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Leave it to the Labs? Options for the Future of Map and Spatial Data Collections

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> *"The ability to provide access to and manipulation of digital spatial data should signal a rebirth and continuance of map libraries and cartographic information centres" (Minton, 1993)*

> *"Digital data is not always the best way to go; in fact often analog products do the job better" (Larsgaard, 1992)*

1. Introduction

In his classic road novel *Zen and the Art of Motorcycle Maintenance* Robert M. Pirsig explores the many philosophical dimensions of what he terms '*quality*' (Pirsig, 1974). This elusive property is much admired, easy to perceive but much harder to define. A dictionary definition might be 'the degree or grade of excellence possessed by a thing'. The problem for the protagonist in the novel is coming to terms with the pre-Socratic philosophy and the difficulties of making quality 'work' for himself and other people. A similar difficulty faces map libraries at the turn of our century. Many see the potential 'quality' offered by GIS, but how should the technology be made available?

This paper argues that 'quality' in map librarianship and documentation in the GIS age depends upon appreciating the dual role of the map as functional information bearer, and as a rhetorical form of power-knowledge (Harley, 1990). Map librarians have all too often assumed that there is a rational scientific answer, a solution to delivering service which can exist independent of the context, and the user, in other words we have implicitly subscribed to functional models, and given too little weight to the complexity of socio-political and economic factors influencing the ways in which maps have been used in society. Generalisations have been made about flexible customer-defined specifications, mapped areas, themes and scales in digital mapping systems, which whilst technically correct, ignore social factors. Optimistic comments have been made how easy the transition can be to the bright new digital future. For instance *"the biggest problem in establishing a library capability...may be just getting the approval to proceed"* (North, 1987). Map librarians who have begun to integrate their conventional and digital services proselytize about the benefits and sometimes ignore the difficulties (McGlamery, 1991). Such simplifications and manifestos do not help those wishing to ensure a quality of service to users and potential users, of digital and conventional map products in the GIS age. It is very important to understand, in greater detail, which aspects of digital mapping are significant for map collections and to the users of maps, what implications the digital revolution brings for traditional map libraries and to position this discussion within the context of the organizations delivering this service to different groups in different societies. Questions about whether map libraries ought to alter their services, about the economic implications of change and about uneven social and spatial impacts of GIS are just as important as enthusing about the new kinds of use made possible with GIS. Only by asking these questions and by rooting discussion in contextual study can we begin to appreciate the detail implied in Larsgaard's comment about analog data, and then decide whether to change, and if so how.

2. The nature of digital mapping

Everyone accepts that the digital map is fundamentally different from the hard copy. Dissecting the nature of this difference is a useful starting point in assessing impact. There has, however, been an unfortunate tendency to assume that there is a single solution to the problems and potential of using cartographic materials in machine readable format in map libraries. The terms *digital mapping*, or *maps on screens* are often used, with little attempt by the map library community to understand the great variety of materials of very different kinds subsumed within these broad umbrella definitions. The nature of the digital map profoundly affects quality of use.

The *storage medium* is important because it influences how much data can be accessed, whether that data can be altered, how the data are organised and what hardware and software configurations are required to access the information. For instance CD-ROM is seen by many as offering the optimal medium for the dissemination of read-only cartographic data for use in libraries, because of the large amount of data which can be stored and accessed in a relatively rapid process. If a decision is taken to support access to CD-ROM based data, then decisions also need to be taken about whether and how to network, and about what hardware and peripherals need to be acquired.

The *format* in which the data is stored is also important. Whether the data is raster or vector profoundly affects storage requirements and the level of interaction which is possible. Different software engines may be needed to translate between formats. A bewildering variety of *file structures* are used by different products. Text files might be in ASCII format, boundary files in DXF format, and attribute data associated with these boundaries as CSV files. Raster data might be stored in TIFF format, whilst a a huge variety of file formats exist for more complex maps combining attribute and polygon data in vector databases. Larsgaard (1992) has suggested a new version of Murphy's law for map libraries: *"whatever form you have your spatial data in, the user needs it in the other one"*.

In addition to a great diversity of file formats and media, accessing the spatial data is achieved using a great variety of *software systems*. Very little relevant software will run under all operating environments, and even when a more generic package exists the UNIX version is likely to seem very different to the Windows or PC tool. Interacting with a standalone PC may be very different to interacting with a PC on a network, and using a SPARCstation poses different problems to those faced in accessing data on a minicomputer or mainframe. So it is not simply the problem of learning about different software packages, it may also be necessary to understand basic operating system and hardware principles, even before understanding the graphic conventions governing communication of mapped information. All of these factors make digital mapping less easy to use than the paper map.

Much cartographic data is of course released in raw form with little packaged accompanying software: here the problem is which of a bewildering array of software products to use in order to exploit the data. Most users do not even know where to start, and few map librarians either have yet come to terms with using raw data in the map library. Figure 1 illustrates some of the different kinds of relevant software and is derived from Moulder, (1992) and Perkins, (1993b). Probably the most important factor for the map library is the complexity of the software and the level of interaction it allows. This is important because of the degree of library staff input required, and the nature of the tasks which can be performed. Few map library users probably require very sophisticated software functions in seeking out mapped information. Most are probably quite happy with a hard copy, fixed format map. At the low end of the software hierarchy little user support is needed, whereas at the high end users need considerable help to exploit the value of the product. At the low end only a limited amount of interaction is possible with the data: functions like zooming, panning, or moving to new 'pages' and limited capabilities for output are relatively easy to learn. At the high end complex nested menus and GIS functionality may require a considerable learning curve in order to reach basic skill levels. Another important factor is the specificity of the software: should packages used on the data be general in purpose, like GISs able to perform a wide variety of tasks on datasets? Or should they be specific task-oriented tools, for instance to plan a route through a road network, to draw a thematic map, to search for a specific place and centre the map, to compute distances? Whereas the paper archive supported many different kinds of use, customised tools exist to carry out very different and separate functions in digital systems. Finally the nature of the datasets available needs careful consideration. Different datasets in digital format are targeted at different user communities, because of very different subject coverage.

In addition to this complexity of media, format and software systems comes the inevitable dynamism of data. Whereas paper copy maps 200 years old can still be accessed today, we have no way of knowing what systems will be operating as vehicles for accessing data, even a decade in the future.

Whether the digital cartographic data is continuously updated or is a single static database is also very important. Many national mapping agencies such as the Ordnance Survey are now able to revise their mapping in digital systems on a continuous basis. Whether changes are date tagged becomes very important for any library community interested in data which is not just current. How to archive changes poses a major problem: should fixed intervals across all the areas be archived, or should new versions only be saved as and when the database changes in a specific area? Which (if any) of this data should be held by a library? Static databases on the other hand (like a regular census) pose much less of a problem for a map library.

To summarise: digital cartography *can* mean scale free data, with customer defined specifications, area coverages and content. However, whereas for hard copy mapping the nature of the user-map interaction is essentially the same, a very great variety of different kinds of interaction are possible with many different kinds of digital product when operating a map library in a digital environment. The hard copy topographic map was readily available to all, as an artefact, whereas its digital equivalent might be fluid information only available to those with access to necessary knowledge, software and hardware.

3. The Library Practice

Table 1 reports the results of some of the studies of the use of digital mapping in different collections: a summary of national trends may be distilled from these data.

The most important conclusion is that despite the proliferation of digital cartographic datasets, very few map libraries have yet decided to take on a dual role as a 'cartographic laboratory' and conventional map library (Kollen and Baldwin, 1993). Recent surveys in Canada, in the United Kingdom, and in the USA confirm that the remit of most map libraries remains to provide their users with access to hard copy published mapping, rather than offering the flexibility of digital data use to their customers. No surveys of pan-European practice have yet been published, but papers published in this volume on this theme reveal an even more conservative situation across the major map collections in Europe.

Library involvement in Canadian collections with cartographic software is so far mostly limited to atlas and information programmes, map creation and presentation graphics and map customising packages and Moulder (1992) speculates that Computer Assisted Design and GIS are *"beyond our present capabilities of equipment and staff support"*.

In the UK very few map libraries yet even use electronic atlases in the map room, largely because of the cost constraints. Most libraries remain repositories of hard copy collections. It is the map libraries associated with institutions using GIS for teaching or other applications which have moved furthest towards offering cartographic laboratory facilities, and even here services are often not offered as part of the map library.

In the United States more active attempts to implement a cartographic laboratory in the map room have been made in the more important map libraries. The position in the United States is more innovative, because of the nature of public domain federal data, the willingness of software companies to collaborate with networks of libraries in order to try to create new markets for their products, the more flexible administrative organisation and the greater status of map library staff. Overall though the majority of the map library community in the United States has not yet come to terms with how to integrate digital mapping with conventional services and the evidence from the GIS ARL project is not so far very encouraging (Kollen and Baldwin, 1993). Even in this heavily sponsored project, with the aim of accessing only a few datasets with a few pieces of software, results suggest significant difficulties in moving beyond experimental implementation. A more detailed investigation of library responses is needed in order to explain why.

4. Library Responses

In conventional map libraries cartographic materials are acquired, described, stored and conserved, retrieved in response to user needs, which may be determined in a reference interview. In the digital library some of these processes are similar and some radically different. So the library response can be expected to differ according to the mix of materials available, the nature of the organisation, the library facilities available, the kind of users and their needs.

4.1 Acquisition

Acquisition of digital data is a more complex process than procuring hard copy maps. I will focus on three issues here. First how to identify what is available? Most of the standard acquisition tools used by map libraries ignore digital products, and systematic survey of publishers' catalogues may be needed. Few listings chart availability. An exception is Wolf and Wingham (1992) who evaluate the state of digital elevation datasets. Related to problems in identifying products is the need for more complex evaluative data, particularly when assessing whether to acquire complex software, such as electronic atlases.

A second problem concerns whether an available dataset can be bought. There are less cartographic digital data sets available at present than hard copy maps, this availability is changing very rapidly, but the evidence remains of huge gaps in digital availability which are never likely to be filled. For instance very few third world surveys are even contemplating replacing their hard copy topographic survey production. The vast proliferation of hard copy town maps, of commercial smaller scale tourist and motoring products, of ephemeral media mapping are also unlikely to be supplanted by digital equivalents. Unless there are profound changes in the ways in which societies use computers and in market conditions, it seems likely that this situation will continue. Hard copy equivalents will also probably continue to be available for most of those products which are now digital.

Unlike hard copy mapping, digital data is much more likely to be available for use on a licence basis, rather than available for purchase outright. This may present major problems for libraries who are unable to specify in advance the precise nature of their usage. Costs of digital products may also be prohibitive. The extreme case is the Ordnance Survey in the UK, whose current pricing structure for large scale digital data effectively precludes library acquisition. Steele (1993) documents the huge costs involved at 1992 pricing levels. It is certainly true that the trend amongst national mapping agencies (the bodies most likely to be producing digital mapping) are towards a more market oriented pricing policy (Robertson and Aitkin, 1992).

The third issue is whether the library should buy datasets at all. The digital format makes true data sharing possible, so it may therefore be more appropriate not to acquire digital datasets, but rather to access them when required over a network, to acquire collaboratively and share resources. Data sharing, co-operative purchase and remote access may be the only viable economic route for map libraries to follow if they wish to continue to allow access to current cartographic data.

So it may not be possible, and it may not be a good thing to buy digital data.

4.2 Archiving and storage

Archiving and storing hard copy mapping has required storage and reprographic equipment and the use of preservation and conservation methods. The problem with archiving and storing digital map data is that future users will need to access both the physical entity and also the information contained in the object (Tyacke, 1987). So in order to guarantee future access to digital cartographic data, the format in which this data is stored has to be understood and accessed in future systems - standards for data storage are critical here.

There is conflicting evidence about the archival qualities of the media used to disseminate cartographic datasets. Whereas the long term storage properties of paper as a medium are well understood no one has yet been able to confirm with certainty, for instance, the long term implications of archiving onto CD-ROMs (Cruse, 1985). There may well be a requirement to translate data to new media, in order to preserve its utility in the future.

The current fashion of using optical storage systems and digital technology to preserve images of hard copy mapping has begun to replace microfilm as a means of ensuring both wider dissemination and future preservation of conventional products. For instance the ambitious Opaline project in the Bibliotheque Nationale in Paris aims to link MARC records of map metadata with scanned images of the hard copy mapping (Duchemin, 1990). Any transformation to a new medium results in information loss. Scanned maps have no structure unlike vectorised images. They may be analysed using various image analysis packages. Inevitably, the greater the resolution, the less the information loss, but the greater the storage overheads. The larger the data sets, the more time consuming and expensive becomes accessing the data at future dates. For instance accessing data stored on a CD-ROM is relatively straightforward if there is a single CD-ROM: multiple CD-ROMs may require an expensive jukebox or dedicated drives in order to deliver an effective service. There will almost certainly also be a requirement to compress data, in order to be able to comply with media storage overheads. In contrast vectorised mapping takes up much less storage space and offers a much greater level of flexibility of use, but it is much more expensive to convert into digital format. No map library I am aware of has digitised its hard copy mapping in order to convert to a fully digital map service: any library vectorising which has been carried out has been as a side-product of other in-house activities.

It may be technically possible to minimise the loss of information, but map use is not purely a functional process extracting information from the source, there are more complex elements which are often ignored by GIS propagandists. Users may need some of the qualities of the information which have been lost in the preservation process. They may wish to analyse the colour wash on the map, to feel the weight of the bound atlas volume, to wonder at the quality of the copper engraved lettering, or to display the map on their wall as an affirmation of their status or as a work of art. Archiving the paper map allows these qualities to be preserved, archiving the digital may change the nature of the interaction between map and map user.

4.3 Bibliographic description

In map libraries housing conventional mapping, the documentation of holdings often also served retrieval needs, rather than being concerned just with description. The two functions are much more clearly separated in digital systems. There are undisputed benefits arising from documenting map holdings (Perkins, 1993a). The problem for the map librarian in the GIS age is that the standards created for conventional cartographic materials may be inappropriate because they focus upon a fixed format entity, rather than upon fluid user-defined information. Also very little guidance or precedent exists for interpreting existing standards and applying them to digital products. So should the map librarian catalogue digital holdings and if so how? Relevant issues include the provision of appropriate spatially referenced metadata, the level of the cataloguing and the object to be catalogued.

The nature of metadata for the cataloguing of machine readable cartographic materials is rather different from record standards for hard copy mapping. The most important attributes of machine readable mapping may well not even be available as fields in standard MARC format records. For instance, accuracy tagging of large scale digital products and date stamping of different elements of the database, and geocoding coverage, are fundamental to successful retrieval of items to satisfy search criteria. The user will need to know the source of digitising and its accuracy (rather than the scale) since display scale is more often a function of the software being used to manipulate the data. If metadata is to be used for successful retrieval of digital products it is important that the data is collected in such a way that retrieval needs can be satisfied. For instance co-ordinate data would have to be collected if it was intended to offer graphical as well as textual area access to data sets.

Possibly the most fundamental difference between a conventional map library and a library holding digital data is the issue of deciding exactly what to catalogue. Over six years ago Mary Larsgaard asked the question '*What does the librarian catalogue*' and concluded that '*Sanity suggests the database not the results*'. (Larsgaard, 1987) One can understand the caution: workloads in map libraries and cataloguing departments would inevitably prevent any serious attempt at this Herculean task. The needs of the user must be balanced against the requirements of bibliographic control and common sense administrative constraints.

So should the output, the screen display, the database, or some of the files be catalogued? Once again the flexibility of the GIS age impacts upon standards and practice. Kollen and Baldwin (1993) offer four different examples of the cataloguing of digital cartographic data and raise important questions about this process. They conclude that there are inconsistencies in the cataloguing of CD-ROMs and that different options exist for what to catalogue and the level of cataloguing. The problem is that the degree of output flexibility varies very greatly from one machine readable product to another, and that conventional MARC based cataloguing rules do not discriminate adequately. For the slide show type of electronic atlas, where the screen or hard copy map image is relatively fixed in format, cataloguing decisions may be analogous to cataloguing of hard copy material. It becomes possible to either create a catalogue record for the item as a whole, with content notes to individual slides in the show if appropriate, or to create parent offspring records to the individual mapped displays. More sophisticated CDs with fixed area components, but variable and possibly user-defined content, might also be catalogued as single items, with notes describing the fixed area files or maps. Alternatively offspring records of the fixed elements could be linked to a parent record for the whole database. For instance the SCAMP CD of 1991 Census data for the UK includes read-only files showing district boundaries within each county, ward boundaries within each county and enumeration district boundaries within each district. Whilst these polygon files may be amended on screen, eg by merging of polygons, their fixed read-only structure on the CD suggests at least a rudimentary listing of files would facilitate access.

On the other hand, more flexible GIS products such as the Digital Chart of the World can clearly not be catalogued with fixed listing of file structures, since here the data structures on the CD would be unhelpful for the user. Here a more flexible range of descriptions of output might be needed. As Larsgaard implies it would clearly be an insane waste of time to anticipate the infinity of design, scale, area and content which is possible from products like DCW, or mapped thematic data on census CDs. However there are clearly examples, even from these products, where metadata needs to be created about an output, rather than about the database as a whole.

One criterion might be to try to anticipate which output would be used again and to describe only these maps, either when they are created by users, or to create the files, catalogue these and stimulate likely future demand. To catalogue only those items stored for future use, whether as hard copy or as files in a GIS might be feasible in some library contexts. An obvious example would be map files covering areas of maximum demand in the library. In my collections this would be map files covering the Greater Manchester conurbation. On the other hand, hard copy generated by users would not be catalogued if the ephemeral images were taken away and were unlikely ever to be needed by another user. This approach to cataloguing decentralises the cataloguing process, and devolves cataloguing decisions to the local level, away from the national or international standards.

The conclusion to be drawn is that user needs should determine cataloguing practice, and that therefore definitive answers to the question of what data to collect, the level of cataloguing and the entity to be catalogued are impossible. Another example of GIS removing the 'fixed' and replacing it with the 'flexible'?

4.4 Retrieval

To create metadata makes little sense unless these are used to retrieve information (or groups of information) from storage. There is agreement in the literature that a mix of textual, numerical and graphical methods offers the ideal solution to retrieving cartographic data from collections, whether hard copy or digital (Perkins (1991), Lai and Gillies (1991) and Morris (1990)). A search capability should give multiple access points to data, allow area searching by place name with look-up gazetteer, interfaced to a graphical search capability similar to that offered as the frontend on better electronic atlases. Narrowing down searches by selecting different fields ought to be a standard facility, and output of results as text or graphic indexes should be possible on screen and as hard copy. Such systems are, however, expensive and the full range of facilities may only be needed by a few users. Few map libraries have yet implemented systems which offer such retrieval facilities for hard copy mapping, yet alone coming to terms with accessing digital cartographic data. Advocates of a fully automated retrieval process such as Lai and Gillies (1991), and North (1987) have failed to appreciate the complexity of the descriptive and system issues, and the huge data collection overheads which apply to hard copy mapping and co-ordinate data capture (Perkins and Guest, 1993).

Deciding which digital data set to access will however become an increasingly central issue in the GIS age. The short term solution to retrieval is to set up one system for digital data sets and packages, and another for the hard copy. Thus a front end offers different choices to the user. It may be an OPAC like textual front end, to navigate the user by menu choices through different potentially useful datasets or cartographic packages (McGlamery, 1989). Selection of an option automatically loads relevant software or routes requests towards an appropriate server. The alternative is a graphical front end, operating either as a hypercard stack, or as an icon based system. Neither of these approaches attempts to use the metadata collected about individual products: they simply help the user to access a product as a whole.

4.5 User services

There is almost no reported literature comparing the use of conventional and digital products in a map library context. Gooding and Forrest (1990) contrast different user experiences with raster scanned and conventional hard copy Ordnance Survey mapping, but no one has yet investigated in any systematic way how users of digital mapping can best exploit their data in the map library. Also no one has yet begun to examine who needs which kinds of digital map data, or looked at the skills required to use different digital products. Most people in the world do not know how to use the information in hard copy maps, so why should we expect that them to be able to interpret more 'difficult' digital products? We should be asking whether we need these products, and if so how can we get maximum value for different kinds of users, rather than rushing headlong towards an uncertain digital future. The limited number of library studies undertaken so far encourage caution.

Moulder (1992), for example, reports on experiences mounting and teaching the use of two simple electronic atlases, and concludes that significant staff overheads are inevitably involved in introducing more complex software into the map library. Introduction of digital systems into the map room tends to generate a different kind of inquiry, often related to software issues, rather than to spatial data itself. The early experiences of the ESRI funded ARL GIS project in the USA reported in a questionnaire survey undertaken by Kollen and Baldwin (1993) confirm that using even a simple GIS in the map room can be very time consuming for staff. Their survey reveals an almost overwhelming response that to use Arcview to access digital map data and produce customised maps involves map library staff in a lot of assistance, ranging up to 4 hours per map! Common sense suggests that if full GIS facilities are to be offered in the map library, then user support activities must inevitably increase and that it makes more sense to require users to attend training courses, rather than to teach on an individual basis in response to specific inquiries. Wong (1993) explores three potential models which might be used as a means of seeing how much user support is required: the personal use model in which individuals use digital products themselves with no input from library staff, the chauffeur-driven model in which the librarian as intermediary serves the GIS needs of the user and the intermediate adaptive interpersonal use model. Differing uses, from a range of teaching needs, through to more sophisticated research requirements would mean different degrees of staff support. Users need to be taught to exploit digital mapping systems to the full, and also taught when a hard copy printed map might be a better solution to their map needs

5. The future

What solutions are available to library managers in the light of these complex trends? What kind of quality will they offer to users in the GIS age?

5.1. Leave it to the labs

The easiest solution for many map libraries might be to ignore digital developments, and but to continue to exploit hard copy products. This is an understandable response, given the qualitatively different nature of digital products. Digital products could still be acquired and catalogued blind, for loan to patrons taking them out and using on their own GIS systems. Many US collections take this approach with TIGER files. The problem will, however, grow worse as the digital products become more established and GIS literacy increases. The risks are that map libraries become dying archives for the period up to about 2000 AD, and that responsibility for providing digital spatial data shifts to other divisions of the library, or even outside to other data providers, once digital production becomes the established norm and when large scale hard copy map publication ceases. Technological change is a powerful engine with all sorts of implications, one of which is likely to be a reduction in the resources available to continue to develop collections and services in the traditional hard copy map collection. Also the technical expertise required to interpret and design maps on screen has been developed over the years in map libraries, so leaving it to the laboratories may well be a short-sighted option, even for those concerned only with historical data.

However, given the costs, and a realistic assessment of user needs, it may be the only viable option. How many third world map libraries, for instance, are likely to be able to consider GIS? How many smaller underfunded collections in affluent European or North American societies have the luxury of considering limited moves towards the digital future? For the majority of libraries quality will have to continue to be offered by existing systems.

5.2. Go it alone: separate development

There are all sorts of measures which, given available resources, can be taken in individual collections to improve their own institution's access to digital data. A PC running electronic atlases in the map room shows at least that the map library is aware of the new technology. Experimenting with more sophisticated software packages in collaboration with other in house expertise is the next logical step down this road. McGlamery (1989), for example, reports on one in-house route to accessing census data in the map room, in which the librarian's role is to provide access rather than to interpret data and their use. It may be relatively easy to set up means to access and use some digital data, in tandem with a continuing conventional map library service, but to make little attempt to marry the two into an integrated system.

5.3. Collaborate and introduce the new technology

A problem shared is a problem halved and collaboration may well be one of best ways to introduce digital products to the map library. There are already many public domain digital cartographic datasets available on the Internet, which may be accessed, downloaded and processed (Beard, 1993; Allen, 1994). Co-operative purchase of digital datasets in the UK by CHEST already allow the research community to use Bartholomew World, Ireland and Europe digital databases, and various OS datasets. Such projects have not yet been contemplated by the library community, but the imminent cessation of hard copy large scale production by the Ordnance Survey may well force UK copyright libraries to negotiate a central acquisition of current digital datasets (Fairbairn, 1993). The ARL GIS Initiative is another good example of active collaboration. Few of the participating libraries would have bought into GIS without the framework and support offered in the project. The importance of the project lies therefore not just in the technical issues, but also in the co-operation and sharing of resources and experience it offered.

5.4. Getting it together: integrating with hard copy services

In-house development and collaboration have not yet come to terms with the biggest problem. How do you combine the past with the future, to offer an integrated map library service combining digital with hard copy services. Is such a goal even desirable?

There are certainly major problems for those institutions charged with preserving an ongoing record of changes in the landscape, when a digital production system replaces hard copy publication (Elliot, 1992). A recent conference in the UK addressed the issues of how best to guarantee access to the future history of the landscape when the OS ceases to publish hard copy large scale plans. The situation of national mapping in the UK is not necessarily typical of the challenges facing all map libraries, because of the unique combination of a complete large scale database, with enormous quantities of vector digital data, a formal system of legal deposit, very broad categories of users and a government policy encouraging the Survey to move towards full cost recovery. However some of the conclusions drawn from this meeting and reported in Fairbairn, (1993) are of critical relevance to other map libraries in the GIS age. His paper reports on the range of technical options possible for delivering usable data to the library using community in the UK. Participants at the meeting agreed that a single solution for accessing historical hard copy maps and digital data would be the preferred option, with the digital integrated with conventional into a single service. What to do with the existing hard copy archive was seen as just as much of a problem as ways of dealing with the digital data. A range of technical options were presented and evaluated, not just from technical, but also from economic, administrative and user points of view. These compared different vector, raster and hard copy service options for current information, historical data and integrated solutions (see Figure 2).

Fairbairn's article does not of course address the complexity of accessing multiple formats of data derived from many different production systems, compiled to very different standards. It shows the complexity of issues for a *single publishers'* technological transition.

6. Conclusions: defining quality?

Only by appreciating the complexity of data and systems and their application in different library contexts can we come to terms with offering a quality of service in the GIS age in map libraries. The form of service offered will inevitably vary according to available resources and demands. We can expect that disparities in the level of service will increase, with a few well resourced collections offering a sophisticated range of conventional and digital services, to elite groups in different societies, and the large majority of map libraries continuing to offer only hard copy mapping to their users. The quality of the information provided in a sophisticated digital map library might of course be inferior to that offered in a well run conventional collection, and it is unlikely that GIS in a library context will improve access to geographic information for the majority. Digital mapping will, however, force all map librarians to move to a more explicit definition of their role, to clarify new flexible standards, to quantify the time spent serving particular needs. Old assumptions will be challenged and questions raised about why and how we do things. This paper does not offer easy answers to these questions. Like Pirsig's Phaedrus we will have to pursue our own individual quests for quality, according to our own ethical standards.

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Table 1: Examples Of Library Practice In Using Digital Mapping

1. Canada

Author	Library surveyed	Results
Znamirowski (1993)	14 Ontario libraries.	No correlation between collection size and use of cartographic software. No GIS use in map libraries. Collections with links to cartographic laboratories more likely to use drawing packages in libraries. Electronic atlas use in 14 collections

2. UK

Campbell (1991)	British Library	No acquisition of cartographic publications on disc
Parry (1994)	University of Reading	Use of electronic atlases, route planners, census mapping packages, topographic and base data and limited software in a University collection
Millea (1994)	Bodleian Library Oxford	Use of six CD-ROM based electronic atlas products in a copyright library

3. USA

McGlamery (1989)	University of Connecticut	Pioneering study of accessing and mapping digital census data in map library
Larsgaard (1992)	University of California	Early developments of GIS facility attached to map library
Minton (1993)	64 research libraries across the USA	Reviews the ESRI GIS-ARL Project which aims: "to provide effective access to federal electronic data, to review and evaluate the introduction of GIS into the library community, to assess short term needs of ARL Libraries to provide government information and to develop new initiatives in research libraries".
Kollen and Baldwin (1993)	University of Arizona and review of GIS ARL libraries	Reviews the library or lab. dilemma, the problems of biblio-graphioc control and the potential of co-operation.
Allen (1994)	Purdue University	Practical aspects of accessing and downloading images over the Internet
Wood (1994)	100 North American collections	Edited review of Map Library in Transition Conference reporting progress towards the digital map library across many North

Figure 1: Types of Cartographic Software

Arranged in *increasing order of difficulty* and *increasing functionality*.

Slideshow Atlas and Information programmes are intended to present fixed pre-defined electronic views of data, together with associated text and statistics. Export to other programmes is possible, but only limited interaction with the data is facilitated. The maps may not be changed or customised. *eg Global Explorer*

Route planners concentrate upon optimising and mapping route choice through a road or rail network and are usually user friendly packages. *eg Autoroute*

Simple Paint Packages allowing manipulation and creation of raster images on screen. *eg Paintbrush*

Map Creation Packages are intended to create simple maps for inclusion in presentations, but allow only very limited user input. They usually include limited boundary files, and sometimes limited thematic mapping capabilities. *eg AAG Map Sets*

Electronic Atlases and Census front ends integrate mapping software with tabulated specific census data. Often allow user defined mapping of census variables on screen, with application of thematic mapping capabilities to these datasets. Usually with a limited range of map design tools and limited export capabilities. *eg SCAMP CD*

Customised Map Creation Programmes include boundary files, worksheets of data and the capacity to link these in order to create user defined statistical graphics. Able to process a variety of import formats and different datasets and to export or create displays of different kinds. *eg Mapviewer*

Drawing packages offer a more sophisticated range of tools for the creation of desktop maps, but usually without the link to worksheets. Often incorporate vectorising modules, multiple layering, fonts, line, point and area symbologies, in order to allow sophisticated on screen desktop map design, and flexible import and export facilities. *eg CoralDraw*

Computer Aided Design CAD Systems for precision drafting, often used in automated production cartography and include basic analytical functions in addition to a sophisticated array of software tools for manipulation of vectors. *eg Autocad*

Geographical Information Systems with the capacity to collect, organise and analyse geographically referenced data, incorporating a sophisticated range of analytical database functions with mapping capability. Supports for instance features such as point in polygon, buffering, geographic query and Boolean searching. Flexible import and export capabilities. *eg ARC INFO*

Figure 2: Options for Data Provision to Digital Map Libraries

(After Fairbairn, 1993)

Shows the mix ot hard copy, vector and raster options available for current digital map production and the historical hard copy Ordnance Survey archive in British copyright map libraries.

Options for contemporary data

1. Provide files to library

2. Install Superplan Service in Library

3. Provide paper printouts from Superplan elsewhere at agreed intervals

4. Provide raster images on CD-ROM on standard sheetlines at agreed intervals

Options for historical coverage

5. Vectorise historical coverage

6. Raster scan historical coverage

7. Keep hard copy archive

Options for combining historical with contemporary data

8. All data in vector form

9. Vector-based contemporary data, raster historical data

10. All data raster scanned

11. All data hard copy