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The Electronic Map Library: New Maps, New Uses, New Users

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Why do we need an electronic map library?

Given the acquisitive habits of map librarians, the fact that digital data "are there" may seem adequate justification for building an electronic map collection. However, the cost of digital map acquisition, and the implications in terms of new technology and new staff expertise require more serious consideration. In this paper, three reasons for the acquisition of digital maps are suggested: firstly that they provide opportunities to create new maps (and to replace old ones); secondly that they provide new and valuable ways of visualizing and using spatial data; and thirdly that they will satisfy new kinds of users.

New maps

A growing problem for traditional map libraries is that many maps are no longer routinely published in conventional printed format. Many national surveys are now focusing their attention on the production of digital data rather than paper-based maps. The Ordnance Survey of Great Britain, for example, is no longer committed to providing printed copies of its largest scale maps, although plot-on-demand is available from OS agents through the so-called Superplan service. This trend has been even more evident in the case of thematic mapping, where the use of digital data in geographical information systems has reduced the need for expensive print runs of conventional soil, geological and other kinds of thematic maps.

Two examples, again from the UK, are apposite. A number of map library enquiries concern land cover information or climatic data. Such enquiries are now hard to fulfil from conventional printed paper sources. The last field-by-field survey of land cover in Great Britain, the Second Land Utilisation Survey, was carried out in the 1960s, and this, although largely completed, was never published in its entirety. Similarly with climate, a number of maps of Britain and the UK have been published in the past by the Meteorological Office or the Royal Meteorological Society, but many of these are out-of-print and the most recent detailed printed rainfall map was based on the International Standard Period 1941-1970.

Yet contemporary *mappable* data in both these thematic areas are available in digital format. Land cover data with a 25 metre resolution are available for Great Britain as a *Land Cover Map* derived by the Institute of Terrestrial Ecology from multitemporal Landsat imagery from 1988–91, while at the University of East Anglia, the Climate Research Unit has recently prepared a new baseline climatology of the UK using 1961–1990 averages. A common feature of these two products is that they are primarily digital data sets, designed to be used in a GIS environment. They may be utilized with a PC and both are designed for applications best achieved through the medium of computer software. The land cover map also forms part of a more general *Countryside Information System* (Department of the Environment, 1993), while the baseline climatology forms an element of a package called *SPECTRE*, designed to model the consequences of climatic change.

Many socio-economic data sets have commonly not been mapped in the past, presenting the map maker with many difficulties, both theoretical and practical. In digital form however they can now be mapped more readily, using the digital boundaries of the spatial referencing systems (EDs, postcodes, grids) used for their collection to create choropleth maps. The British census, carried out decennially since 1801, generated relatively few maps before 1970, and those few covered only a modest range of themes. The gridded data of the 1971 census however heralded the birth of many digitally produced census atlases, while from the late 1980s, and especially following the release of the 1991 census data and related digital boundary files, the printed census atlas has effectively been replaced by the do-it-yourself census mapping package epitomized by SCAMP-CD (Schools Census Analysis and Mapping Package), from Claymore Services, a low-budget set of key census statistics, digital boundary files and topographic detail which can be combined into customized maps using Claymore's MAP91 software.

New applications

The nature of of some of these datasets and the way they have been formulated hint at some intended applications. The digital land cover map provides a baseline for a programme of monitoring change in the countryside, while the climatic dataset contributes to the predictive modelling of climatic change. Geodemographic information from censuses and elsewhere can now be used to reveal a wealth of spatial correlations and co-variations, and is in regular use for market research. Digital road networks have provided a basis for route planning and optimization and for automatic vehicle location and in-car navigation systems. Not all these applications are appropriate to map library use of course, but they illustrate how the information formerly locked in static maps or tables can, in digital form, be manipulated to solve many problems more easily.

New users

The user base and the customary usage of different map collections vary greatly, but Figure 1 shows the four main pools of enquiry at the University of Reading's map collection. These categories are reflected in the nature of this kind of collection, whose stock-in-trade for the last twenty-five years has predominantly been modern topographic and thematic mapping world-wide. The share of usage between the four groups is not equal, however, being heavily weighted in favour of "reference" and "research".

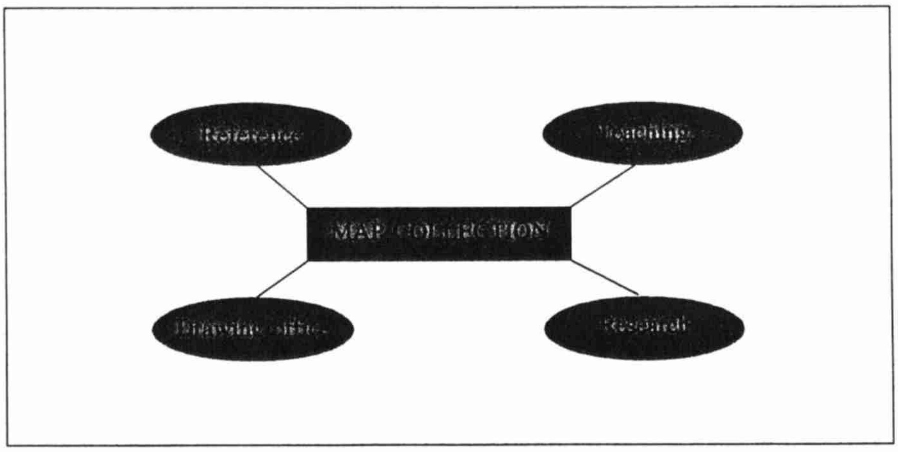

Figure 1: Pricipal pools of map collection users of a UK university map collection

The reference use attracts a widely spread range of users whose requirements are both eclectic and unpredictable. Research use on the other hand is characterized by a consistent use of specific spatial information over an extended time period, and research is increasingly making use of digital rather than analogue data.

At present, rather few from the pool of reference users arrive at the map collection expecting to gather information from digital maps (many are still uneasy about using conventional maps). But user profiles *are* changing, and there is a growing tranche of users who are both computer-literate and who *do* expect to find digital data in the contemporary map library (and often have high and unduly optimistic expectations).

Map collections must also be prepared for the up-coming generation. Young people presently in secondary (high school) education are not only veteran arcade gamers, but are also increasingly familiar with using CD-ROM based reference material both at school and in the home. Many of the new multimedia educational products (like Microsoft's *ENCARTA Encyclopedia*, for example) have attractive and interesting user interfaces, and entertaining and helpful ways of navigating through the rich files of data using Boolean logic and hypertext. Many of these products include maps. Within three years, Dorling Kindersley, a pioneer publisher in combining education and entertainment for young people, expects to have ceased publishing books in favour of interactive CD-ROM based learning products. Map curators therefore must also prepare to meet the expectations of the next generation.

Setting up the electronic map library

Having justified the need for electronic or digital maps in map libraries, one may consider how such mapping could or should be introduced. Two models are suggested for doing this, one radical and the other more cautious. The radical model, which has emerged primarily in North America, amounts almost to a paradigm shift for map libraries and the role of their curators. Although the new paradigm is as yet far from clear, at the very least it implies a comprehensive redefinition of user needs and the transformation of institutional and practical policies (see, e.g., Allen, 1993; Wong, 1993; Wood, 1994). This model has been catalyzed by the ready availability, and indeed the free distribution on CD-ROM to many American libraries, of public domain digital data, and by the enormous growth in a very short time span of data distribution through electronic networks, especially the Internet. Many subscribing to this model believe that unless redefinitions take place, there may be no future role for map collections and their curators (cited by Wood, 1994)!

In UK map collections, however, a second, more cautious model has been more typically adopted. Here, the introduction of digital mapping facilities has been tempered by government attitude to ownership of digital data. The UK government's Tradeable Information Initiative advocates full cost recovery for both the collection and dissemination of government data. This has led to a commodification of spatial data by government departments, resulting in high prices and tiresome copyright restrictions.

The consequence has been that map libraries have so far lacked the funds (or the influence) to become major players in the acquisition of digital spatial data. Indeed government mapping organizations such as the Ordnance Survey may have been wary of entering a serious dialogue with libraries on this issue because of the danger of data leakage to users who would otherwise be required to pay for it. Academic use of some government-supplied datasets has been facilitated by special terms for acquisition negotiated through a CHEST (Combined Higher Education Software Team) deal, but such arrangement are made for institutional research and teaching purposes and have tended to by-pass map collections. This situation causes immense frustration for map libraries, and it seems that any initiative must come from the library community. One possible solution is being explored by the University of Edinburgh Data Library; this involves the formation of library consortia for purchasing or leasing digital data, and the provision of controlled public access points to the data through a networked data service (Burnhill, 1994).

In practice, however, and pending further developments, many map libraries in higher educational institutions have taken a modest and independent route to digital map acquisition by purchasing a range of moderately priced electronic atlases and data sets which are available complete with retrieval and mapping software on CD-ROM or floppy disk. There is perhaps a further advantage in acquiring these kinds of products in that curators can catalogue, curate and control the use of them and so retain them unequivocally in the map collection's domain!

At one time, the high cost of computer hardware was also a major impediment to the acquisition of digital maps in map libraries. But now many mapping applications may be run on low-priced stand-alone PC or Macintosh systems. The hardware components need however to be chosen carefully since they determine to a large extent the digital capability of a map collection. In the USA, the government has defined the minimum workstation for Federal Depository libraries for its own CD-ROM products as a 486SX machine operating at 25 MHz, with 16 megabytes RAM, 3.5" and 5.25" high density disk drives, between 120 and 210 megabytes of hard disk memory, an IDE or SCSI interface and VGA display capabilities. Also required are a CD-ROM drive, Windows environment and colour printing or plotting facilities (Kollen and Baldwin, 1993). Already these specifications seem limiting. A 486DX machine with a faster clock speed and higher capacity hard disk would probably now be regarded as a necessary entry level specification, and a larger than usual screen size is advantageous. The message is clear: investment in hardware is not a once only cost, since it will inevitably require periodical upgrading. And while these costs may compare favourably with those of installing a few new metal map cabinets, the funding structure of the institution may not be adjusted to this new demand for high-end technology from the map library!

There are other institutional considerations for a university collection, where the map curator may be but a small player in the development of an overall information technology strategy. There are many vested interests: the university's computer services may wish to have control of the distribution of digital, including spatial, data, or the social science or economics library may regard geodemographic data as its own preserve. Map curators need therefore to promote themselves as experts in the handling of spatially related data sets.

What is available?

Computer map packages do not form a single tidy class, but straggle across a range of data and software programs in various combinations. There is much variation in what can be done with diverse packages, ranging from the simple screen analogue of the paper map or atlas, providing ready-made graphics with minimal possibility to modify the data or its presentation, to packages which have much of the functionality of a full-blown geographical information system. But whereas a GIS is essentially a software program (or suite of programs), most of the packages considered here are also rich in data and come ready to use.

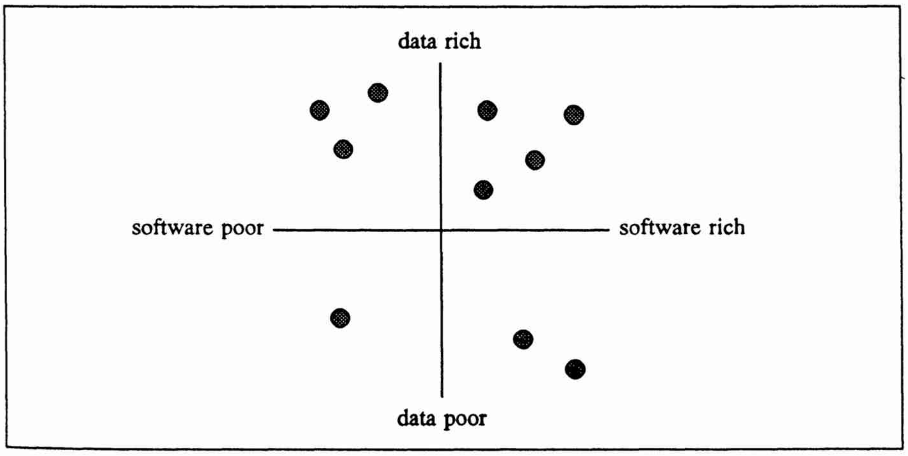

Figure 2: Classifying mapping packages by data and software properties

The best of them fall into the north east quadrant of Figure 2, being data-rich but also able to use the computer's power to explore and interact with the data and to customize their graphical presentation.

Regarding the functional capabilities of the packages, it is evident that there is a progression from static maps ("slide shows", or in Muehrcke's terminology "whole image" maps) such as the original *Electronic Atlas of Arkansas* to packages such Chadwyck-Healey's CD-ROMs of the 1991 population census of Great Britain, which allow a measure of data analysis and the construction of potentially unique thematic maps. There is not however a simple continuum from software poor to software rich packages. Software may be engineered for different kinds of application, as can be seen in Figure 3. Packages which are dedicated to on-screen drawing and design for example are quite different from thematic mapping packages which marry statistical data to an area-polygon base map.

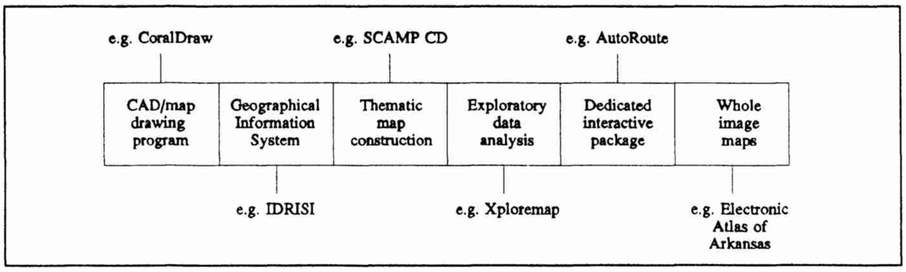

Figure 3: Types and examples of computer mapping packages

Of the sixteen stand-alone electronic map packages currently held in the map collection at Reading, most fall into one of three broad categories, namely electronic atlases, route-finders and statistical (thematic) mapping packages. Although GIS facilities are available in the map collection, these have not –so far– been integrated into the general map room services. Similarly, CAD-type drawing packages remain in the domain of the drawing office. While almost all these packages have potential for fulfilling both simple or more complex map enquiries, it is probable that the more complex the task, the more likely it will benefit from a "software rich" package.

Map users - what do they want?

A number of researchers, including (among those writing in English) Board, Castner, Morrison, Muehrcke and Sandford, have considered the nature and ordering of map reading tasks. Most studies however have been undertaken in the context of a map-communication model, or the learning of map reading skills, and have been more concerned with how the map is decoded than the nature of the enquiry which led to the map being read. Thus map reading complexity is defined in terms of the interaction of visual perception and map design rather than the sophistication of actual map enquiries. Sandford (1986) and Board (1984) are among the few who have given some limited attention to the nature of map enquiries, and Gersmehl (1981) suggested a graded series of behavioural objectives in topographic map reading on which Figure 4 is based.

Map curators, of course, know all about the nature and variety of map enquiries from their own professional experience! But they too have published little about this. As Gillispie points out (Gillispie, 1990), published studies have mainly made use of the circulation statistics of map type and user profile, such as are routinely collected by large libraries. But curators know that most map collection users seek information rather than a specific map, and, more often than not, it is the curator who defines the appropriate map source.

Map curators need to assess their users' needs if they are to find digital solutions to their enquiries, and they need to "think digital" in order to identify those kinds of map enquiry which can better be met by electronic rather than conventional paper map-based solutions.

Matching electronic maps with user needs

Map using tasks, whether of low or high order, may require either qualitative or quantitative information. While both may be provided by the conventional paper map, the digitally based electronic map or atlas has the potential to deliver *quantitative* information more efficiently than by conventional map reading.

Perhaps the simplest, low order map reading enquiry concerns the location of places, for example the country in which a place is located, where in a country a place is located, or increasingly, where in geographical space a coordinate reference (collected using GPS instrumentation) is located. Electronic world atlases are well equipped for dealing with some of these questions, with ability to search for a name and find the relevant piece of map, or to identify latitude and longitude by simply placing the cursor on the site. Their current limitation is in the poor resolution of screen maps, which is insufficient to meet many requests, and the absence of indications of data quality (many packages are vague about their sources, and are known to contain many errors). Furthermore, users looking for a location often require more than a spatial reference; they need a qualitative description of the place and/or its relative location.

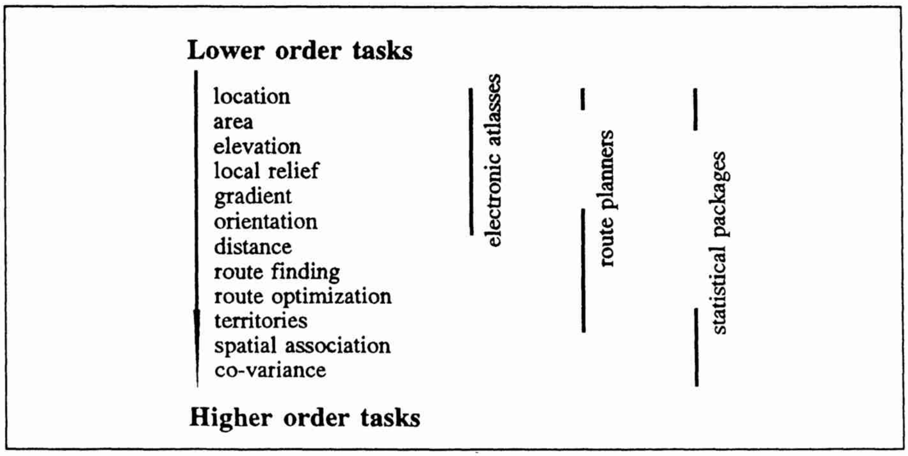

Figure 4: Relation of electronic map packages to map reading tasks (after Gersmehl, 1981)

This rather more sophisticated map reading task also needs a level and range of detail still only to be found in large conventional atlases or on topographic maps. Some compensation may be offered by the ability of many such packages to link maps to statistical or written descriptive information. In some recent products (for example DeLorme's *Map'n'Go*) the multimedia concept is exploited to provide slide shows, videos and speech to enhance the cartographic representation of place.

One not uncommon request is for the correct spelling of a place, and there is perhaps scope for an electronic gazetteer with a spell checking facility for standardized geographical names!

Many map reading tasks require the extraction of metrical information from maps such as altitudes, orientation, gradient, distances, and areas. Even some of the simpler electronic atlases have a capability to extract *some* of these data. A useful feature in the "utilities" menu of *PC-Globe* for example, is the calculation of direct line (Great Circle) distances between locations identified either by name (from the package's gazetteer) or latitude/ longitude coordinates. What these packages will not do is to select, filter and relate values in the way a real GIS would be expected to.

Route finding packages are generally more interactive than the electronic atlases just discussed. *AutoRoute,* has been the market leader in the UK, since its launch in 1988 by the company NextBase (now part of Microsoft), which used the Ordnance Survey 1:625,000 scale resolution digital road map as a basis for an intelligent route planner which calculates and displays fastest, shortest and preferred driving routes (Anthony, 1991). NextBase has subsequently produced packages for a number of European countries and the USA. Route planning may seem a trivial use of a map collection, but it is also a very common one and this and similar route planners provide a useful introduction to the "added value" which can be supplied by computerized maps. NextBase also recognized that the package had the potential for many other applications and has developed a companion package called *MapBase* which can be used to plan territories, calculate drive zones and add thematic information. But even the basic route planner is amenable to more than simple route planning, and was recently used at Reading to calculate a matrix of driving distances between 180 European cities.

The map displays for route planning packages are usually limited in content and design, since their function is to show the route calculated by the package, rather than the range of information needed when planning and navigating with a conventional atlas. This limits their use for general purpose map reading. A recent CD-ROM version of *AutoRoute* incorporates excellent 1:250 000 scale raster digitized Ordnance Survey maps of Great Britain, but these cannot properly be integrated with the route planning network, which is at a coarser scale. One of the most interesting packages to be launched recently, however, DeLorme's *Map'n'Go*, has succeeded in incorporating relatively high quality maps which adjust automatically and well to different zoom levels and on which route selections can be highlighted.

The most interactive electronic mapping packages in the range under discussion are the census mapping products which, for Great Britain, have been produced by Chadwyck-Healey and by Claymore Services. These are dedicated specifically to the retrieval and analysis of census variables, and combine the convenience of a stand-alone system with the potential for serious research with a major thematic data set.

One further kind of map use can sometimes be accommodated by electronic mapping packages: the user who requires a simple A4 sized base map which can be taken away for use in a presentation or written report. Requests of this kind are often extremely difficult to fulfil, notwithstanding the existence of a number of printed collections of reproducible outline maps marketed for this purpose. Electronic atlases offer a potential solution here, and are already much used for this purpose. The software for creating maps from digital data can be regarded as a set of map making tools. They do not offer the flexibility of a pen or a CAD package, but they do make the technical side of the operation one which requires relatively little skill.

Conclusions

The scenario of digital map use presented in this paper is one which involves map curators in a more rather than less interactive role with the users of their map collections. The gentle introduction of digital mapping into the traditional structure of the map room gives both curator and user an opportunity to discover and accommodate, to relate and compare the functionality of digital maps to that of their hard copy counterparts.

The ascendancy of digital maps has meant that the map collection's function and the curator's role have become less distinct. It has been suggested that map curators should be redesignated as "spatial data librarians", dropping the word map from their title (Lai and Gillies, 1991). But there is surely a danger here, because something which remains very important in the digital age is the appreciation of the power of the map as a graphic image more revealing than the data on which it is based. While completing this paper, a postcard from Canada announced the arrival of the *National Atlas of Canada* on the Internet. As Patrick McGlamery has observed, perhaps soon nobody will feel it necessary to visit a map room any more! Yet there are still plenty of people who need to understand and make sense of those graphic images, whether on screen or paper, and map curators are the mediators who can provide that essential guidance.

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