

- A change in direction for JISC from being a network provider with a bit of information to a realisation that it is committed to the information enabling business. Malcolm Read, JISC Secretary, has suggested "The DNER is what we do!"

eLib phase 3

When contemplating what should come after the first 2 phases of eLib, it was time to think beyond the bounds of the Follett report. Phase 3 was based on 4 propositions. Three of these were as follows:

- Some of the successful eLib projects needed limited continuing support to make the transition to be self-sustaining services.

- Distributed document delivery and other services were hampered by the lack of a national union catalogue. We do not know reliably where the resources to borrow are! Although JISC was engaged in constructing a physical union catalogue for a small set of research libraries (*COPAC*), it was felt that the distributed approach based on the Z39.50 distributed database protocol could have many advantages.

- With the rapidly increasing amount of material in the digital domain, and particularly with that subset with no print equivalent (and sometimes no possible print equivalent), making some progress on digital preservation was essential.

The fourth area was what became known as hybrid libraries, and will be covered in greater length later in this paper.

Looking at the 3 areas described above, initial results from projects in progress indicate

- It is possible although difficult for projects in digital information to migrate to sustainable services (we believe). This is possible at present only where costs can be pared to minimal levels. Business models for digital information are in rapid flux, and it is not yet easy to see how sustainable businesses in this area can be built. In the academic world the desire for barrier-free information is very strong. Even in the commercial world, it appears the only people getting rich are holders of ballooning stocks based on wild valuations; very few profits are being reported.

- Distributed union catalogues can be built, although the technology is still fragile due to the varied implementations, interpretations of the Z39.50 standard, and the many different profiles in use. Although we hope the work on the *Bath*

Profile will provide more robustness, this will take time (Lunau, Miller and Moen). Meanwhile, there are other scalability issues to do with network load, and the search impact on targets, which may prevent expansion of this approach from a regional to a national scale. For the moment, centralised union catalogues such as Kinetica have some significant advantages where they have a sustainable business model. Alternatives to Z39.50 may emerge, but will have to confront the same semantic interoperability issues as Z39.50 has had to. This will not be easy or simple, as the lengthy development work on Dublin Core as a cross-domain metadata standard illustrates.

- Having noted that on-demand publishing for learning and teaching is beneficial but fraught with difficulty particularly relating to timeliness, the *HERON* project attempts to overcome the difficulties by preparing and building up a resource bank of pre-cleared and pre-digitised texts, to be available at standard prices for universities to deploy in Electronic Short Loan systems at the click of a request button. This idea still has great potential, but there continue to be difficulties, not least the initial views of the publishers about appropriate pricing models. These are being offered through an arrangement with the Copyright Licensing Agency (*CLA and the digitisation of text*). Most are going for "text-book substitution" models, linked to the full course membership, rather than "library substitution models". HERON fears these pricing models will so dampen demand as to effectively destroy the market during the project's funded period. By the time the publishers revise their pricing models, the opportunity may have been lost.

- The recognition of the importance and the difficulties of establishing services for digital preservation is increasing. The eLib *CEDARS* project is only a pilot experimenting with exemplars, and is not expected to create a service. Hoped for changes in the copyright laws to provide for legal deposit of non-print will increase the pressure for preservation services, but we have as yet little idea how these services will be established in any sustainable fashion. Links with Australia have been critical in helping develop our thinking in this area. JISC is keen to establish a Digital Preservation Coalition with others such as the British Library, the National Preservation Office and CURL, and is taking the lead by appointing a Digital Preservation Co-ordinator.

Hybrid libraries

The motivation behind the hybrid library program area was extremely pertinent to the subject area of this paper. Diversity is a major problem as real libraries struggle to come to grips with the digital information world:

- Results from eLib Phase 1/2 projects, and from other programs internationally, were extremely varied, but there had been little study of the impacts of bringing in several of these technologies to play in real library environments.

- Corollary to the above, many "digital library" projects (especially those from the US National Science Foundation's Digital Libraries Initiative) were expressed in terms quite independent from real library environments. Digital Library projects often appear to be "single topic" services without the needed breadth. We felt libraries had a continuing value in HEIs, whether or not the domain was print or digital. In particular, libraries have roles in selection, presentation and mediation

of resources, although they deal with them in very format-specific ways. So diversity already exists within the library; one view of the library is as imposer of order on diversity. Even for existing or legacy digital material, mostly CD-ROMs and bibliographic or full-text datasets, the interfaces which are offered are extremely varied, not to say idiosyncratic; specialisation and differentiation of interfaces have occurred as vendor marketing tools. The result is a hodgepodge of different approaches which the would be user of information must navigate. In truth these different approaches are barriers to the user; they are sustainable only while there are small numbers of digital resources but not as these numbers increase.

The idea of the hybrid library program area emerged from these and related thoughts. As is usual, the final program to emerge from the proposals presented in response to the call may not have explored these areas as deeply in some areas as we would have liked. Nevertheless the program outlined below is producing some very interesting results, which indicate that much can be achieved with some careful thought and modest investment.

The hybrid library seemed to be an idea whose time had come; several unsuccessful bidders felt they would still pursue their ideas, albeit at a reduced rate.

A few examples from the hybrid library projects are

Agora

Agora is working with a commercial vendor to develop a standards-based broker system (based on a 3-tier architecture with thin, web-based client, intelligent brokers based around library policies, and distributed resource providers) suitable for hybrid library use. The architecture is based on the MODELS Information Architecture (Gardner, Miller and Russell). The broker aims to provide levels of integration across diverse data sets mainly through the use of Z39.50, and expects to integrate more than 40 Z39.50-based resources.. This project has been adversely affected through difficulties experienced by their commercial partner. We hope these difficulties are now behind them, with the benefit of significant stress testing of the underlying software in Australia.

Agora supports the aggregation of resources in groups called "information landscapes" which can then be searched. The same idea appears again in HeadLine, below, and Agora has worked with other Phase 3 projects including RIDING to develop collection level descriptions (Brack), to help define the information landscape. Agora provides a complete process for the user from discovery of a collection through to a document request and delivery.

The project has also developed a major requirements catalogue for the hybrid library (Newton-Ingham, Palmer, Kay, and Smith).

BUILDER

BUILDER is working in an institutional context, and aims to exploit all the synergies possible in the institutional resources available to them, to deliver innovative services.

Although BUILDER appears to have focused on products, this is because of its belief that demonstration is better than explanation. Their cycle could be described as "think

far, build near, try out and evaluate." Much of this work has centred on toolkits for their particular local environment: Talis for the LMS, and IIS with SiteServer for the web server. These tools are linked together in clever ways to produce a whole variety of demonstrator products which can be viewed on their web site.

Of particular interest are their use of SiteServer to construct a search engine across multiple sites (eg the set of hybrid library web sites, or the set of Birmingham University web sites) which will index and search complex binary objects including PDF, Word and Powerpoint files as well as HTML. Also, the thin client demonstrator makes a substantial proportion of their CD-ROMs available to web-based users.

Probably the most popular service is the exam paper service, which has been formally evaluated (Dalton and Nankivell, Exam paper analysis). It was initially restricted to on-campus access for legal reasons, but this year being extended off campus with added authentication. To this end they have explored authentication approaches linked to their Novell LAN and also to their particular OPAC's borrower identification system. They have also looked at the integration of electronic journals, and of local and remotely digitised resources. They have run a pilot electronic short loan system involving over 60 documents including 4 complete books; once again this has been formally evaluated (Dalton and Nankivell, Electronic short loan analysis papers). They plan to be early users of HERON.

HeadLine

The information landscape is a term used to refer to the set of information resources of interest at any one time to a user. HeadLine is particularly concerned with tailoring the information landscapes. To this end HeadLine is constructing an interface based around a *Personal Information Environment* (PIE) which allows groups of users to be presented with initial views from their teachers but subsequently to adapt these to suit their own needs. Authentication and authorisation are critical for this work, as are links to MIS systems so that the initial requirements of students can be assessed automatically. Building these links has been found to be considerably more complex than was expected.

The project has also completed a significant analysis of Library Information Service Enquiries, and has prototyped a system called SHERLOC to help users find documents on the physical shelves (*Shelfmark & Resource Locator*). They are investigating a document delivery service between the partner sites, of the kind useful to a multi-campus institution.

HYLIFE

HYLIFE is interesting in demonstrating the wide variety of solutions which may be appropriate for different groups of users. It is our most "geographically challenged" project, including Plymouth in the south and the University of the Highlands and Islands Project in the far north, with several partners in between. Some aspects of the project are already being brought into service at the University of Northumbria at Newcastle.

Interesting findings from HYLIFE include evidence that students view information retrieved electronically as intrinsically more valid than print sources. Given widespread concern in the LIS community at the difficulty in distinguishing garbage from good digital information, this emphasis emphasises the need for guidance on quality.
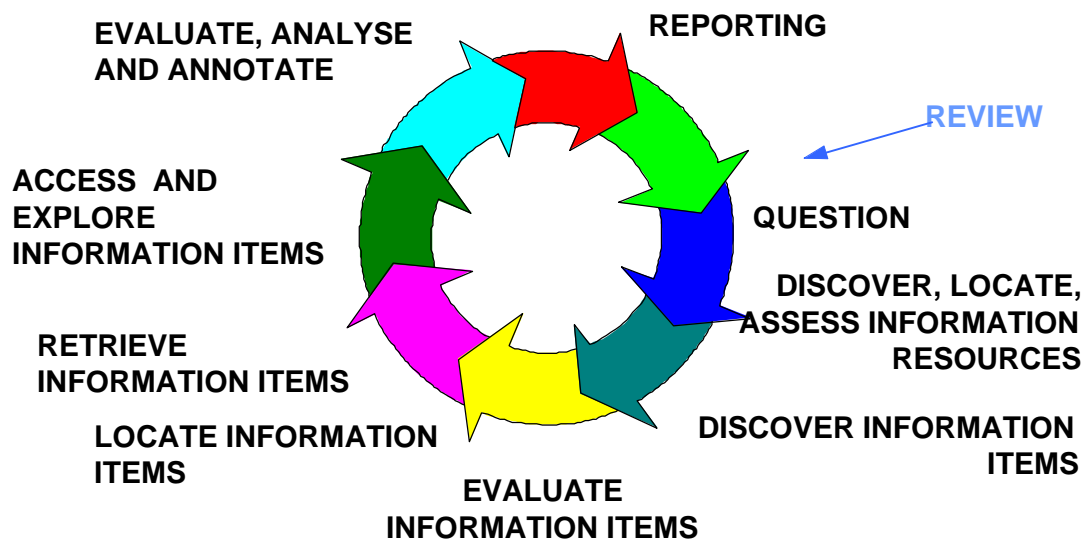
The HYLIFE annual report for 1999 also raises concerns at issues related to what it calls "the convergence of book and gown" (chapter 3). It is getting less possible to clearly distinguish and separate the educational, academic process, managed by faculty, from information provision, managed by the library. Information delivery becomes an intimate part of the educational process. Although HYLIFE is concerned at a perceived threat to funding independence for the library, there is also clearly value in being an increasingly irreplaceable part of the whole process.

MALIBU

MALIBU has also made progress on many fronts, but two in particular are worth noting. The first is a pre-prototype searching agent allowing cross searching of web sites using HTTP (sometimes disparagingly referred to as HTML scraping) (Harris). The advantage of this implementation over rivals is claimed to be the ability to bypass the target's state while maintaining its own state as a broadcast search. Although it is potentially high maintenance, this approach may prove extremely valuable in the short to medium term.

The other major development in MALIBU is the pair of complementary models of the Hybrid Library (Wissenburg). The first is a user model and the second is a technical services model. Forming models of the hybrid library was one of the tasks for the projects.
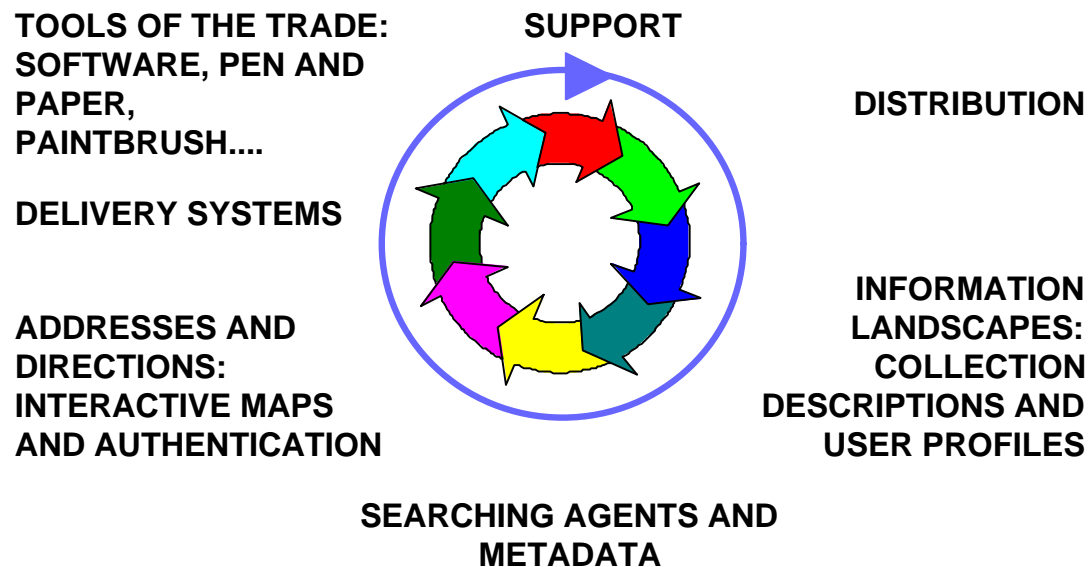
Usage Scenario

EVALUATE, ANALYSE AND ANNOTATE

REPORTING

REVIEW

ACCESS AND EXPLORE INFORMATION ITEMS

QUESTION

DISCOVER, LOCATE, ASSESS INFORMATION RESOURCES

RETRIEVE INFORMATION ITEMS

LOCATE INFORMATION ITEMS

DISCOVER INFORMATION ITEMS

EVALUATE INFORMATION ITEMS

Figure 1: MALIBU Usage Scenario model

The user model shows the stages a user goes through, often iteratively, in discovering, evaluating and using information. The model above starts from the user having some kind of question.

Technical systems

TOOLS OF THE TRADE: SOFTWARE, PEN AND PAPER, PAINTBRUSH....

SUPPORT

DISTRIBUTION

DELIVERY SYSTEMS

ADDRESSES AND DIRECTIONS: INTERACTIVE MAPS AND AUTHENTICATION

INFORMATION LANDSCAPES: COLLECTION DESCRIPTIONS AND USER PROFILES

SEARCHING AGENTS AND METADATA

Figure 2: MALIBU Technical Systems model

The technical services model shows the services that are needed to support these user stages. See the MALIBU documentation for further ideas on the applicability of these models.

The Resource Discovery Network

One of the successes of eLib Phase 1 was the set of subject-based Internet gateways (eg ADAM, EEVL, OMNI, SOSIG etc), which provided quality-tested access to of Internet-based resources. This idea was worth extending, but it was not easy to see how this could occur fairly across the subject spectrum. The decision was taken to establish a networked organisation, the Resource Discovery Network (RDN), which would integrate and extend this work, seeking additional financial and other support.

The RDN is organisationally based on the model tested with the Arts and Humanities Data Service, with the RDN Centre running common services, interoperability standards and systems. A range of "faculty-level" hubs addressing a larger subset of the subject spectrum are located in institutions with strong links to the subjects embraced by the hub; this subject-linkage is seen as one of the strengths of the approach. Each faculty hub may have a number of subject-level gateways associated with it.

Initial hubs have been created based on eLib projects covering social sciences, business and law; engineering, maths and computing; and medical/biomedical. Additional hubs are being established covering humanities and physical sciences. At least 3 more hubs are needed, but the funding is hard to find.

Gateway architecture

SOSIG

BIOME
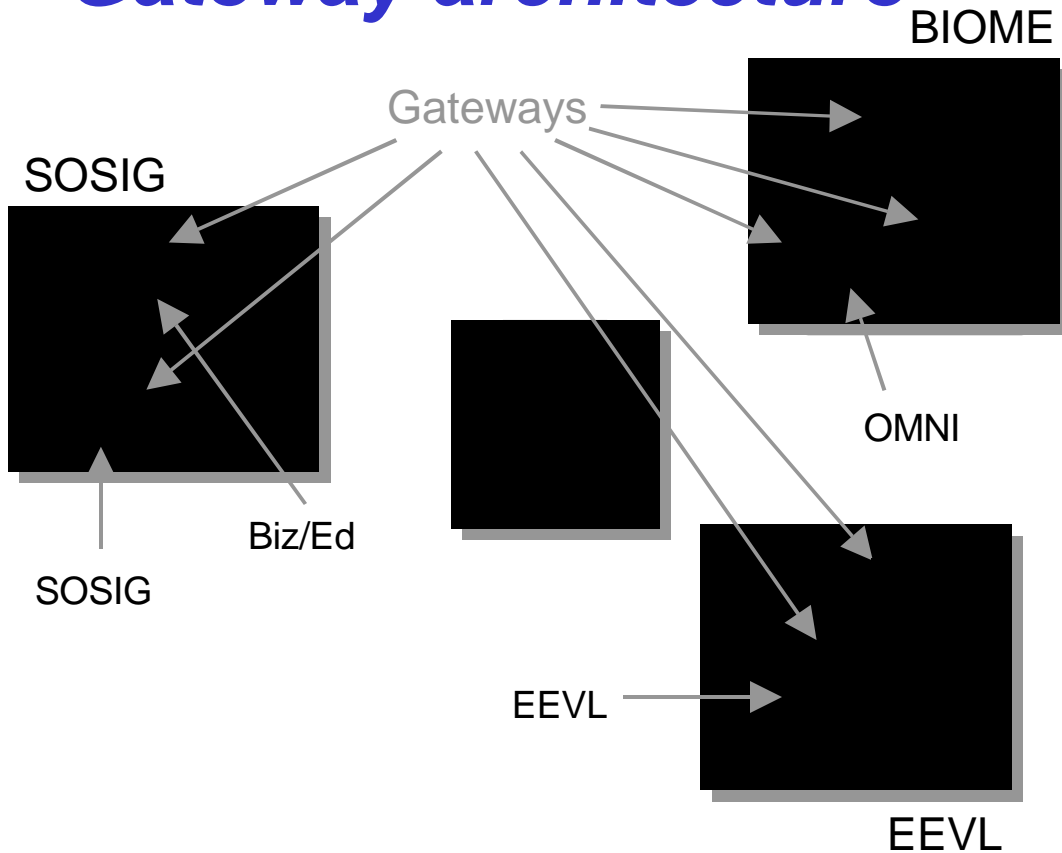
Gateways

OMNI

Biz/Ed

SOSIG

EEVL

EEVL

Figure 3: RDN centre, hubs and gateways

The diagram above from Andy Powell of UKOLN shows the RDNC as the hexagon in the centre, 3 of the faculty level hubs as the rounded boxes, and subject gateways within the hubs. The RDNC would provide cross-searching capabilities between the hubs and gateways.

The RDN is also trying to develop international co-operation with others working in this field, especially in the US, in Scandinavia, and here in Australia. This co-operative activity goes under the name "IMesh", and an international workshop was held in Warwick in mid 1999 to try to get co-operative actions going. A project called "The IMesh Toolkit" has been funded jointly by JISC and the National Science Foundation of the US, to develop tools to help IMesh participants share information and access each others' resources (*Imesh Toolkit*). However, beyond this we have as yet failed to really excite interest in international co-operation on a large scale. Perhaps this is partly because many efforts are isolated, single subjects, rather than spread across several subjects. An integrated set of gateways can see the value of a trade such as "you concentrate on math while we look after physics", in ways which are more difficult for isolated projects.

The JISC Collections

Meanwhile, JISC was continuing to develop its portfolio of digital collections. Initially, these had been presented to users through home grown and proprietary interfaces. The prime example of this was the BIDS ISI service. Later services began to develop from this base, providing a family resemblance for users. Services were established at 3 Data Centres. Then, as always, the limitations of proprietary in house developments began to emerge, and there was pressure to use commercial interfaces which the student might encounter later in the real world. This extended to the point where one dataset (INSPEC) was offered with a choice of interfaces from 6 data hosts, a separate choice by the library once the decision to subscribe was taken. While this approach gave some benefits, it started to increase the diversity problems already referred to.

Now the collection extends to over 40 datasets covering areas such as statistical and geospatial data as well as bibliographic and full text.

An important development has been the development of a JISC "Collections Policy" (*An integrated information environment for higher education*), describing the framework in which collection and retention decisions will be made.

The DNER

JISC had, some time before, borrowed from and adapted another Australian idea: the Distributed National Collection. This became for us the Distributed National Electronic Resource. Initially this expressed two simple ideas. First was the notion that the provision of digital resources should be physically distributed for redundancy and avoidance of single-point-of-failure reasons. Second was the belief that the collections offered should fit within a national framework, the JISC Collections Policy.

Over time this approach to the DNER began to develop, spurred by the increasing diversity of the resources being offered and by concerns about the sustainability of this diversity:

- The location of resources was determined more by historical "accidents of negotiation" than by logic. This was in keeping with the distributed idea, but it turns out that different Data Centres have their own differentiation (more diversity). Also, it appears that users have a greater sense of "network place" than we had expected.

- The diversity of interfaces has already been noted. It is not so much the diversity itself (since fitness for purpose will always drive some diversity), but the wanton use of diversity as a market differentiation tool which is of concern. We believe in different interfaces, oriented to the needs of particular user groups.

- There was beginning to be a diversity of authentication approaches. As the idea of the DNER moved in concept from a small set of individual resources towards resources as components of a whole, the problem of authentication and authorisation was thrown into sharp relief. Bluntly, users did not want to remember more usernames and passwords. The response to this was ATHENS 3, about which little more can be written here, other than that it is very valuable, far from perfect, possibly inadequate for the task, a triumph of pragmatism, and/or a

disaster in the making. Take your pick! These emerging problems were overtaken by a crisis as it suddenly appeared the IPR to ATHENS had been sold to a commercial entity. After much negotiation, it now appears we have a stable basis to use and develop ATHENS, but the experience has left us with major concerns. It is essential to continue to provide continuity of the ATHENS service for some time to come, and to provide some much-needed improvement. At the same time we have to move towards more commercial, off the shelf solutions, should appropriate services become available (and they do not appear to be available yet). JISC has now established a whole new work area to develop authentication and security through a new committee, JCAS.

- There was an increasing need to be able to "join up" different service, so that when a bibliographic reference is discovered from a search of an abstracting and indexing dataset, the location of the journal could be discovered from a union catalogue, and the article requested via ILL or document delivery. This joined up integration was impossible with the diversity of interfaces. A dataset independent protocol such as Z39.50 appeared potentially a most important component.

The idea of the DNER suggests that in making arrangements for information provision, we should architecturally separate the front end from the back end. This provides the option of a range of different interfaces to the same data. One of these at least should be the data provider's native interface. While data providers should continue to provide these, to extract the very most from their resources, they get in the way of most users, other than the dedicated researcher intensely familiar with the resource.

Any particular user group will have interests in a range of datasets from different data providers. The DNER allows a user group to provide access to this range of resources, independent of the data provider, in much the way that a library's books are arranged by subject but not by publisher.

The DNER plans the construction of *portals* (dread word; the name portal is the subject of continuing debate and is used here in a slightly specialised way) to facilitate user-centred access to the resources. One difference between gateways and portals in this usage, is that gateways offer *surface* linking (connecting you to collections of resources which must be navigated on their own terms as separate environments), while portals offer *deep* linking (allowing you to search within remote collections of resources, but staying within the portal environment), Portals are envisaged to be standards-based web-fronted brokers (probably using Z39.50 and other appropriate protocols), similar to the hybrid library broker in Agora, capable of multiple types of integration. From *The DNER: Description of the DNER*, this integration would include:

a) Integration of access to existing services, through a variety of entry points tailored to appropriate communities rather than to the data owners, data suppliers or even data types.

b) Integration through enabled cross-searching; the ability in one search to access several datasets (we call this breadth rather than depth searching, as only the common data features will be searchable and some of the functionality will be lost).

c) Integration through linking to value-added services such as ILL, document acquisition transactions, etc, especially in a "joined-up" way where information is carried across appropriately and does not have to be re-keyed.

d) Integration across domains, eg searching across different media types, curatorial traditions etc.

e) Access to a wide range of sources through non-traditional interfaces.

So we have again a 3-layer architecture: a set of resources at the bottom, a set of portals based on brokers in the middle, and the users through web browsers at the top. There would be many cross-linkages between the layers.

The set of portals might include

- One central, JISC portal: a starting place for anyone, especially those who have not yet identified a specialist portal which suits their needs.

- A set of subject-oriented portals; these are seen as natural extensions of the RDN faculty-level hubs and their associated subject gateways.

- Then we hope to extend the hybrid library idea to encompass local portals to the DNER. Local portals could support access to non-JISC resources licensed by the institution. A local portal could even be extended as "personal portals", including access to resources which an individual has subscribed to.

- Further into the future, we expect more specialised portals. First and simplest of these could be portals dedicated to particular media types such as still images, and time-based media such as movies or sound, or maps.

- Then we envisage portals with specific world views, such as a geo-spatial portal.

Out of this will emerge the idea of different views of the same data appropriate to different groups of users.

Extending the DNER for learning and teaching

To date, JISC's resources have been characterised as generally more oriented to research than to learning and teaching. Diversity is less of a problem for researchers, intensely focused on a small set of resources, than it generally is for learners, who are often exposed for successive short periods to a wide variety of resources.

This year, the Funding Councils have decided to provide significant funds to encourage greater exploitation of JISC resources in the learning and teaching environment. This will result in a major program from the basis of JISC Circular 5/99 over the next 3 or 4 years. It is too early to say what form this program will take, although responses will have been submitted by the time this paper is given.

Summary

To summarise the eLib program has developed from a diverse set of projects in Phase 1/2 to a rather more focused set in Phase 3, where the hybrid library projects represent a particularly important strand. The idea of the DNER has developed from simple beginnings to a complex concept of "joined up services". Underlying infrastructure issues including access management, middle-ware and standards have been tackled. A significant portfolio of datasets has been amassed. The future holds increasing attempts to control the increasing diversity through developing ideas of the DNER, coupled with an emphasis on making digital resources more accessible for learning and teaching.

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