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COMPUTING

FOR BBC MICRO, ELECTRON AND TORCH USERS

DOMESDAY PROJECT

THE BBC VIDEO DISC DAZZLER



IN THE WARE HOUSE
MUSIC 5000
CUMANA'S UPGRADE

ELASTIC ELECTRON STRETCHED TO 64K

COMPLETE GUIDE TO DATABASES

EDUCATION
DISCOVERING DINOSAURS TO
SCHOOL ADMINISTRATION

DOMESDAY DAZZLER

Gordon Taylor spent some considerable time at the BBC exploring their new Domesday System: he thinks it's "The Kingdom through a looking glass"

William the Conqueror in 1086. To tie in with the series, the Domesday Project was launched in November 1984 jointly by BBC Enterprises, Philips and Acorn. The Project was the idea of Peter Armstrong (an executive producer at the BBC who became its Editor) and it was hoped it would be a contemporary survey of the Kingdom using the latest technology to handle the quantity of information. It was also to make use of the computers in schools. The BBC are "recycling" some of the money received as royalties on the BBC Microcomputers, and the Department of Trade and Industry has also contributed towards the total project cost of some £2.5 million.

The medium chosen was not a book, but interactive video discs, using the Philips LaserVision system. Discs were preferred over tape because they are much faster in interac-

which avoids any wear. The information is carried on the reflective coating on the inner face of the plastic disc, which protects it. Moreover, the LaserVision system has been developed further to handle digital data, which allows the discs to hold vast quantities of text, numeric data, and computer programs, in addition to audio and video. Such discs are known as LaserVision Read Only Memories (LV-ROMs), and the system as Advanced Interactive Video (AIV).

Advice on the content of the discs was received from an Editorial Board. Major contributions to the data and its processing came from the Universities of Essex, London (Birkbeck College), Loughborough, Newcastle, Sheffield, Southampton, and Wales (Bangor). In addition, community groups — mostly some 14,000 schools — surveyed much of the



Figure 1 Community Disc. Level 0 map. The high-lit area shows the extent of the South side



Figure 2 Community Disc. Level 2 map. Block size is 40 x 30 km

The BBC is to broadcast a major television series to coincide with the 900th anniversary of the completion of the Domesday Book — the survey of England that was ordered by

tive use, and are cheaper to replicate in quantity. The LaserVision discs cannot be written to or corrupted, and a non-contact (optical laser) method is used to read them,

country in 4 x 3 km blocks, and were supplied with special data collection software for use on

C O N T I N U E S ►

DOMESDAY SYSTEM

BBC and RML Micros. Another major contribution came from the BBC/Open University Production Centre at Milton Keynes. They transferred all the maps and photographs to 1 inch video tape, which was sent (with others) to Philips for transfer to the "master" discs. The BBC, Philips, and Acorn have all contributed to the Operating Software. However, the Retrieval Software, which provides the user interface, was written by Logica, under contract to BBC Enterprises.

indexes to, and names of, picture sets, essays, and datasets. These files occupy some 344 Mb on the two sides of the Community Disc, and 208 Mb on the National Disc. However, the Domesday discs are a product of the television age, designed for easy understanding. Not only is much of the information presented in movies or still pictures, but all the data can be presented as graphic charts and maps.

Everything on the discs is subject to copyright, and they include details of most of the

data to a printer, or to floppy discs, for your own private use.

For this article, I have drawn extensively on the (draft) User Guide. The reason is that the system is so vast (it would take seven years to view all the material), while the timetable did not allow me to have unlimited "hands on" time. However, I also visited the major participants, and formed the view that the very high standards usually reached by them individually have been equalled, or even exceeded, in this project.



Figure 4 Community Disc. Level 3 map. Availability of Level 4 maps is shown by the grid



Figure 3 Community Disc. Level 2 map. Block size is 4 x 3 km

The two resulting double-sided Domesday discs are "an electronic exhibition" — "a database with pictures — aiming to depict 'British Life in the 1980s'". The Community Disc is intended as a popular record, based largely on maps and submitted photographs and text, while the National Disc is more formal, including film, commissioned photographs, selected essays, and statistics, most of which can be accessed via a pictorial Gallery. As well as the maps and pictures, the Domesday discs include many files, eg gazetteers to maps, and

copyright holders. Although the copyright for the maps remains with the Ordnance Survey, and for the official statistics with Her Majesty's Stationary Office (HMSO), that for the community data has been assigned to BBC Enterprises, so reducing the number of copyright holders from around a million, to only about 50. This was done to simplify the matter of rights for use on the video discs, and re-use in this or any other form. There is however, an implied licence to view the contents of the discs, and to download pages of text and

Operation

The discs are played on a "delivery" system — so called to distinguish it from the "authoring" system used to create interactive software. It consists of a new player (the Philips VP 415), a modified Acorn BBC Micro (the Master Turbo AIV), and a colour monitor which can display RGB-linear signals. Unless already "configured", the system should be "initialised" with `<CTRL>Q<BREAK>` and "booted up" by pressing `<SHIFT>BREAK`. This

Figure 5 Community Disc. Level 4 map (street plan). Block size is 8 x .6 km.

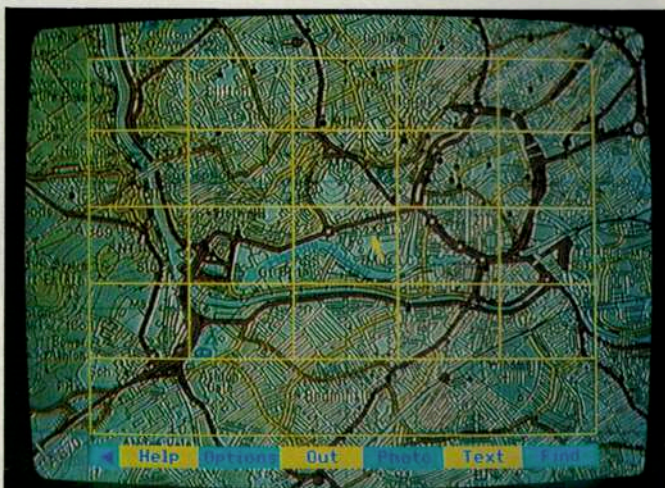
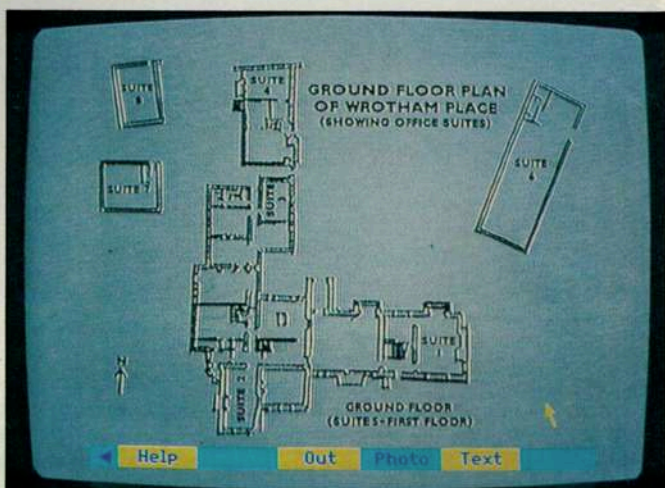


Figure 6 Community Disc. Level 5 map (floor plan). The ground floor plan of Wrotham Place



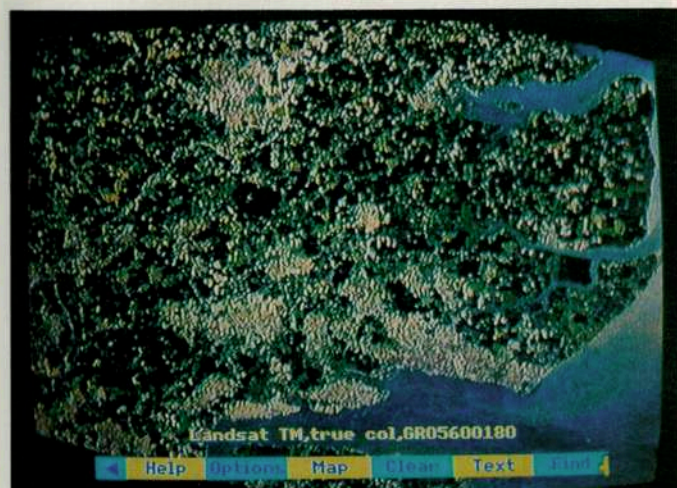


Figure 7 Community Disc. Level 2 photograph. Thematic mapper true colour composite. Bands 3 2 1 linearly stretched. 100m pixels after processing by GeoData, Southampton and Sheffield Universities and the Royal Aircraft Establishment

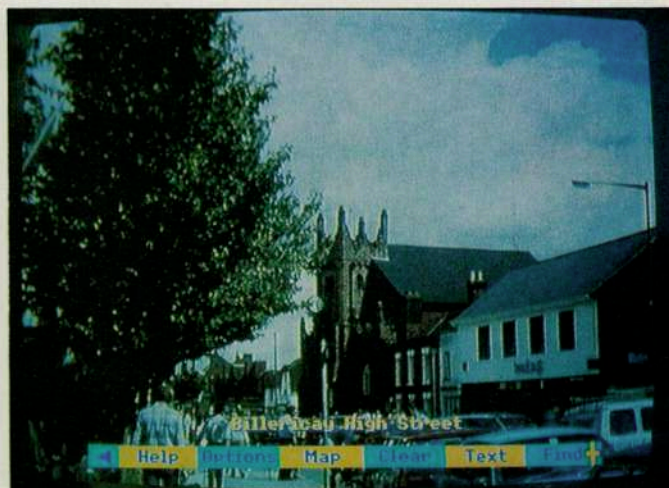


Figure 8 Community Disc. Level 3 photograph. Billerica High Street.

takes about 40 seconds, since it loads some other code before the Retrieval Software — all from the video disc. No floppy disc is required.

An on-screen Pointer is used, which is generally an arrow pointing to the North-West, but changes to a cross when on the Menu Bar. The Pointer may be positioned by a trackerball (which is included, though a mouse can be used instead), or by the cursor keys on the keyboard. A trackerball is preferable to a mouse as it needs less desk space, and can be fixed down if required. "Action" is effected by the left button of the trackerball or mouse, or "Return" on the keyboard, and "Change" is effected by the centre button of the trackerball or mouse, or "TAB" on the keyboard. The Pointer can be used to navigate around the maps, the Gallery and the Surrogate Walks.

The Menu Bar consists of six rectangles of alternating cyan (light blue) and yellow at the bottom of the screen. These allow selection via the Pointer, and carry "dynamic" labels for the function keys <F1> to <F6>. With these being in a single horizontal line, the BBC Micros have by far the best arrangement for this purpose — as belatedly recognized by IBM with the latest PC keyboard. The keycard repeats the cyan and yellow rectangles, with labels for <F0> (Remove/restore Menu Bar), <F1> (Help), <F7> (Previous), <F8> (Next), and <F9> (Remove/restore computer output), but <F2> to <F6> vary. Each of the 54 different Menu Bars represents a different system "state", and since "Help" is also "context-sensitive", offers a choice of up to six different subroutines. Selecting from the Menu Bar can be done either by positioning the Pointer, and pressing "Action", or with the

function keys <F0> to <F6>. To "page" through picture sets or text essays, you can position the Pointer to the left or right of the screen, and press the "Change" button (like turning a page), or press <F7> or <F8>.

Search words and some commands are entered via the keyboard. There is a one-line Message Area at the top of the screen, but the "Find" option uses a full screen. The Community Disc is driven largely by the Pointer and trackerball, and the National Disc mostly from the keyboard. The text is computer-generated from data (rather than held on video screens), and displayed in 40-columns — but is proportionally spaced, unlike the standard Mode 1, except when showing tabular data.

C O N T I N U E S ►

Figure 9 National Disc. Picture set of Design Council awards

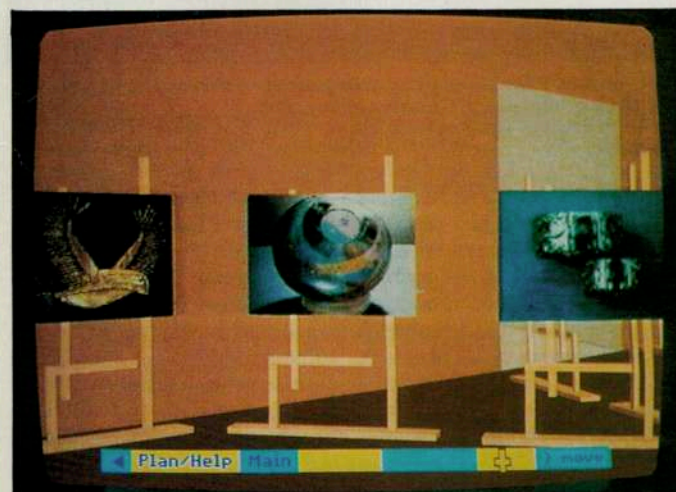


Figure 10 National Disc. Surrogate walk around a stone cottage

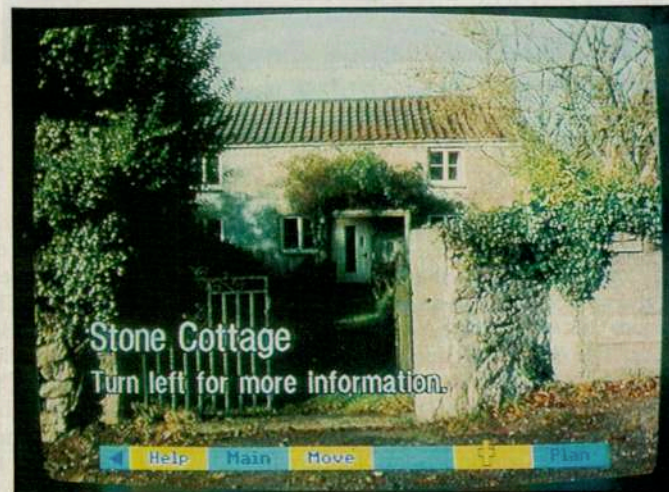




Figure 11 The icons show where close ups are available



Figure 12 National Disc. Tabular dataset. Ownership of household appliances (eg G = home computer) by social class. Bar chart

Text or graphics can be switched off (with F9) in order to view any underlying video — such as a map or photograph — more clearly. The aim has been to enable you to do all the simple things without using the User Guide. To that end there are “context-sensitive” “Help” texts, and a number of audio-visual “Demo” sequences one minute long. Also under “Help”, there is a “Bookmark” function, which is a record of where you are. One can be held in memory, while others can be saved to, and loaded from, a writable (eg floppy) disc.

systems, and also the Channel Islands, which use the French mapping system. The maps are arranged on six “levels”, of successively larger scale. The Level 0 (whole UK), and Level 1 (country) maps were specially produced. The Level 2 maps show blocks 40 x 30 km from the Ordnance Survey 1:625000 series, the Level 3 maps blocks 4 x 3 km from the 1:50000 series, and the Level 4 maps blocks 0.8 x 0.6 km from the 1:10000 series, while the Level 5 floor plans were locally produced to various scales (see Figures 1 to 6).

the Menu Bar. In city centres, and at points of special interest, small yellow rectangles show where a further “zoom” in is possible. As well as “zooming” between the Levels, you can move across them, by “map-walking”. The Pointer may be positioned in any of eight areas near the edge of the screen, to determine the direction of movement when you press “Change”. Your place is kept when you use “Help” (or other facilities, via “Options”), and you pick up where you left off, even when you turn over the disc — eg when “map-walking”

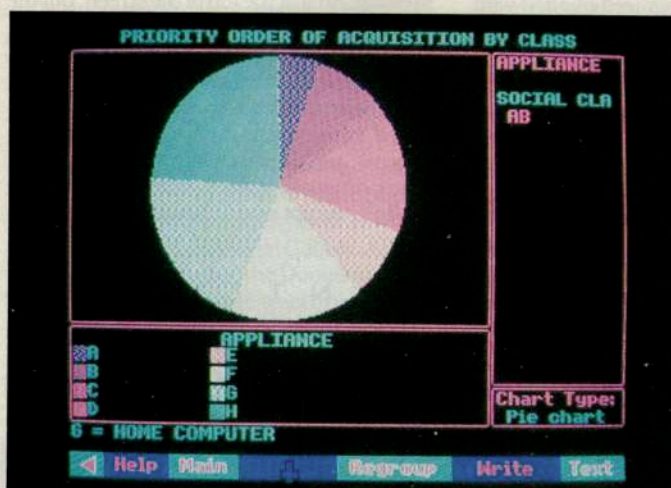


Figure 13 Pie chart



Figure 14 National Disc. Mappable dataset. Men of working age in Greater London area by 1 km squares windowed to exact boundary

The Community Disc

The opening sequence shows the Domesday logo and a copyright message, followed by a “zoom” out to the whole of the United Kingdom. The complete sequence lasts about a minute, but can be shortened by pressing [ESCAPE]. There are 25,000 maps on this disc, covering the whole United Kingdom. This includes both Great Britain and Northern Ireland, which are on separate Ordnance Survey

The Community Disc contains all the maps of Levels 0 to 2 on both sides, and those of Levels 3 to 5 divided between the “North” and “South” sides. These are either side of a line just south of York (with a slight overlap), with the “North” including the Orkneys and Shetlands, the Isle of Man, and Northern Ireland, and the “South” including the Isle of Wight and the Channel Islands. To “zoom” in, you position the Pointer and press “Action”, and to “zoom” out, you select “Out” on

across the line between “North” and “South”.

The “Grid Reference” (actually the two coordinates) of a point can be read out from maps using the Pointer. You can also measure distances and areas (with up to 50 points for each). Although this works only for the current map, for larger features you can either measure the parts separately and add them together, or go up to a higher level. Distances and areas may be expressed in either Metric or English units.

The Community Disc includes a Gazetteer of all the place names that appear on the Level 3/1:50,000 maps, together with their Grid References. Places can therefore be found either by Grid Reference or by Name. For example, you can select "Find", and enter a grid reference via the keyboard. This may be expressed in either of the two forms recognised by the Ordnance Survey — all-numeric (eg 05507 02560) or alpha-numeric (eg TL 507 560). For the latter, the first two digits — which designate a square 100 km by 100 km — are replaced by a two-letter code. This works on the maps of Levels 1 to 4, using Grid References of appropriate resolutions. Level 0 contains too many different National Grids (Great Britain, Northern Ireland, and the Channel Islands), and Level 5 consists of floor plans which are not to a fixed scale. A yellow cross will indicate the exact grid reference point. Alternatively, you can use "Find" and enter a place name (or the first few letters thereof). This will either display a map, highlighting the kilometre square closest to the centre of the village or town, or show a list of possibilities in alphabetical order, from which you may select with the Pointer.

Many of the maps have associated photographs and text, which may be accessed via "Photo" and "Text" respectively. Level 0 has one satellite image of the whole UK, and Level 1 one satellite image per map, while Level 2 has up to seven aerial photographs or remote sensing images per map — the latter in either true or false colours (see Figure 7). Similarly, there are text essays linked to Level 0 on the UK as a whole, to Level 1 on the six countries or islands, and to Level 2 for most of

the 40 x 30 km blocks, plus some traditional areas, such as the Grampians. Many Level 3 areas have up to three photographs and 24 K of data, consisting of photo captions and up to 20 pages of text — provided by the schools and other local groups (see Figures 8, 15). The disc contains some 20,000 local photographs and 200,000 pages of local text. These are associated with over 9000 of the Level 3 maps, covering 105,000 (out of 220,000) square km, mainly the populated areas. However, there is room for over 70,000 photos and corresponding text, to cover the whole UK, so more may be added in later editions of the disc. There are no pictures or text for Level 4, and those for Level 5 are limited to the special features covered at this level.

For direct, indexed access to the picture sets and text essays, you can use "Find". To determine the scope of the search, you first select the appropriate map (which remains visible behind the "Find" screen). Retrieval is possible directly by name, entered between quotes, or by typing one or more "keywords", of which there can be four per photograph or screen page of text. However, these keywords are not necessarily present in either the short or long captions of the photos, or in the text. Only groups of three or more characters are recognized as words, and the length of the complete string can be up to 120 characters. No leading or trailing wildcards are allowed (or are necessary) thanks to the use of "stemming" of the words, rather as in a dictionary. Negatives (express or implied — eg except) are not recognised, but multiple words are automatically "inclusive-ORed" together. For instance, "Soil distribution" acts as "soil

distribution" or "soil" or "distribution". As a rule, one word gives too many "hits", and 10 words would be very slow to process. Three to four words are about right, and will probably result in items you want appearing at the top of the list. The responses are shown as a group with perfect matches, then groups with increasing numbers of items in the index — each ordered alphabetically. Up to 100 responses are acquired at once, of which 21 are displayed, and one may have its number highlighted. You can page through using the Menu Bar or function keys. Another 100 may then be picked up, until 100 percent of the search is completed. Once selected with the Pointer, you can page through a picture set or text essay, and also jump to the start or end, by using the Menu Bar or function keys. Individual pages may be downloaded to a printer or to a magnetic disc (see below).

The National Disc

Whereas the Community Disc is centred around maps, the contents of the National Disc are organised by topic. It starts up with the Gallery, which is a sequence of computer-generated graphics of an exhibition complex. This was created using a Bosch FGS 4000 and a Quantel Paintbox, and is stored as a series of video images (as opposed to being generated by the BBC Micro) (see Figure 9). Navigating the Gallery is by turning left or right by 45 degree increments, and by going forwards or backwards. You can call up a plan with "Help", which shows where you are, and the direction you are facing (see Figure 16).

There are eight directions of view from every position in the eight "rooms", in which about 230 pictures give access to the 579 picture sets, and 32 signs (or "plaques") give access to most

Figure 15b

Transport - Roads

Page 29

{TRANSPORT: Roads.}The original Domesday surveyors would have used the ancient Icknield Way which developed as a series of parallel tracks using the open country of the lower chalk foothills, and running diagonally through our block from Royston in the S.W. to Newmarket in the N.E. This line to-day is followed by the A 505, A 11 and A 1304. Even more important would have been the remains of two great Roman Roads, Ermine St. or the original Great North Road crossing the block from Royston to Huntingdon, now A 14, and the Via Devana, originally from Huntingdon to Colchester by way of Cambridge (now the A 604). S.E. of Cambridge the Roman route has been abandoned and remains a bridleway on the Gog Magog Hills to near Horseheath while the modern road follows the valley of the upper Granta.

Figure 15a

0520	0240	TEXT INDEX	TL 20 40
1		SOUTH CAMBRIDGESHIRE	
2		Urban Landscape of Cambridge	
6		Rural Landscape-Chalk Belt	
12		The Rhee Valley	
15		The Western Plateau	
17		The Ouse Valley & Fenlands	
18		Farming Scenery	
19		Other Towns	
21		Education	
26		Science and Technology	
29		Transport - Roads	
35		Transport - Railways	
38		Transport - Waterways	
39		Transport - Airports	
40		Conclusion	
See:		The Southern Fenland Basin	

C O N T I N U E S ►

of the Overview essays, while nine open doorways look out to the Surrogate Walks (Figures 10, 11). The picture sets contain up to 100 or more photographs, and total some 22,000, including portfolios from 30 contemporary photographers, and over 6000 from the Domesday Photographic Competition. There are 2083 essays in all, averaging some 35 screen pages, and concentrating on "today" (ie the 1980s). The Surrogate Walks are sequences of some 2000 photographs, showing the exteriors, interiors and close-up details of nine environments, ranging from a down-town city centre to a stone cottage. They are stored on the videodisc in an ordered fashion so that the user can "walk" through them, as with the Gallery. Again, a plan can be called up for each, showing your position and direction.

In addition, the National Disc contains about 9000 numeric, category, or "incidence" (ie Yes/No) datasets. The material is drawn from virtually all the country's recognised sources of quantitative information, in both the public and private sectors. It includes both "hard" physical and economic data, and that on social attitudes etc. Examples include data from the 1981 Census of Population, and the British Social Attitudes Survey. The spread of topics, and the level of detail available for each subject, corresponds broadly to the attention given in all the UK's publicly funded research programmes over the early 1980s.

All the above material may be accessed using "Find", much as for the Community Disc. This allows direct, indexed searching — as in a dictionary. The datasets are either classified by one or more independent variables, and "chartable" in line, bar or pie charts, or classified by grid coordinates, and "mappable" by "Areal units" — either "Grid" (eg km squares) or "Area" (administrative areas) (Figures 12, 13, 14). These are of 22 different types, such as counties or parliamentary constituencies — numbering 3696 in all. Data may be "mapped" at various resolutions — eg 10, 2, 1 km — which take progressively longer to process. The administrative areas are irregular in shape, and "windowing" may be used to blank out parts outside the boundary. Because there is no frame store, when the player is doing a data access, it must lose the video access, and the screen, eg map, blanks. After the data is mapped, it is switched to "Transparent Mode", and the underlying geographic map is restored. The grading of the class intervals for the chartable and mappable data is adjustable by the user. This facility can also be used to convert (multi-class) numeric or category data to (two-class) incidence data. Two sets of incidence data may be "linked" for comparison, while two sets of numeric data may be "correlated" (ie used to determine Spearman's Rank Correlation).

Print and Write

The video images are not handled by the computer, but provision is made to obtain a hard

copy printout and to save ("Write") a file of computer-generated text and data — though only one page at a time. Datacharts and datamaps may be "dumped" to a printer in bit-image mode, using the "Bookmark" option. Alternatively, high-resolution, multi-colour hard copies may be produced by a plotter on paper or transparent film, with a program which can read the "Write" files, (such as the Linear Graphics "Plotmate" plotters, with their free Dataplot program). Any necessary "star" commands may be entered after selecting "Help", then "System" on the Menu Bar.

Documentation

The User Guide for such a powerful and versatile system is inevitably large, but it is very well-organised, and easy to read. It conforms to the usual Acorn BBC A5 wire-bound format, and includes a Contents List, and a comprehensive Index. Better still, it is extensively illustrated, with photographs showing each step of every major operation.

Everything on the National Disc may also be accessed via the "Contents" option, since it is all stored under a hierarchy of subject headings. This allows a structured search — as with a thesaurus. Although less comprehensive in retrieval than "Find", it also offers cross-references. The four headings at the top of the hierarchy are: Society, the Economy, Culture, and Environment. The second level has 45 specially commissioned Overview Essays, and the bottom level has all the remaining items.

The other side of the National Disc is designed to run with Constant Linear Velocity (CLV), which allows up to 60 minutes of movies, rather than Constant Angular Velocity (CAV) (as the other three sides), which would allow only 36 minutes. It holds about 120 short clips which record moving images of the 1980s, mostly news or sporting events.

They are linked in seven "montage" sequences in chronological order — one for each year from 1980 to (August) 1986. Each lasts for about eight minutes. They can be accessed via the "Find" and "Contents" options, and turning the disc over when prompted. Alternatively, this side may be played as a standard LaserVision disc, and the "year" sequences chosen from a list of titles, using the remote control handset.

Comparisons

The original Domesday Book (which covers only part of the Kingdom) contains some two million words — with some data (only embedded, not tabulated), and no pictures. With its much larger scope, the 32 volumes of the 15th edition of Encyclopaedia Britannica contain over 30,000 pages, 44 million words, 87,000 articles and cross reference entries, plus 24,000 photographs, drawings and

maps. It costs £1110 with the cheapest, plastic covered binding.

The two double-sided Domesday Discs together contain material for about a million screen page displays. Around a quarter of these are video images, still or movie, with the remainder being computer-generated text, data, and graphic displays. There are more than ten million words on the Community Disc, and over two million on the National Disc. In addition, the Domesday Discs are provided with several indexes, including the visual ones of the maps and the Gallery. The contents of the three CAV disc sides are equivalent to perhaps 300 reference books, and the data alone to over 1500 IBM-PC floppy discs.

In terms of Ordnance Survey maps, the Domesday discs contain at Level 2 the equivalent of the 1:625000 "Routeplanner", at Level 3 the complete set (Sheets 1 to 204) of the 1:50000 "Landranger" series, and at Level 4, maps of some 70 Town and City centres at 1:10000. In printed paper form, the total cost of the maps would be over £5000. The maps on the discs are even more valuable, since they are linked with the Gazetteer of place names, the National Grid (coordinate system), and the ability to measure distances and areas.

It has been estimated that it would take about seven years to call up and examine all the material on the two discs. Hence they almost certainly contain some errors — quite apart from the spelling mistakes in the community (largely "school") texts, which have been left in deliberately. However, since the Project afforded a rare opportunity for correcting the errors and omissions in the original sources, the data on the Domesday discs is probably more reliable.

Compared with on-line databases, the AIV system can "deliver" detailed colour pictures — even movies — which are not practical over telephone lines. Even data is available at a much higher rate (about 100 times as fast), giving a far quicker response, and without communications charges. Moreover, the nature and timing of enquiries are confidential to the user, rather than being open to "analysis" by the database "host" and others. Furthermore, the Domesday Discs offer twice as many pages of information as the 300,000 of the entire Prestel database.

An earlier Acorn interactive video system, based on a BBC Model B Microcomputer, and a Philips or Pioneer LaserVision player, was launched in October 1984, targeted at the "professional" education and training market. Known as the Interactive Video (IV) system, it is now based on the Master 128, and is priced at about £3000 plus VAT. Users can run interactive programs, which may be created even for existing discs, using the "frame-based" authoring language Microtext Plus, developed at the National Physical Laboratory (see my review in *A&B*, Jan/Feb 1984). No discs or programs are included, but the authoring language is available for about £220. The broadly comparable Teletape Videologic MIC-2000 system, based on an IBM-PC compatible computer and a LaserVision player, was priced at £3500 plus VAT.

in April 1985. However, both these systems use ordinary LaserVision discs and players, which do not offer the same range of capacities and functions as the LV-ROM discs and Philips VP 415 player.

When the Domesday Project was conceived some three years ago, the delivery system was seen as based on a Model B with a Second Processor, and a LaserVision player, which at the time of the announcement in November 1984, was expected to cost £975. In the event, the computer has been enhanced substantially, now being based on the Master Turbo. Moreover, the VP 415 player has a much larger data capacity, a far smaller data error rate, a greatly increased data transfer rate, and can overlay the video with computer-generated text and graphics that are typically of 320 x 256 pixels, rather than the 80 x 75 pixels of Teletext. At the same time, the exchange rate has halved to around 3 Dutch guilders to the pound — and so the system has become appreciably more expensive. The price for the complete AIV system, including the two Domesday discs, is expected to be £3990, plus VAT. As this is higher than expected, especially for schools, who contributed so much in collecting community data, the consortium partners and their dealers are discussing a concessionary price for all schools. A dealer-fitted kit will be available for upgrading existing Master Turbos to the AIV specification. In addition to outright sale, systems will be available on leasing terms. The AIV systems and the Domesday (and other) discs are to be marketed via a network of Acorn and Philips specialist dealers. The aim was to get them to the dealers before the launch on November 25th, so they should be available immediately afterwards.

Other Operating Software

Programs can be written by users and others to run in place of the Domesday Retrieval Software, controlling the system directly via the usual MOS and special VFS commands. EXEC files, which can be written in a suitable word processor, can be used for simple lists (see *A&B*, January 1986 p68). To use branches and loops as well, a programming language (such as BBC BASIC), is needed.

Specific provisions have been made in the Retrieval Software to allow that loaded from the video disc to work with additional software loaded from floppy disc. Enhancements or additions are expected (from either the consortium members or from third parties) which will allow "tours" though the Domesday disc material to be "recorded" for subsequent replay — eg in a presentation or lesson. Other developments could allow users to compare and combine their own data with that on the Domesday discs, and to map it over Domesday maps, and to subject the Domesday data to more advanced forms of analysis and graphical display.

Other Discs

Further LV-ROM discs are already in preparation. The BBC expects to release one on ecology next Spring, and BBC Milton Keynes hope to upgrade their "Weight World" gymnastics disc from the present IV format (see below).

The AIV system can also be used to play existing and forthcoming interactive video (IV) LaserVision discs — eg the Open University "Teddy Bear" disc, (a tutorial on plastics and metals for the Faculty of Technology), the Wiley "Science Laboratory" Disc, and the eight Interactive Video in Schools (IVIS) discs). These carry no digital data, and the operating software must therefore be loaded from floppy discs. This is machine-specific, but Acorn BBC Micro versions are, or soon will be, available. The VP 415 player will also play all other (PAL) LaserVision discs — both Active Play (CAV) and Long Play (CLV) — such as those listed in the Philips Silver Disc Club catalogue. These number about 30 CAV discs, and 700 CLV discs. The AIV system is thus far more capable than a standard LaserVision player, of which there are already some 10,000 in the UK.

As a further sign of things to come, BBC Enterprises, Philips and Logica joined in January with the French company SEP to develop an intelligent voice and picture storage and retrieval system for use by the general public. This pre-competitive research builds on the experience gained in the Domesday Project, and is funded by ESPRIT — the European Strategic Programme for Research and Development in Information Technology.

Discussion

The Domesday discs should be of great value as a business and educational reference work. The system provides rapid access to an enormous amount of information, much of which is theoretically in the public domain, but which in practice is often difficult to obtain. Despite its vast capacity, the system fits easily on a desktop. Users could include:

- Market researchers and economists, using the data on personal consumption (eg housing, ownership of appliances — by region, social class etc.), newspaper readership (by region, age, year etc), and activities throughout the day.
- Those promoting British Design and manufacture at home and abroad, using the photographs and descriptions of the 193 products which won Design Council Awards in the years 1980 to 1985, plus maps and data on local employment and transport facilities etc.
- Local government planners, using the maps and data on local amenities.
- Travel agents planning and selling holidays in the UK, using the maps (measuring

distances), and the local photographs and data on amenities.

- Estate agents, again using the maps, photographs and data on amenities. In addition, with appropriate software, their own data on properties available (perhaps classified by number of bedrooms, garage, price range etc) could be overlaid on the maps.
- Teachers, using the system as a curriculum resource, eg for geography, using the maps, and data on local land cover and amenities.
- Libraries, using the system to answer queries, both local and national. However, the most convincing proof of its value is to try the Domesday system for yourself.

Conclusions

The BBC, Logica, Philips, and Acorn deserve to be congratulated on their achievement with the Domesday Project. As well as prompting new standards of performance for both hardware and software, it has been completed in a remarkably short time. They have contributed credibility, method, resources and innovation, and — with the help of the Universities and many others — have created a world-beating product — an "electronic exhibition" that can be explored with ease, but is almost unlimited in its potential. Moreover, if proper account is taken of its unique capabilities, it is remarkable value.

With these origins, there is every prospect that the new standards for LV-ROM discs and players will be adopted widely, leading to a major new market for both hardware and software. Would-be purchasers can therefore invest with confidence, and enjoy both the immense immediate benefits, and still greater returns in the future. Clearly the same technology could be used for an "electronic encyclopaedia". In short, the Domesday System offers "Today the United Kingdom, tomorrow the World".

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C O N T I N U E S ►

How the Domesday System works - a Technical specification

The Discs

It was always foreseen that the Domesday system would be designed to use interactive video discs via the Philips LaserVision system. These optical discs have a track density of 16000 per inch (compared with, for instance, 96 per inch for an 80-track floppy disc). This is achieved by very accurate servo control of both the focussing and tracking of the optical reading head. The spiral track is some 31 km long, and the capacity is 54,000 video frames for sides designed for Constant Angular Velocity (CAV) and 90,000 frames for Constant Linear Velocity (CLV) sides. Both types are normally played at 25 frames/s, in accordance with the PAL television standard. High quality still frames are achieved easily with CAV discs, since they hold one frame (two interlaced fields) per turn of the spiral track. Moreover, they can be maintained indefinitely without wear, thanks to the non-contact method of reading the disc.

Although the video and audio information is stored in series of "pits", with "lands" between, LaserVision is an analogue (pulse width modulation) system, in which the length of the pits is significant. On standard Laservision (CAV) discs, data may be held in the analogue images (as for Teletext). While this is available alongside audio, it has a capacity of only 170 bytes per frame (ie 9 Mb per disc surface). Later in the Project, digital data coding was adopted which, when used, replaces the "audio track" (actually the audio bandwidth of the single combined signal). With a capacity of 6K per frame, the maximum data capacity is 316 Mb per disc surface — ie 36 times as much. However, it is still well within the 512 Mb per volume allowed by the Video Filing System (VFS).

In addition, the digital coding improves the error rate enormously, from 1 in 10⁻⁵ (which is acceptable for audio, video and normal text, which has appreciable "redundancy") to 1 in 10⁻¹⁵ (which is needed for numeric data and particularly computer programs). Audio is still possible in those parts of the track where data is not required (and switching between them takes only 10 frames, or 0.4 seconds). However, each minute of audio reduces the data capacity by some 9 Mb. The "audio tracks" of two of the three CAV disc surfaces are packed full, with data wherever audio is not required. Such discs are known as LaserVision-Read Only Memories (LV-ROMs). The Domesday Discs could be termed

"smart", since in addition to video, audio, and data, they contain their own Retrieval Software (which is downloaded to the computer).

The Delivery System

The delivery system has four main levels of operating software — each running on separate microprocessors. The Acorn BBC Master Turbo Co-Processor contains the (Domesday-specific) Retrieval Software, and the Master 128 itself the usual Acorn Machine Operating System (MOS), and the special Video Filing System (VFS), while the Philips VP 415 player contains the LaserVision Disc Operating System (LV-DOS), and the low-level Control Software.

With the great increase in data capacity, a higher transfer rate became essential to ensure speedy response — eg when loading Retrieval Software subroutines into the computer, or when searching datafiles. Hence the RS-232 serial connection of the previous VP 830 Series videodisc players, with a typical data rate of 9600 bits per second (ie about 1K per second), was replaced by the industry-standard Small Computer Systems Interface (SCSI) parallel "bus" connection, with a maximum data rate determined as the lesser of those of the videodisc player and the computer. Since that of the player is 50K/s and that of the BBC Micro is 25K/s, the maximum data transfer rate is 25 times as fast as before. The control signals from the computer to the videodisc player still use a serial path — now in a spare pin of the SCSI "bus".

Computer and Software

The Acorn BBC Master 128 is fitted with a Turbo Co-Processor, for additional RAM memory and twice the processor speed, and a board next to the power supply, carrying an SCSI controller and an ultra-stable integrated oscillator. The latter is used instead of the standard "crystal", to ensure reliable synchronising of video and computer output ("Genlocking") in all conditions. The recently-modified battery pack (which powers the CMOS RAM) is relocated underneath the case, just forward of the power supply. The SCSI provides high-speed communication between the computer and (up to eight) suitable peripherals, such as the new video player. In addition to video, audio and text and numeric data, the video disc carries the Retrieval Software. Hence no floppy (or hard) disc drive need be connected (though they can be — for saving and loading writable files of various types).

The Retrieval Software was fully specified and written by Logica, to an outline requirement from the BBC. It is written in BCPL (which was developed at Cambridge University, and is a forerunner of C), and totals some 200K. Since this exceeds the capacity of the Turbo Co-Processor, only part (the "kernel") is resident all the time, and the remainder is loaded as required. The Retrieval Software

acts as a dedicated database management system, which allows the user to access a vast number of pictures, and items of text and data. The three CAV disc surfaces may be catalogued with *CAT, to reveal the Retrieval Software modules, index files, names files, and text and datafiles. For example, the National Disc contains 38 files which range from an initialisation module of 332 bytes to a datafile of 135 Mb, and occupy 208 Mb in total. Each of the three CAV disc surfaces has files called MAPDATA, GAZETTEER, INDEX, NAMES, and DATA*. MAPDATA files hold the frame numbers of the (normally) eight maps adjacent to the current one, for use when "map-walking", while GAZETTEER files hold all the place names shown on the Level 3 maps (270,000 on the Community Disc, repeated on each side, and 60,000 on the National Disc), each with the corresponding frame number. The INDEX, NAMES, and DATA* files are linked, forming a pathway to the video frames. The INDEX is a list of keywords, which are "stemmed", much as in a dictionary. It does not include all the words in the text, but nor are the keywords just those in the titles, or in the captions or text.

Up to four per photograph or article could be chosen freely by the contributors — though the Project team did suggest 37 primary or "Specific" keywords to use as one such. There are 4200 keywords in the Community North INDEX, 6000 in the Community South INDEX, and 7500 in the National INDEX, and each keyword has a list of pointers to the respective NAMES file. This contains a list in alphabetical order of every item on the disc, and its location in the DATA* file. On the Community Disc, an item is a set of three photos, or a screen page of text, while on the National Disc, an item is a Surrogate Walk, a picture set (averaging 50 photographs), an essay (averaging 35 pages), or a dataset. The DATA* files contain the photo captions, both short and long, and the corresponding video disc frame numbers.

The Retrieval Software uses both the main and "shadow" screens of the Master 128 greatly to improve performance during requests for "Help". Thus the main screen RAM continues to hold the current text or graphics, while the display is switched to the "shadow" screen RAM, to which the Help text is written. Some of the remaining RAM memory in the Master 128 is used to hold an alternative character set or font. The standard Domesday text display uses Mode 1, which is 40 columns by 32 lines in four colours (though even this is proportionally spaced, save when putting up tables). For displaying pie charts, more than the standard four colours of Mode 1 were required. Hence 12 distinct "mixed" colours were chosen from the Extended Colour Fills offered by the "Graphics Extension ROM" (GXR) commands in the Master Series Operating System. However, for showing mappable data, only eight colours were needed, implying Mode 2, which normally allows only 20 characters per line. For consistency with the other screen displays, an

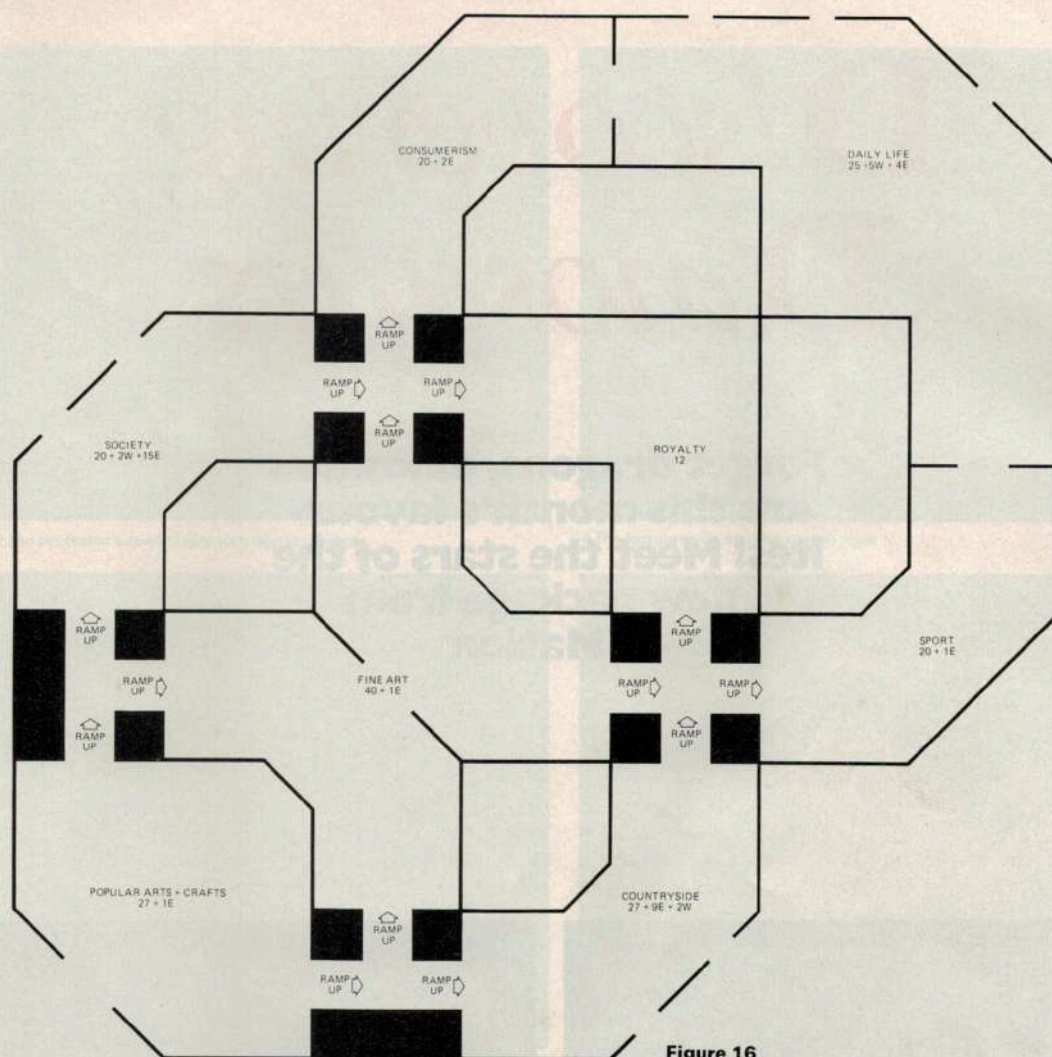


Figure 16

alternative 40-column font was defined, with a character width of only 3 pixels (and one for the space).

The 64K of Sideways RAM in the Master Series computer is used as a "cache" to hold the status of any overlay while "Help" is being used, and also to hold the "Bookmark". The Retrieval Software operates via the Machine Operating System (MOS) as usual, together with the special Video Filing System (VFS), and any writable filing system, such as the ADFS, and acts as a "shell" for them all. Thus, for example, *TRACKERBALL is issued automatically when required, rather than by the user. The current filing system is that held in the CMOS RAM with *CONFIGURE FILE n, or reset via the "System" option.

The VFS is a 16K ROM, written by Acorn in 65C102 machine code, based on the Advanced Disc Filing System (ADFS). It is fitted in the one 16K ROM socket on the motherboard, since the two 32K sockets are "overlaid" by the 64K of Sideways RAM, which is used by the Retrieval Software for "caching". The VFS may be selected with CTRL-Q-BREAK. It contains the "star" commands *TRACKERBALL and *MOUSE to enable these devices. (Actually, either command may be used for either device, even though they have different connections to the User port). It also includes

commands such as *FRAME, *PLAY, *LOAD etc, for accessing and reading the video disc — whether for audio and video, or for data. Other commands determine how the computer and video outputs are combined. The default is "Hard Key", where any non-black computer output overlays the video (actually by appearing in holes "punched" in it). "Transparent" mode displays the computer output at reduced brightness, which allows the video (eg, a map) to show through. "Highlight" mode is where any black computer output causes the underlying video to be displayed at reduced brightness, while areas covered by non-black output show at full brightness. The VFS translates such commands into SCSI commands which are recognised by the LV-DOS. Hence to the Retrieval Software (or any other operating program), the videodisc player is just another disc drive.

Videodisc Player

The new Philips LV-ROM player contains a Z80 processor which runs the LV-DOS, (resident in 32K of ROM), and acts as an SCSI controller. It also contains digital data decoding chips, much as in a CD-ROM player,

which reduce the error rate from 1 in 10-5 to 1 in 10-15. The computer display has 256 lines, while the PAL video has 512 visible lines out of a total of 625. Hence the RGB signal is sent as two identical "interlaced" fields, combined with the video, and fed to the monitor. The LV-DOS system, the digital data decoding chips, and the video mixing and Genlock boards are held in a base casing. This base is then added to a VP-410 player (which has many improvements on the VP 830 Series, and contains another processor running the Control Software, resident in 64K of ROM), to make a VP-415.

Monitor

The AIV system includes a Philips CM 8533 12 inch colour monitor, which has a dot pitch of 0.42 mm (suitable for displaying 80-column text). It also has a loudspeaker, for outputting the audio from the video disc. The video and audio and computer output are fed via an AV Euroconnector (or SCART plug), and can also be connected to most modern domestic (PAL) televisions. The output could be displayed to larger audiences by using a direct view monitor/TV of up to 26 inches (such as the Philips Matchline), or a projector (such as those made by Sony and Electrohome).