Title: **The Changing Management of Networked Electronic Information Resources.**

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Abstract

It is suggested that the Boston Consulting Group (BCG) Matrix is an appropriate model for the lifecycle of the use of networked information resources at UK universities. Despite the fact that the metrics for this model – the market share and market attractiveness - and the traditional measurement of return-on-investment are not directly applicable to this field.

The BCG Matrix is examined in its suitability for this application as are the extensions and alternatives that have been proposed for its various failings.

The use of networked CD-ROMs as information resources is the focus of the report as between 1985 and 2005 it has passed through all four stages of the matrix. The duration of this life-cycle gives an opportunity to examine the internal and external factors that have driven this and the changes in management style required over a technology's life.

A case study into the use of networked CD-ROMs at the University of Birmingham is presented showing how practical use of the technology mirrored the theory and a survey is made of other UK universities to prove the case study is representative of general circumstances.

The report finds that the use of the model is a valid one as its predictions are bourn out in practice in the life of the technology and in the case study. The survey shows that the case study is typical of UK university experiences in almost all respects.

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Contents.

1. Introduction.

We live in an information-heavy world. According to Reuters (1996),

> "More information has been produced in the last 30 years than in the previous 5000. A weekday edition of the New York Times has more information in it than the average 17th century man or woman would have come across in an entire lifetime."

Efforts need to be made in the areas of both information provision and interpretation to make sense of this glut of information. In the 1980s and 1990s, CD-ROM technology was seen as an ideal way of fulfilling needs in both areas. Previously datasets had been available only by directly connecting to centralised data centres. Library/informational skills were needed to effectively search the data - making the process open to experts rather than consumers - and costs were high for both the connection and data retrieved.

CD-ROM technology allowed data to be made available locally within institutions and advances in their user interfaces negated the need for extensive training or mediated searching. Costs become non-recurrent (other than for subscriptions to dynamic datasets) and were not tied to the volume of usage. The next logical step was to network these resources within institutions and allow their use first within then later outside the university library.

This report investigates the usage and management of CD-ROM technology within the framework of the Boston Consulting Group matrix and consists of four areas under examination :

i) The Boston Consulting Group Matrix – the pros and cons of using this model and particularly its suitability to this application.

ii) The lifecycles of CD-ROM and CD-ROM networking technologies and the internal and external factors that drove their lifecycle changes.

iii) An extensive case study showing how the use of networked CD-ROMs (and the management of these resources) at the University of Birmingham followed this lifecycle as it passed through four different networking solutions

iv) A study of the use of networked CD-ROMs in other UK institutions to consider how typical the case study is of general experiences.

The principles covered in this report – the use of networked electronic resources, the factors that drive a technology and the use of the BCG model to assist in their management – are applicable to many technologies in many fields. However, for the practical reasons the scope of this report has to be limited. If considers the use of CD-ROMs as a directly accessed storage media – not their use as an off-line storage or archiving solution. Also, the use of other media such as DVD, magnetic storage and the Web are only considered in relation to the use of networked CD-ROMs rather than in their own right.

The focus of the report is on their use in UK higher and further education. Their use in the private sector is a niche market which deserves its own, narrower project and their use in other countries, particularly the US and far east, has to be omitted from this report for clarity's sake.

The key hypothesis of this report, therefore, can be summarised as :

> The BCG Matrix is a suitable model to use for the management of networked electronic information resources, despite the properties of this matrix (market share, market attractiveness, profitability and return on investment) possibly being either immeasurable or inapplicable.

In the writing of this report, the focus shifted from the original intention to place less emphasis on the 'change management' (management of change) of electronic information resources and more to the changing management issues. As a result, the title has been changed from its original "The Changing Management and

Change Management of Networked Electronic Information Resources". This is discussed further in Appendix A.

2. The Boston Consulting Group Matrix.

2.1. Background.

The Boston Consulting Group (BCG) is a consultancy firm that was started in 1963 by Bruce Henderson which developed work done by one of their consultants, Alan Zakon, for the Mead Paper Corporation into the BCG matrix. This is a non-industry-specific method of analysing business units and products by viewing the business as a portfolio of businesses. Essentially this is a "simplifying tool" (Morrison and Wensley, 1991) that shows, via a matrix, the current situation or placement of an item within its field and, as a result, also within an identified lifecycle.

This BSG matrix, which is also called the Group (or Market) Share/Growth matrix or colloquially the "Boston Box", is the basis for this report on managing electronic resources.

The matrix is a scatter graph (which can be developed to include further data) plotting the current market growth of an entity - typically an organisation, strategic business unit (SBU) or product - against that entity's current market share. These being calculated (Hax and Majluf, 1983) as

$$\text{Market Growth Rate (Year } x\text{)} = \frac{\text{Total Market (Year } x\text{)} - \text{Total Market (Year } x\text{-}1\text{)}}{\text{Total Market (Year } x\text{-}1\text{)}} \times 100$$

$$\text{Relative Market Share (Year } x\text{)} = \frac{\text{Business Sales (Year } x\text{)}}{\text{Leading Competitor's Sales (Year } x\text{)}}$$

The field of this graph is divided into four sectors (as shown in Fig. 2.1, below) from which predictions about that entity's status can be determined :

Wild Cat : the entity has a low share of a fast growing market. To maintain this position the entity needs greater financial resources so a decision needs to be made whether to invest or to divest and consider alternatives. During this stage, the cash flow is negative as a larger investment is needed to progress to the 'Star' stage and minimal income is generated. This is also referred to in some texts as the 'Question Mark' stage.

***Star* :** the entity has a high market share in a fast growing market. The entity is financially self-sustaining and the recommendations are to increase promotion, expand the product or service and invest in further research/development. The cash flow during this stage is generally stable as the investment required falls and financial benefits start to appear.

Cash Cow : the entity has a large share of a market that is not significantly growing (or may be shrinking). It is during this stage that the bulk of income is expected to be generated and for this reason the ideal is to reach this stage quickly and then sustain it for as long as possible. This can be used to support other business activities and the priority should be to defend and maintain the current position.

Dog : the entity has a small share in a slow or negative growth market. At this stage the entity again needs financial investment that, although likely to be less that in the Wild Cat stage, is hard to offset with the low income it brings. Planning should concentrate on the short term with minimal risks and a limited future. Cash flow during this period is difficult to predict as income generated and investment needed to maintain the service or process are highly variable. In some cases the small income that is generated by a Dog is sufficient to justify its existence indefinitely.

While the names for these sectors have become common usage, they were initially criticised for the negative connotations of terms like 'Cash Cow' and

'Dog'. Hax and Majluf (1983) note that when Mead Paper, the original source of the methodology, adopted the BCG matrix they gave these areas more business-friendly names : Cash Cow became "Bond", Star became "Savings Account", Wild Cat became "Sweepstake" and Dog became "Mortgage".

By comparing an entity to its competition, its strategic importance and future direction can be evaluated. This can be used to compare an organisation against that of competing organisations, a SBU against other SBUs within the same organisation or a product against its competition both within a marketplace (from competitors) or within an organisation (from other products competing for resources).

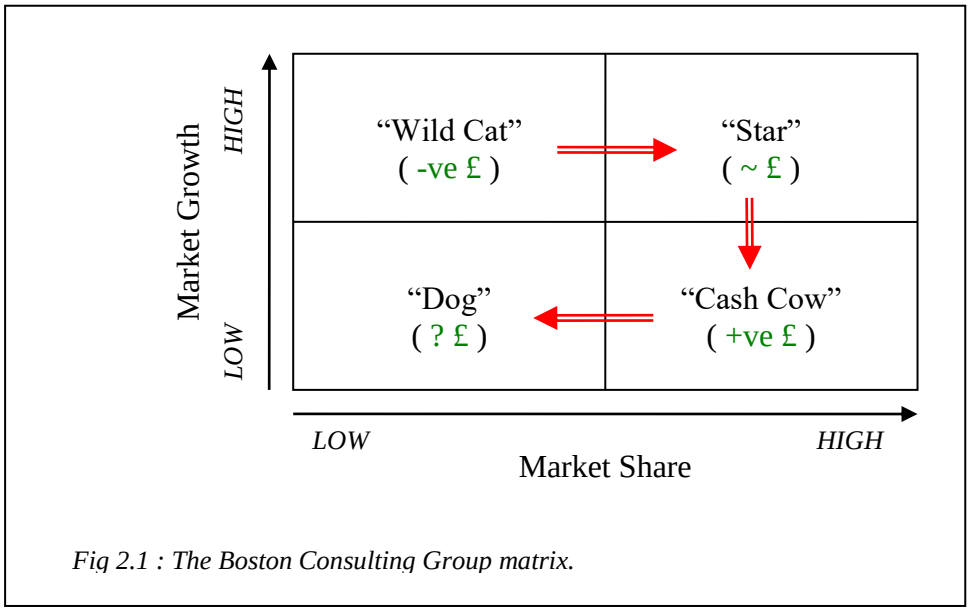


Fig 2.1 : The Boston Consulting Group matrix.

A feature of the BSG matrix, as shown in figure 2.1, is that it is expected that entities pass through more than one sector of the grid during their lifecycle. An entity that begins as a Wild Cat can, if it gains a sufficient share of the growing market, become a Star. Once this has been achieved and the market growth begins to lessen the entity becomes a Cash Cow until its market share eventually drops and the entity becomes a Dog (and is eventually divested). Ideally the income generated as a Cash Cow is greater than the investment required for the Wild Cat to reach that stage and the entity generates a profit.

It is also possible for a product to enter the matrix as a Star rather than a Wild Cat. To achieve this, a large market share needs to be acquired "instantly" in a fast growing or semi-matured market. For example a large-scale electronics company bringing out a product in a new (to them) but established high-tech market such as Amstrad bringing out an in-car Sat Nav. The company could use its experience in related markets to give a cost-per-unit advantage and create an "instant" market share. This has the benefit of entering the process without the initial Wild Cat investment overhead but this is off-set by the costs required to 'generate' the market share.

In a worst-case scenario, investment is made in a Wild Cat that does not result in a greater market share. If this happens then the entity remains a Wild Cat until the market growth eventually slows and its positioning within the matrix shifts to that of a Dog. The cash flow of a Dog is an unknown factor but it is harder for the Wild Cat investment to be recouped without the income from the Cash Cow stage in-between.

Application of the BCG matrix is particularly effective when the entity is a technology (Perkins, 1990) and this is key to the investigation of the management of networked CD-ROMs discussed in this document.

A demonstration of a practical implementation of the BCG matrix is presented by Stern and Stalk (1998). The situations of various business units are compared; specifically their statuses within a generic, organisation-wide corporate strategy against their placing in the matrix and the proposed strategies within this context. Cash Cow SBUs may seem to be outperforming those in other sectors and may be rewarded with re-investment in an area that, according to BSG, may already have matured. Dog SBUs tasked with generating income face an impossible task and long-term investments are a waste of resources. Wild Cat and Star units, since they fail to generate sufficient cash flow get a limited investment and fail to evolve into Cash Cows. Without this funding, both types of unit are doomed and may be forced to divest before turning profit.

Morrison and Wensley (1991) identify the reasons for the initial popularity of this matrix in the 1970s as its being psychological (the matrix and concepts having 'intuitive appeal'), fashionable, qualifiable by research and an acceptance by corporations of a management solution that was able to simplify complex factors while at the same time generate radical proposals. By 1972, two years after its public launch, the BSG matrix was in use by over 100 major US companies and the growth in adoption continued throughout the 1970s.

A survey of 38 UK Business Schools by Morrison and Wensley in 1991 showed that the matrix was taught on one or more courses by 100%, as part of a Marketing or Marketing strategy course by 74% and as part of a Business Studies degree course by 55%.

2.2. Limitations and Alternatives.

Stern and Stalk (1998), amongst others, identified limitations to the BSG matrix – the keys ones being that :

- High market share is not the only success factor of a unit. Indeed, the proportional link between cash flow – by definition the ultimate measure of commercial success – and market share may be weak for a number of reasons : an entity may have access to low-cost materials (un-related to market share); the effect of market share may be overcome by superior technology; innovations achieved by a unit may be exploited by allied or competitive units; profits may be affected by strategic factors other than market share.
- Market growth is not the only indicator of attractiveness of a market. A market that has reached maturity and is no longer showing potential for growth may also be attractive if the income generated by that market is projected for growth or even long-term stability.
- The performance of a unit within a sector is relative only to the same unit in other sectors, not to other units. That is to say, a unit may be classed as a

Dog based on its market share and growth and may show a cash flow that is down on its previous performance when it was a Cash Cow. However, it may still out perform other units that are still Cash Cows : albeit ones within markets that are less lucrative. It is also true that the assumptions regarding investments and income generation may not be correct. The amount of investment needed for an item to progress from Wild-Cat to Star may not be a high (making achieving an overall profit easier) or the income generated by a Cash Cow may be less than anticipated (having the opposite effect).

In answer to theses criticisms, McKinsey and Company (in collaboration with General Electric) developed a nine-cell portfolio matrix as an alternative to the BCG matrix. This is illustrated in figure 2.2.

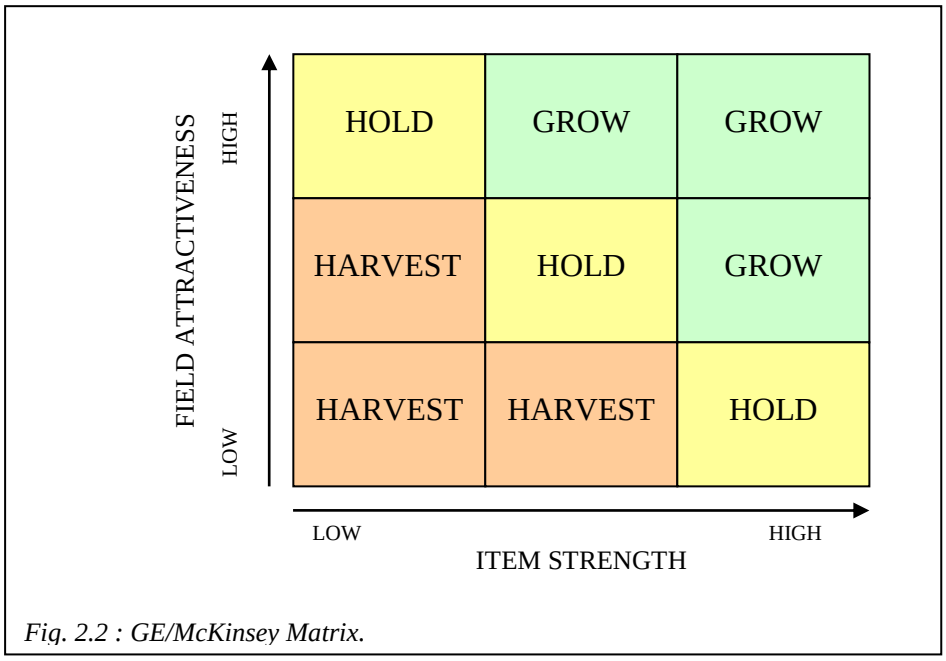


Fig. 2.2 : GE/McKinsey Matrix.

As well as having more cells than the BCG matrix (and therefore a more tightly-identified status) this solution generalises the axes into the more abstract ‘strength’ and ‘attractiveness’ attributes. The criteria for quantifying these are by evaluating a range of factors for each and appropriate weighting factor – based on the circumstances of the evaluation – to each.

Collis and Montgomery (1999) outline typical factors that can be used for each of the GE/McKinsey axes. As well as the market growth rate that was identified as the key indicator in the BCG matrix, market size is also seen as an indicator of market "attractiveness". Also commonly used are low levels of demand variability, profitability and rivalry specific to the particular industry, the global opportunities the market presents and other "macroenvironmetal" factors such as PEST (Political, Economic, Socio-cultural and Technological).

The other axis, the business unit "strength" is determined by factors such as brand equity, production capacity and access to distribution channels as well as the BCG matrix's indicator, market share (and the growth thereof). Profit margins can also be used as a factor in determining a unit's strength relative to competitors.

The strategic use of the GE/McKinsey matrix is that by plotting SBUs' current and projected locations onto the grid, the recommended actions can be determined : either to grow (invest), hold (maintain) or harvest (divest) the unit. There is also variation within these actions : a low-strength/low-attractiveness unit is prime for immediate harvesting while those of mid-strength/low-attractiveness or low-strength/mid-attractiveness – also identified in the matrix as units to harvest – could face a phased harvesting over a longer timescale.

2.3. Extensions and Applications.

The use of the BCG matrix can be extended to offer guidance beyond the investment and positioning originally intended. While this seems a reversal of the originals intent of the matrix as 'simplifying tool' in practice it is a natural development – by reducing a complex managerial situation to its simplest form, truths that may have otherwise been obscured can be revealed and used to develop a new and sometimes unexpected strategy.

One development is the use of the matrix sector to predict the expected pattern of ROI (return on investment) in addition to the cash flow. Morrison and Wensley (1991) say that the Wild Cat ROI is expected to occur randomly, Star to increase, Cash Cow to maintain a constant rate and a Dog to gradually decrease. These rates of ROI are approximate and the positive and negative growth in the Star and Dog stages are difficult to predict and are not expected to be symmetrical. Conversely, monitoring the ROI may be used to give an indication of an impending transition. For example, a plateauing increase may forecast a transition from a Star into a Cash Cow. While this plateau may show the level of ROI expected to be maintained while a Cash Cow it cannot, of course, predict how long that period may last.

Another secondary use of the BCG matrix is in its comparison to the stages of a product or industry's lifecycle. The matrix's sectors can be seen to (very approximately) correspond to the lifecycle stages of Introduction, Growth, Maturity and Decline.

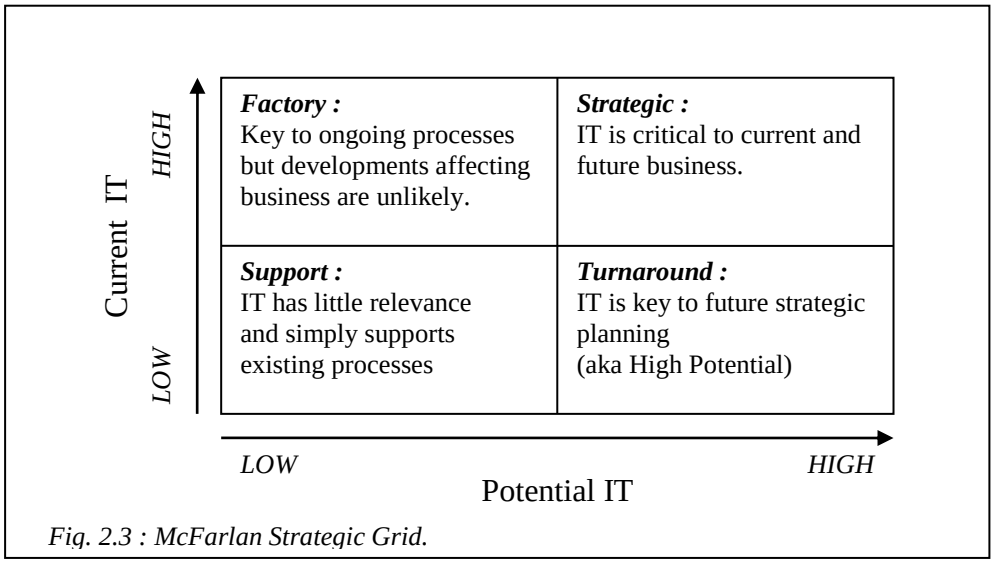


Fig. 2.3 : McFarlan Strategic Grid.

The BCG matrix can also be compared to the McFarlan Strategic Grid (McFarlan, 1989) This grid plots an organisation's current against potential IT impacts to create the independent but similar grid seen in fig 2.3 above. This

can also be used to identify other management information such as the Requirements, Management Logic, Internal IT Role and User's Role. Parsons (1983) goes as far as to identify 'Linking Strategies' that are applicable to various sectors within the grid (see table 2.4 below).

Parsons' IT strategies, based in turn on the Porter's competitive forces framework, are a suite of six generic strategies – scalable for any business model - that provide opportunities for competitive advantage. These are :

- *Centrally Planned* – an integrated corporate and IS strategy with top-down planning.
- *Leading Edge* – continuous upgrade of IT to achieve advantage with experimentation encouraged.
- *Free Market* – the empowerment of users to decide their own IS/IT strategies with little or no central control.
- *Monopoly* – the opposite of Free Market, a centralised IT service whose primary success indicator is user satisfaction.
- *Scarce Resource* – the control of IT strategy by (intensive) budgetary control.
- *Necessary Evil* – the reduction of IT usage to a minimum, all usage must be cost-justified.

Table 2.4 – Parsons Linking Strategies.

	McFarlan Grid Sector			
	Support	Turnaround	Factory	Strategic
Centrally Planned	●	●	○	○
Leading Edge	●	●	○	○
Free Market	○	●	●	○
Monopoly	○	○	●	●
Scarce Resource	○	○	●	●
Necessary Evil	○	○	●	○

Applicable ● Not-applicable ○

Pyburn (1983) concurs, stressing that an organisation's approach to IS/IT planning for any given project is dependent on that project's quadrant within the grid.

Ward and Griffiths (1996) compare the BCG and McFarlan Grids and find a direct correlation between sectors and take this further to identify the association between BCG quadrants and their required generic management styles - see table 2.5 - and that the change from one quadrant to another results in gains (for example, more independence indecision making) and losses (less funding). These styles are : the speculative "entrepreneur", the expansionist "developer", the delegating, hands-off "controller" and the watchman-like "caretaker".

BCG Matrix	McFarlan Grid	Management Style
Wildcats,	Turnaround	Entrepreneur
Stars,	Strategic	Developer
Cash Cows	Factory	Controller
Dogs	Support	Caretaker

Table 2.5 – Combining matrices.

At this time, some institutions that felt information was critical to their success created a board-level Chief Knowledge Officer with responsibility to oversee information flow organisation-wide as well as line-manage the CD-ROM network. Earl and Scott (1999) describe the role of these officers as following one or more of the following types :

- The *entrepreneur* who is willing to champion risky new initiatives
- the *consultant* who can match new ideas with business needs
- the *technologist* who is fully IT literate
- the *environmentalist* who is able to design settings and processes to maximise knowledge.

Which can also be compared the management styles identified by Ward and Griffiths above.

If Ward and Griffiths' styles are associated with the current position within the BCG or McFarlan grids then the role of the management required must also change over time as the indicator (the organisation, SBU, product or – in the case of this report – technology) evolves. If this is correct then, as Beath

(1991) proposes, we should see the role of the CD-ROM network manager or champion changing as the implementation and use of the resource changes. This changing role may be addressed either by a single manager consciously or subconsciously changing management style or by the post of manager being held by different people over the technology's lifecycle.

Beath also notes that as technology lifecycles shorten their champions are expected to change roles throughout the life of a single post whereas this previously happened over the life of a career.

3. The CD-ROM Technology Lifecycle.

The previous section considered the theory of management based on the MCG matrix and McFarlan's grid. This section looks at the technology life-cycle of CD-ROM technology – in particular its networking – over the four periods previously identified : the initial 'WildCat' period when the market was small but fast moving, the 'Star' period when the market had matured but was still moving fast, the 'Cash Cow' period when the market was peaking but movement had lessened, and the final 'Dog' period with the market shrinking again as movement had all but ceased.

In each period we will attempt to define a time frame and investigate some of the influences on the CD-ROM market that contributed to its position within this sector of the BCG matrix and its subsequent movement.

3.1. The "Wild Cat" Period (-1991).

The first period in a technology, the 'wild cat' period is one where the technology's market is small but showing fast growth. In regard to university IT this means a "flavour of the month" service that is highly desirable to potential users and demanded by existing students and academics.

This stage can be thought of as consisting of two beginnings – firstly that of the CD-ROM as an optical storage technology, secondly as a networked information resource.

3.1.1. The CD-ROM.

The Compact Disc (CD) was developed by Phillips and Sony in the late 1970s from the technology previously used by LaserDisc products,

predominantly Philips' 12" Laservision system. The birth of the CD is generally accepted to be the publication in 1980 of the Philips/Sony 'Redbook' which specified the physical and logical formats of the Digital Audio CD (CD-DA).

A CD is a 1.2 mm thick disk, 80mm or 120mm in diameter, of polycarbonate plastic (the same plastic as used in bullet-proof windscreens) with a central 15mm hole. According to Immink (1998), a Philips engineer on the Redbook project, the size was chosen as being comparable to the diagonal size (115mm) of an audio cassette.

This disk is coated with a 40-80nm thick reflective recording layer made of either super purity aluminium or gold - the latter being used only for higher quality or durability. A protective lacquer is then added onto which labels may be added (see fig 3.1). As this lacquer layer is thinner than the plastic layer it is easier to damage a CD from the lacquer/label side than the reflective side.

Data is stored in 'pits' (as opposed to 'land') in the metal layer that are 100nm deep, 500nm wide and 850nm - 3.5 μm long. To put this into perspective, if a CD were expanded to the size of a football pitch the width of a pit would still be less than 0.5mm. In bulk (non CD-R) CD creation these pits are written from the lacquer-side of the CD so to they reading-laser they appear as hills rather than depressions.

Data is read from a CD by shining a 780nm-wavelength laser through polycarbonate layer. The difference in height between the recording layer's pits and land is 0.25-0.1 of the beam's wavelength causing the reflected light to be affected by 'destructive interference'. Binary information is stored on the disc as the transition or non-transition between areas of land and pit rather than directly as pit or land (see fig. 3.1).

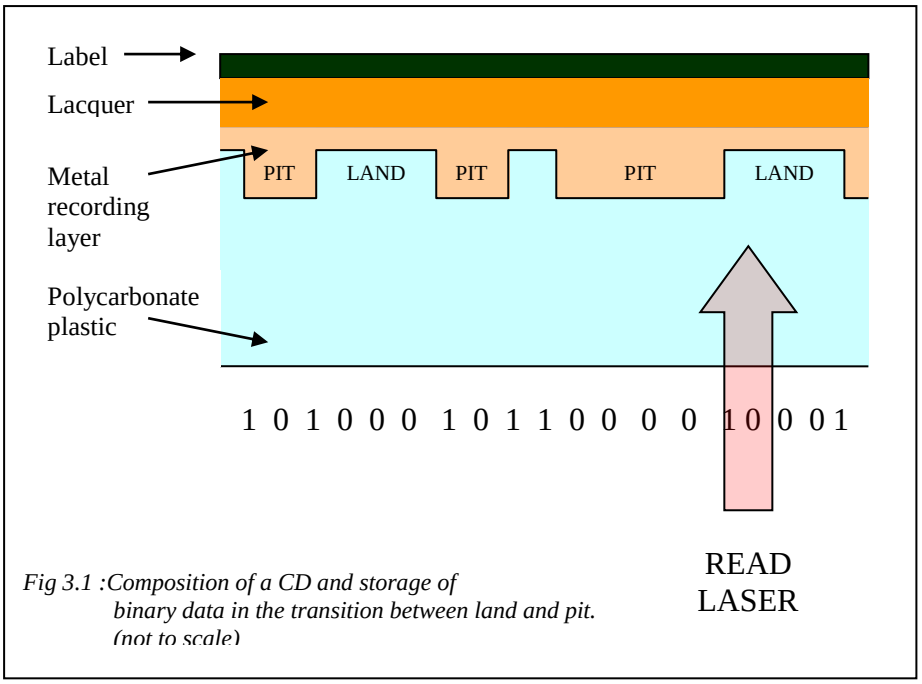


Fig 3.1 :Composition of a CD and storage of binary data in the transition between land and pit. (not to scale)

Unlike the previous technology of 'vinyl' records, which spun at a constant angular velocity of 78, 45 or 33 1/3 rpm, CDs spin at a constant linear velocity. This means that the read or write head moves over a given length of recording surface irrespective of where on the surface the it is. To achieve this, the disc spins slower as the head moves from the hub of the disk (where the recording area begins) outwards.

Data is stored in 5550 blocks of data, each holding 2048 bytes. This gives a raw data capacity of 681,984,000 bytes per disk. Audio data is read off the disk (by standard speed readers) at a rate of 75 block/sec. giving each disk an audio capacity of 74 min.

While the audio CD format was created in 1980 the first commercially available audio CD, the Japanese release of "52nd Street" by Billy Joel, wasn't released until October 1982. In the UK, CD-DA remained the preserve of classical music until the release of Dire Straits' "Brothers in Arms" in May 1985. This CD included 10 minutes more content than its LP/Cassette alternatives and popularised CD-DA amongst casual audio users.

The CD-ROM (Compact-Disc Read-Only Memory) as a data, rather than encoded audio, storage medium was not announced until June 85. To enable this Sony and Philips developed the High-Sierra format for storing directory structure and file data on the disk. This was named after the High Sierra Hotel and Casino in Lake Tahoe, Nevada where the initial conference took place. This was later published as the "Yellow Book" (see below) and subsequently ratified as the international standard ISO9660.

The development of this format, as described by Schwerin (1986), was crucial to the acceptance of the technology as a mass-market product. Without such a standard, producers of datasets would have needed to create disks tailored to individual drives. Consumers also demanded a standard format as buyers didn't want to risk a repeat of the (at that time ongoing) Betamax/VHS format war.

The High-Sierra format specified four things :

- The physical characteristics of the disk (which was already in common use).
- The method of reading and writing data (ditto)
- The volume and file structure specification.
- Application-specific requirements (such as Photo-CD and CD-I).

Audio CD drives as mentioned above spin at a constant linear velocity, reading 75 blocks (150 Kb) per second. As Schwerin (1986) points out, this should be compared to online services that were being accessed at the time at a speed of 9600 baud – the equivalent of 1.2 Kb/s. There was initially little to gain from spinning faster than this when playing audio data as the audio is output from the speakers at the same speed. Later CD-A readers used faster technology to read data into a solid state buffer prior to digital-to-analogue conversion. This enabled "skip-proof" playing of CD-A disks which was popular while exercising, for example.

CD-ROM drives improved on this data flow and double- (300Kb/s) and quad-speed (600 Kb/s) soon followed. Over the life of the CD-ROM drive

speeds improved to over 32x standard speed. Beyond this manufacturers found that physical imperfections in the disks became the limiting factor as increased speeds amplified any 'wobbles' and led to read-errors.

Between 1980 and 2000 a suite of "books" were published specifying the CD formats including CD-DA, CD-ROM, CD-I (CD-Interactive - an unsuccessful multimedia format developed by Sony/Philips), CD-R (recordable, write-once, data CDs) and CD-RW (re-writable data CDs). These were known as the Rainbow books and are listed in table 3.2, below.

Colour	Date	Format	Contents
Red	1980	CD-DA	Digital Audio
Yellow	1985	CD-ROM CD-ROM XA	ISO 9660 data Extended Architecture
Green	1986	CD-I	Interactive
While	1987	"Bridge" formats including VideoCD.	
Orange	1988	MO CD-R CD-RW	Magneto Optical Recordable ReWritable
Beige	1992	PCD	PhotoCD
Blue	1995	E-CD CD+ CD+G	Enhanced CD-DA plus Graphics
Scarlet	1999	SACD	Super Audio
Purple	2000	DDCD	Double Density

Table 3.2 : Rainbow book CD standards (from Schwerin, 1986).

3.1.2. Networking the CD-ROM.

The purpose of a library is to share and disseminate information whether it is in the form of physical or electronic media. Traditionally physical media within a library (whether book, journal or other recording) are either loanable or for reference use only. Initially, CD-ROM titles were included in this latter category being either permanently mounted on dedicated workstations within the library or loaned out to users for use only on identified library workstations.

However, the convenience of being able to remove the source from the library and the universal expectation of being able to do this led libraries to look into ways of 'circulating' CD-ROMs as soon as they became available. The option of physically lending out the disk for users to remove was untenable for a number of reasons :

- The disks themselves were expensive to purchase (a matter of hundreds if not thousands of pounds depending on the title) or replace if lost or damaged.
- The early disks' search software was awkward to install without technical experience.
- The standard specification of PC did not include a CD-ROM drive and peripheral drives were expensive (upwards of £500).
- Many titles licences prohibited usage in this way without authentication and metering of usage.

Instead, the recommended approach was to network the titles so that they could be accessed virtually rather that physically from clustered student-accessible workstations or from academics' desktops.

To network a CD-ROM, Brainard (1995) identifies five CD-ROM network architectures :

Internal standalone drives. While technically not networking at all, for some situations this was economic than setting up a CD-ROM network. This solution had the benefits of allowing complete control over CD-ROM usage by physically restricting access to the disc and having no impact on other, existing, network traffic. However, this solution required a higher initial investment in terms of CD-ROM drives (as these were not standard on desktop PCs at this time), incurred a level of user inconvenience when swapping or transporting disks and had a lack of control/security over the use of disks when in the user's possession.

Peer-to-peer access. This method of networking is popular in small offices where there is a need to minimise the network infrastructure. All workstations on the network are connected to each other and allow resources – particularly printers and, at the time, modems - attached locally to individual workstations to be accessible from others on the network. Allowing other network users access to a CD-ROM drive mounted on a single workstation allowed the control over usage that standalone installations lacked without the overhead of installing a complex network. The disadvantages of this method included the effect on the host workstation's performance during usage by another user and possible network/CD-ROM software compatibility issues.

File server extensions. This is the method of adding CD-Rom drive and appropriate drivers to an existing fileserver. By this method the administrator can leverage existing hardware and software costs. There are also the benefits of high performance (through data caching on the server) and up to around twenty drives can be accommodated per server. As the CD-ROMs are available as networked volumes, existing tools could be used for centralised management and providing a high level of both physical and logical security.

Plug-n-play CD-ROM miniservers. This solution was a later addition to the methods of networking CD-ROMs and consisted of dedicated hardware that attached multiple drives directly to the network (similar to hardware printservers networking standalone printers). Volumes either appear as if on existing servers or on a new "server" configured by the miniserver's firmware. These miniservers are the easiest solution to install, can be anywhere on network, and are both expandable and scalable either by adding multiple drives or multiple miniservers in "packs" or "farms". There is a need for additional resources on a fileserver if the new volumes are logically linked and performance is typically not as good as using fileserver extensions or dedicated servers

CD-ROM Servers. The final method is to install a CD-ROM or 'optical' server in the form of a dedicated hardware and software solution. This is a networked PC (typically of high-end user rather than fileserver specification) with multiple drives directly attached and offers the highest performance of networked CD-ROM solutions. Dedicated servers can host up to over 100 discs and most have option to network 500+ disc CD-ROM jukeboxes – although these latter devices have networking implications of their own. As with the previous solutions, management can be centralised but without the burden on existing server of extensions or miniservers. Optical servers' only disadvantage is their higher cost relative to other solutions.

In choosing a networking protocol, there was little viable choice at this time. Novell Netware - originally developed in 1981 by Brigham Young University graduates as 'ShareNet' – was the clear market leader with, by the early 1990s more that 70% of the total networking market (Connor, 2007). The remaining 30% included alternatives such as AppleTalk and other Unix/non-PC systems which were impractical for networking Microsoft-centric CD-ROM software.

Microsoft attempted to break into this market with MS-NET in 1985 and LAN Manager. The latter of theses included native support for CD-ROMs and for this reason was the protocol of choice for many CD-ROM networkers. LAN Manager was replaced by the Microsoft/IBM collaboration 'OS/2 LAN Server' but it was not until NT Server that NetWare was challenged (and later usurped) in its supremacy.

The majority of CD-ROM titles at this time were designed for standalone (non-networked) use as CD-ROM networking was still considered an expensive and niche market. Most titles that were sold with a networking licence – at an appropriate fee – used the same search software as the standalone equivalent and made no provision for their use on a network. This often included design features such as the local storing of temporary files that made networking problematic. Knight (1996) outlines these

problems and notes that titles often came with sparse, if any, networking instructions.

Even titles that seemingly were networkable caused problems with the way their search software optimised searching. In searching a large database the software could either pre-load the entire index or incrementally load pages when needed. The former approach meant that initial load times for the software were longer but subsequent searches were performed faster – especially attractive if the user is expected to perform multiple searches or search refining within a single session. The latter approach resulted in slower searches but a faster start-up time which would be preferred if the user is likely to 'drop-in' to the software and perform a single search before moving on.

With a locally mounted CD-ROM drive these trade-offs were acceptable but the performance for a networked drive was affected by the drive speed, the networking software (including any hardware/software caching) and the traffic and speed of the network in-between the user and the disk. Slow start-up times, for example, were acceptable to a local user who could see and hear the activity of the CD-ROM drive but a remote user facing a seemingly non-responsive screen may give up in frustration.

The loading of search indices into a workstation's memory as opposed to a local hard drive for improved performance had particular problems for networked titles.

In the early days of CD-ROM networking, the predominant operating system, certainly for commercial titles, was MS-DOS. However, although ISO9660 Level 1 restricts file names to 8.3, etc. to ensure compatibility there were sufficient differences between MS-DOS and ISO9600 formats (in particular how directory structures and the location of files within a disk are stored) to make CD-ROMs unreadable as DOS disks.

To overcome this, users needed to load a program called MSCDEX.EXE (the MicroSoft CD EXtensions) which was originally available as a separate utility but was incorporated into MS-DOS from version 6.0 onwards.

The architecture of the PC allowed only 640 Kb to be available to MS-DOS users. Famously, Bill Gates is supposed to have said at the time that "640K of memory should be enough for anybody." However, no reference is ever given for this quotation and Gates himself (1996) has denied saying it. It was not until the release of MS-DOS 5 in 1991 that this was increased when users were able to address Expanded (up to 1024 Mb) and later Extended (over 1024 Mb) memory.

For standalone DOS users, however, this 640 Kb needed to hold the DOS operating system, MSCDEX, any hardware-specific device drives, a title's search software and possibly have space to cache indexes to improve performance. For this reason many titles stipulated a minimum 'Free/available RAM' requirement that was perilously close to the 640 Kb limit and often required creative juggling of system configurations to make them work.

Networking a CD-ROM made these problems much worse. In addition to the programs listed above, a networked title also needed to load hardware-specific drivers for the user's network card and for the necessary network protocol(s). At the same time, administrators networking titles beyond areas of their direct control (to other departments outside the University Library, for example) may have had little control over system configurations.

All of this made an obstacle course of the networking of a title that was designed for standalone use.

While networking OS such as NetWare and LAN Manager either included or later developed native support for CD-ROM volumes, the industry

pioneers in CD-ROM networking solutions were OptiNet and SCSI Express.

OptiNet (Russell, 1991) was released by Online Computer Systems (later Meridian Data) in 1987, predating SCSI Express by three years. This was a DOS-based optical server that initially worked as a redirector solution. This meant that calls for CD-ROM data were intercepted by software on the users' workstations and transferred across the network to the optical server where they were performed and the data returned across the network. The practicalities of using and administering OptiNet, including monitoring and metering, will be discussed in section 4.1 of the University of Birmingham case study.

Later a second, similar solution was developed by SciNet (based on the original OptiNet code) called CD-Manager that instead of redirecting user requests, mapped the CD-ROMS as NetWare (and later NT) networked volumes. CD-Manager also included support for pre-cached or virtual CD-ROMS – see section 3.3.1 – which were logically indistinguishable from physical disks, making migration to this new technology easier.

SCSI Express was released by Micro Design International in 1990 and was also developed initially for Novell. As well as supporting bundled and third party CD-ROM drives - unlike OptiNet, SCSI Express, supported only SCSI CD-ROM drives.

SCSI (Small Computer System Interface) drives were able to transfer data faster and had a standard interface (the alternatives required proprietary interfaces and interface device drivers) but were significantly more expensive than non-SCSI drives. This made SCSI Express more attractive for a long-term investment in a CD-ROM network as the drives would be fast enough for longer and there was no problems supporting legacy interfaces. SCSI was also used for other peripherals such as scanners, optical jukeboxes and internal or external hard drives (all of which SCSI Express natively supported) and is still in use, in various extended formats,

today. OptiNet, on the other hand, was a cheaper immediate solution if an institution planned to upgrade their drives over time.

The SCSI Express software also handled the ISO-9660 format mapping problem server-side (unlike OptiNet which still required MSCDEX to be installed on every workstation). While this freed up the scarce workstation RAM, it presented problems for some CD-ROM search software that expected MSCDEX and made direct calls to it. For these titles a faux-MSCDEX application was required to translate the calls, negating the benefit of the server-side mapping.

Later improvements to SCSI Express included support for the Windows NT networking protocol, mapping multiple disks contiguously to a single drive letter and caching frequently accessed data to available hard drive space.

3.2. The "Star" period (1991-1994).

During this period, a technology is in a large, fast growing market as is seen of as an attractive, "must-have" resource by users. The general, non-networked and non-informational CD-ROM had certainly achieved this during the latter part of the 1980s. Games and 'Home Edutainment' titles had been consistently selling well since Microsoft launched their first home-oriented CD-ROM, "MS Bookshelf" in September 1987.

For the academic market, the majority of research and publication during thie period is into the improvement of the technology. The use itself of the CD-ROM as a networked information resource is referred, in passing, as both 'indispensable' (Doering, 1998) and 'omnipresent on the network scene' (Nathans, 1998).

A key management problem during this stage is that many of the major steps forward become standard specification in a short space of time. This leads to

key investment decisions needing to be made rapidly and makes strategic planning more difficult. According to Hines (1994), implementation strategies at this stage were key to a service's success and "determine whether information technologies are a boon or a bane."

During this time the market for CD-ROM networking solutions was expanding rapidly. At the end of this period Lieberman (1995) gives a summary of the state-of-play and shows how the market innovators were adapting their products while new rivals were appearing. Amongst the innovators were :

SmartStorage – a "middleware" solution that integrated existing hardware (particularly from JVC) including CD-ROM jukeboxes with Netware and Unix.

CD Connection (formerly CBIS) – provided a solution running under the Banyan, Netware, NetBIOS and the new NT networking operating systems. This was aimed mainly at the US education market both higher education and K-12 (primary/secondary schools).

MDI – SCSI Express remained a market leader and was available either as a software-only or software and hardware package. Functionality was expanded to include support for networking other (non-CD-ROM) optical hardware such as WORM (Write-Once-Read-Many) drives for online archiving.

Meridian Data – OptiNet remained a popular solution but was overtaken by its successor, CD-Net Plus. This was a software-only solution that was compatible with Netware (running as a loadable module) as well as Microsoft's (Windows 95, Windows 3.1, Windows for Workgroups, Windows NT, DOS) and IBM's (OS/2, OS/2 Warp) operating systems.

Into this market new challengers were appearing, predominant amongst these were Ornetix (who saw CD-ROMS becoming a commodity and focussed on scalable software solutions) and Microtest. The Microtest solutions were available as software solutions for existing hardware, bundled

hardware/software, and the proprietary DiskPort hardware. This consisted of a box the size of a video cassette which plugged directly into the users LAN and a SCSI interface into which and SCSI-compatible drive or stack of drives could be plugged. Once configured, this device appeared on the user's network – Netware and Windows NT were supported – as a standard fileserver and so made CD-ROM networking available without significant funding or experience.

In the UK, IRIS from Info Technology Supply Ltd (ITS) was released and quickly established widespread popularity. ITS had been supplying IT solutions to UK education since 1988 and is still developing new applications for CD-ROM networking (over LAN and WAN) and electronic resource management.

3.2.1. The Backlash against the CD-ROM network.

Prior to this time, university libraries had been seen at the time as a traditional, non-IT field. They now underwent a change that many librarians felt threatened by. Although libraries' key operation – the acquisition and circulation of physical media - had become reliant on automated Library Management Systems some years previously, these systems were seen as assisting librarians and their resources. Electronic information resources, however, were viewed as threats to replace first the physical books and journals (with unanswered questions about the long-term curation of these resources compared with their paper-based predecessors - Lambert, 1994) and eventually library staff themselves.

One criticism was that the introduction of disintermediation - the 'elimination of the intermediaries skilled in exploiting and supporting systems and information sources.' (Penfold, 1999) – would lead to an antisocial production-line or fast-food library experience. Boddy and Gunson (1996) talk of librarians at this time who "felt that computer

systems led to conformity, or were not sufficiently adaptable to local requirements and led to the depersonalisation of the library service."

There was also a backlash against the benefit that the networked CD-ROM, and later the Web to a greater degree, bought – the increase in information availability. Klapp (1986) claimed that information was becoming "noise-like ... by its sheer volume or rate exceeding channel capacity". Sharr (1996), however, sidestepped the issue of signal-to-noise ratios and questioned whether the human brain had the capacity to "absorb information and make decisions" at the "significantly" increased speeds the new volume of information required.

Despite these complaints, the popularity of the resource amongst the end users was undeniable. Omaji (1994) says that the chief reason for non-use of CD-ROM databases was actually a lack of awareness of their existence than any negative impression.

3.2.2. Managing the CD-ROM Network.

O'Donovan (1994) notes that the position of managing a CD-ROM facility within an institution's staffing structure was uncertain due to the lack of organisation experience over the role. It was thought to be either destined to be a separate responsibility to be managed organisation-wide or distributed and integrated within departments. It is interesting to note that this uncertainty was repeated some years later regarding the administration and design of institutions' Web presences.

Also, Desmarais (1995) comments that this new role (tentatively titled a "cybrarian") falls between the remits of the existing IT and Library departments and a large part of the role is the ability to 'translate' between the two parties.

CD-ROM network management at this time required a number of managerial skills extra to the IT skills required :

- resolution of conflicts - both inter-departmental and inter-subject. This was especially the case with larger institutions..
- vying for funding (especially in smaller institutions).
- selection of resources including evaluation and funding at both service and title level.
- balance of service provision to the desktop (in academia) or workstation (public and academic libraries) and any customer support this may incur.

This management is specific to the CD-ROM network and library staff already in position handled most institutions acquisition of titles. CD-ROM network managers needed to work closely with these staff as well as enquiry staff, subject experts and, if disks are lent out, circulation desk staff.

The introduction of a CD-ROM network may have implications of other areas such as inter-library loans whose existing policy may have to be re-evaluated in light of either greater access to full-text resources (decreasing demand) or to abstract or indexing databases (increasing demand).

This new service also gave the opportunity for a new source of management information – automatically collected where possible – that could be used by senior management to both prove the value of the new service and also highlight areas for improvement.

Networking of CD-ROMs was initially seen as a tactical (rather than strategic) issue as the costs were negligible but by 1992 UMIST was spending 7-8% of their acquisitions budget (the money previously used for both mediated searching and physical information resources) on electronic media and Aston University 15% (Abbott and Smith, 1994). Abbott and Smith also raise the question of when a service moves from

'operational' to 'strategic' status – whether this is based on the service's use or user pool or based on the financial impact on the department. In Aston University's case the latter approach was taken with a threshold set at 10% of the acquisitions budget.

These costs, however, could seldom be directly transferred from previous resources. Even if the new electronic resource is a direct replacement for an existing, non-electronic, one the existing one is not necessarily withdrawn. Also there are the 'hidden' recurrent costs of both electronic and non-electronic resources to consider when making comparisons.

Funding for a new service can also come from non-recurrent, 'pump-priming' funds although these are suitable for capital (eg. hardware) rather than ongoing (service) costs.

3.2.3. Changing Technology.

In terms of PC technology, the early 1990s was a time of constantly moving goalposts. In networking CD-ROMs the three areas of instability that had the greatest effect were those of new operating systems, changing network protocols and the growth in the popularity of optical storage amongst end users.

The text based MS-DOS operating system had dominated the PC OS market from the launch of its first public version (v1.1) in May 1982 until 1995. The end of this dominance was signalled by the launch on March 18th, 1992 of Windows 3.1. Previous versions of Windows had been available since 1985 but it was v3.1 that finally achieved widespread success. This was incrementally updated over the following three years to Windows for Workgroups 3.1 (Oct 1992) that added peer-to-peer resource sharing using SMB (over NetBIOS protocol) and the service pack Windows for Workgroups 3.11 (Dec 1993). There was also

a Windows 3.2 release but this was only a simplified, Chinese-language version of v3.1.

A key feature of the Windows GUI (and later OS) was a hardware abstraction layer (HAL) that created a buffer that allowed independence of applications from hardware and drivers. As mentioned in section 3.1.2, CD-ROM drives under DOS required hardware specific device drivers and applications using these needed to make direct calls. MSCDEX had improved this situation for direct file access but the HAL improved the sophistication of this and extended the functionality to other peripherals.

However, while Windows-specific CD-ROM applications and search software proliferated, support for legacy DOS software suffered. Not all software would run under the Windows GUI in a DOS window (requiring users to leave Windows completely and return to DOS to use the title) and the direct, native accessing of device drivers by was problematic.

This situation was soon to be exacerbated by the release of Windows 95 - the first version of Windows that ran as a pseudo-Operating System (actually booting to an unseen DOS version 7 before loading the GUI) rather than an optional application installed on top of DOS. This will be considered further in section 4.1 of the University of Birmingham case study.

The dominance of Novell's NetWare in the networking OS market continued during this time but was not to last. After a series of unsuccessful networking products, Microsoft launched Windows NT Server in 1994 and by the end of the decade the market positions of Novell and Microsoft had reversed as shown in fig. 3.4 (derived using data from Hiner, 2005 and Gabel, 1999).

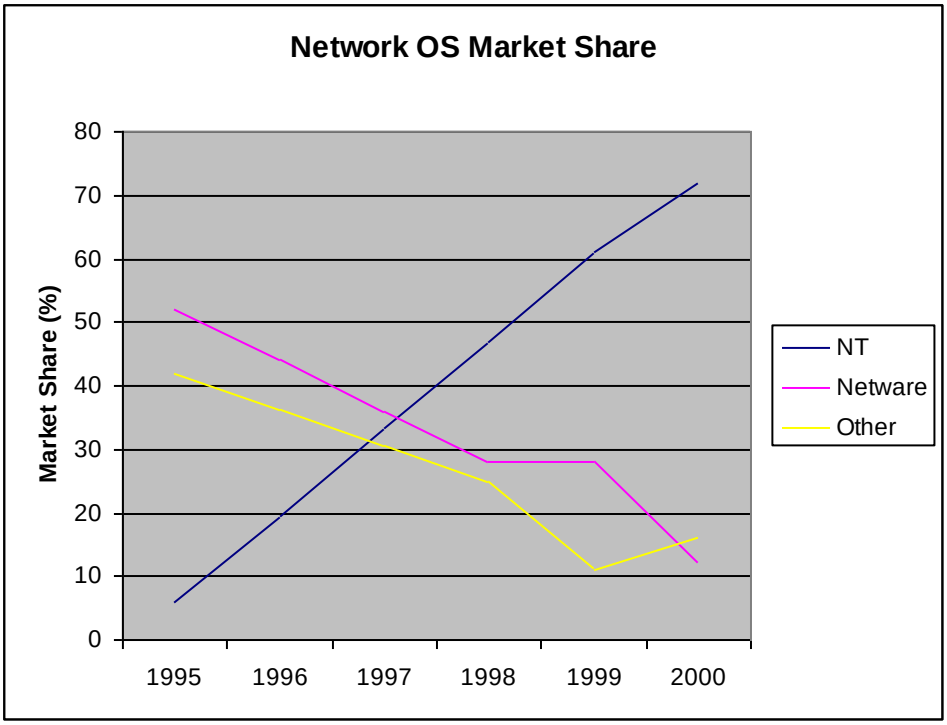


Fig. 3.3 : Network Market Shares, 1995-2000

The rapid growth of the NT protocol had implications for CD networking in the same way as the adoption of the Windows GUI/OS by DOS users (covered above). The closer tie between the user interface and the network made NT-based solutions more transparent to the user while existing installations needed to find a way of bridging from Novell solutions to NT or migrating to an NT solution with minimal disruption. NT application providers claimed that their graphical interfaces made their administration easier but some 'traditional' network administrators disagreed, preferring hands-on command-line/textual interfaces. There was, however, no concrete empirical evidence to support either opinion.

With their prices falling, a CD-ROM drive was becoming a standard peripheral on even entry-level PCs and so becoming established amongst home and non-library users. This had two implications for the networked CD-ROM. Firstly, local CD-ROMs frequently created networking conflicts with networked disks usually because the redirector software used by the networking solution was unable to co-exist with the

MSCDEX required by the local drive. Even solutions that did not use locally installed drivers were affected indirectly : individual CD-ROMs search software either needed a MSCDEX 'faker' to run (which was also incompatible with a local drive's MSCDEX) or would automatically look for an available CD-ROM drive, find the local one before the networked on and report an error when it was unable to find the disk.

The second implication of the widespread availability of local CD-ROM drives was non-technical - a change in user expectations. Users were now able to load and evaluate CD-ROM titles independently of centralised control. This led to problems when users compared networked titles with the same disk when mounted standalone and found that :

- Performance was degraded due to hardware or network capacity issues,
- Functionality was restricted – for example, printing was disabled since it was not possible to support every possible printer configuration,
- Universal access was not possible at all times due to concurrency limits,
- Multimedia titles' content could not be shared across the existing networks, or
- The disk would simply not networkable at all for other technical or licensing issues.

3.3. The "Cash Cow" period (1994-2002).

This is the period during which the market share is large but there is low to zero growth. In commercial terms, cash flow is positive producing the bulk of the item's profitability. In CD-ROM networking terms, where profitability is not anticipated, the equivalent is that the resource is at its most 'cost-

effective', the technology is replicable and is seen by students and academics as a service that an institution is "expected" to have as a matter of course.

During this period CD-ROMs' popularity was also effected by improvements in information dissemination in general. The growth of the Internet and World-Wide Web showed users a cross-platform service which was available from anywhere on- and (increasingly importantly with the growth of part-time and distance learning) off-campus.

The new online content bought other benefits (a generally unified appearance and interface) and difficulties (higher set-up costs, security issues, being hostage to the whims of bandwidth and technical problems anywhere between the user and the host). Doering (1999) noted that managers had been accused of being blinded to these difficulties by the allure of the new technology.

Although there is minimal market growth during this period the need for a networked information resource has not diminished – in fact, the growth in usage during the previous, "mandatory" stage made it so common-place as to be unremarkable unless there was a fault and users were without it. Indeed, the only reason that production of CD-ROM drive units began to decline is their replacement by the backwards-compatible, similarly priced DVD drive (Freeman, 1997). The threat was a technical and economic one rather than a social or organisational one.

It is interesting to compare the costs of CD-ROM drives (as taken from product releases reported in issues of CD-ROM Professional magazine) against the costs of the equivalent capacity of hard drive space (historical data from Grochowski and Halem, 2003). In 1989 storage on a CD-ROM cost $1.4 per megabyte while an average hard drive of the time cost $44.50 for the same storage. By 1993, however, the price of hard drives had fallen dramatically to a cost of $0.88 per megabyte. In the same time the price of CD-ROM drives had fallen to a per-megabyte cost of $0.84.

These figures may be qualified by a number of caveats : the price-per-megabyte of a CD-ROM drive assumes that the disk in use is filled to capacity with information. This is seldom true and a poll of disks in use in 1996 (Craft, 1996) gives an average size of data on networked commercially sourced disks as being 450Mb which instantly increases the cost-per-megabyte by over 40%.

Also, the fall in prices of CD-ROM drives and hard drives being bought to market does not reflect the improvements in drive technology over this time. While the speed of hard drives increased incrementally, CD-ROM drives passed through three generations in this time and the latest drives were up to eight times as fast as the earliest.

Irrespective of these factors, it is clear that by 1993 the capacity/cost benefit of using CD-ROM drives over hard drives had been lost. This led to the hybrid solution of pre-caching described in section 3.3.1 and turnkey network-attached storage solutions which included built-in CD-ROM drives for data transportation (LaCie, 2001).

3.3.1. Pre-caching CD-ROMs.

With the fall in the price of hard disk drives, the option of pre-caching CD-ROMs became very attractive – although many, including Craft (1996), preferred the term ‘Virtual CD-ROMs’ to “pre-cached” pointing out that a data cache is usually more dynamic in nature. This was the practise of copying the contents of a CD-ROM onto a networked hard drive as mentioned in the previous section. The data can then be accessed as any other networked data.

Virtual CD-ROMs had a number of advantages over conventionally networked CD-ROMs, including :

- Faster access times – hard drives read times were, at worst, commonly comparable to quad-speed CD-ROM drives' speeds of 600Mb/s with seek-times 10-20 times faster (depending on the location on the CD-ROM of the data) (Schwerin, 1986). Also, hard drives were engineered for concurrent use by multiple users though faster seek-times and dynamic, solid-state data caching. Concurrent use of CD-ROMs, on the other hand, resulted in severely degraded performance.
- Cheaper byte-for-byte storage costs. Craft (1996) cites that CD-ROMs networked by the University of Birmingham at the time contained, on average, 450 Mb of data. This represented £69 of hard drive space (4.9% of a £1,395, 9.1 Gb SCSI hard drive) versus £200 for a quad-speed SCSI CD-ROM drive.
- Negating the need for MSCDEX, or other device drivers, to be loaded on the clients' PCs.
- Removing the possibility of conflicts with locally installed CD-ROM drives.
- Improved support under Windows (compared with networking via OptiNet).

However, there were also a number of disadvantages with Virtual CD-ROMS. Early CD-ROM titles could either have data-encoding specific to the CD-ROM disk (often as a method of copy prevention) or had software which required MSCDEX to be loaded. When there were no technical hurdles to overcome, some suppliers' licences prohibited the copying of data in this way – usually because they provided a similar alternative such as SilverPlatter's ERL or OvidONLINE (see section 3.4.2).

Networking Virtual CD-ROMs via Novell Netware also had an overhead cost in an increased amount of RAM required on the file server. Novell NetWare specifies that at least 6Mb of RAM had to be added to the server's specification for every 1 Gb of added hard disk. This had implications both in terms of cost (of solid-state memory) and put a technical limiting factor on the total amount of storage space.

3.3.2. The Rise of the Web.

Although CD-ROMs were seen by many as a 'transitional' technology, O'Connor (1995) notes that as late as 1995 there were still predictions of a further ten years of market growth. These predictions failed to recognise the impact that the Internet (and in particular the World-Wide Web) would have on the field of electronic information resources. In fact, in 1992/3, prior to the Internet explosion, experts were predicting that the next boom media would be Interactive TV (Lashinsky and Ryan, 2005).

The origins of the World Wide Web can be traced to Tim Berners-Lee's work on ENQUIRE at CERN in 1980 but the accepted launch of Web as a publicly available service was on August 6th, 1991. The use of the Internet as a medium for electronic resources by academia predates the Web as universities were already using eMail, FTP distribution and Usenet Newsgroups for information sharing prior to the Web. An example of a fledgling information resource of the time is Gopher. This was a hierarchical bulletin board/listing service searchable via WAIS, Archie and Veronica. Although by 1992, Gopher was "the hottest new thing on the Internet" (Frana, 2004), it soon faced strong competition – as shown in figure 3.4 - from the Web's more easily adaptable Hypertext. When Gopher's developer, the University of Minnesota decided to start charging for licenses in February 1993 its downfall was inevitable – especially two months later when CERN declared that the Web would remain unlicensed and free-to-all forever.

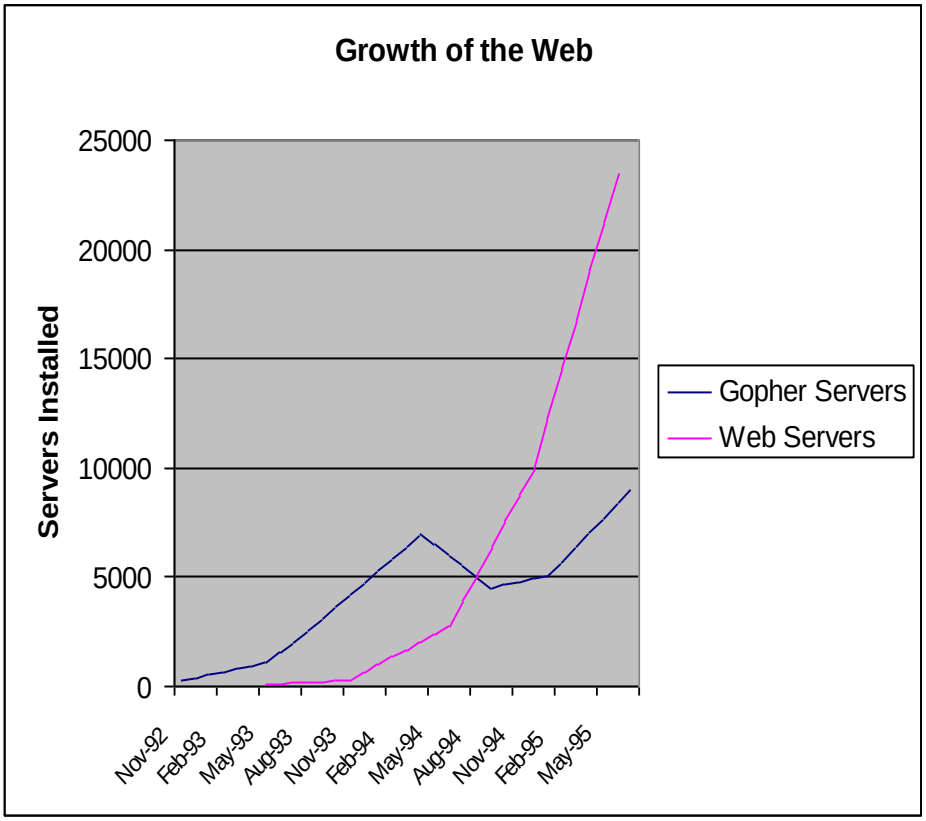


Fig 3.4 : Initial growth of the Web (derived from Frana, 2004)

Services such as Gopher (and similar systems such as Coypu and x500 directories) evolved from pre-Internet textual online services which were accessible either via modem-based dial-up or PSS – packet switch stream, a UK (British Telecom) data network that was linked to universities via the X25 hardware. The benefit of these services was to formalise the organisation of the data available into forms that were both acceptable to information professionals (who wanted complete yet rational data – and metadata where possible) and accessible by lay-users. This approach was taken further by the Web.

Essentially, the reasons for the success of the Web can be seen as analogous to those for CD-ROMs :

- Cheaper – with UK Universities attached to the internet directly through JANET (the Joint Academic NETwork), there were no direct costs to access web sites other than subscription fees to

closed resources. This advantage was later temporarily lost when for a time traffic from US web sites through transatlantic links were charged for.

- Commonality in interface design – The Windows-based CD-ROMs benefited from a common look-and-feel that also extended to non-CD-ROM applications. Through this users found it easier to perform commonplace tasks (such as saving data and printing) for which previous, pre-Windows applications had proprietary methods. The Web-based resources devolved these functions to the browser - so that once a user was familiar with their particular browser they were easily accessible – as well as Web-specific functions such as bookmarking pages and stepping back a page.
- Consumerist – the pre-Web resources (especially pre-Gopher) tended to require more expertise in their administration, connection and use. The Web's click-and-see approach promoted unmediated end-user usage and authoring software soon encouraged end-user publication.

Fig 3.4 above showed the initial take-up of the Web up to 1995. This growth continued throughout the 1990s. During this time the use of the Web for hosting online databases was developed.

Schwarzwalder (1996) documented the spread of databases to the Web. Some were new titles that had not previously existed (eg. Ei Engineering Village) and had added Web-specific functionality such as alerting - the regular emailing of changes to stored search results. Other databases had previously been available on CD-ROM (e.g. the U.S. Patent and Trademark office) or in previous internet formats such as textual via telnet (e.g. the US Environmental Protection Agency).

The initial drivers to the creation of Web databases were industrial public relations (with the protean Web seen as a repository for online brochures) and governmental cost-cutting exercises. In an example of the needs of

academia taking precedence, commercial databases began with the provision of Web interfaces to bibliographic databases. These started in 1995 with a few bold, but not always successful, efforts to rush to get products to market.

The use of the Web as a method of self-publication by non-informational organisations was soon applied to databases. At first, producing a web database involved either a degree of high-level CGI programming or the batch production of suites of static pages from an inaccessible database. As scripting languages that allowed dynamic web pages became available so functions were written which could embed into the pages the output from database applications such as MS SQL Server and mySQL. This led to both the development of new in-house databases and the networking of previously LAN-only datasets. This can be directly compared with the way some organisations had made their data available on CD-ROM by packaging existing documents (often MS Access datasets) with royalty free reader software.

The arrival of the Web in the public, non-academic consciousness is often (Rainie, 2005; Lashinsky and Ryan, 2005) marked by the IPO of Netscape on August 9th, 1995. Demand for shares was so high that trading couldn't open. The event made millionaires of its staff (one manager's 20% stock was worth $660 million by the end of the day of the IPO), became front-page news around the world and started the 1990s dot-com boom. Within four years of this launch the US Web audience had exceeded 50 million users – a figure that Rainie notes took radio 38 years and television 13 years to achieve.

Just as CD-ROM technology has started in academia and spread to the general population, so had the Web.

3.4. The "Dog" period (2002 +).

During the final period in the networked CD-ROM life-cycle, the technology is in a small and static, if not shrinking, market. In academic circles the service becomes overlooked as a 'Legacy' system that is only retained for titles where no alternative is available.

The use of the networked CD-ROM is replaced during this period either by intranet based datasets (moving from CD to DVD or magnetic storage technology – Rowe, 2000) or subscription-based Web sites.

Any remaining CD-ROM titles are either :

- Titles of static data whose suppliers are either not longer trading or do not see further investment in that dataset as economical.
- Titles from highly esoteric suppliers who do not have the resource to maintain a subscription-based web presence (an example being minor non-profit organisations) and distribute databases to a limited pool of subscribers – often on individually created CD-R disks using generic software – for example distributing spreadsheets or databases with a reader application.

3.4.1. CD-ROMs vs. The Web.

Initially, the use of CD-ROMs as resources remained popular in the face of competition from the Internet as experience in networking CDs had been built up and their use was aimed at closed or LAN systems rather than the open and unsecured Internet (Conrad and Depp, 1994). However, while the use of the Web for information resources has a number of benefits over the traditionally networked (a method for networking CD-ROMs directly over the Web is considered below) CD-ROM, there are two main concerns over its use.

The first concern is one of cost. To make a small, esoteric data set available via CD-ROM technology requires an outlay in creating search software and physically producing the discs. If the production run for a title is small then producing the discs in-house using CD-Rs is viable. Otherwise, a production run on 1000 disks is still only estimated at a cost of under $2 per disk (Wiedemer and Boelio, 1995). Producing regular updates to dynamic datasets using the same search software has minimal ongoing (recurrent) costs.

Producing the same dataset on the Web requires the authoring of the interface – an initial outlay comparable in price to the production of standalone software. However there is a recurrent cost in maintaining the Web site (either in-house or via an external web-hosting company) for the lifetime of the resource's usage. For the producer this cost can be offset by passing the costs onto the customer in return for the convenience of an Internet resource. Also, in the early days of online datasets there was a cost for the end user in terms of dial-in subscription costs. Wiedemer and Boelio calculate that at the widely user 9600baud access speed it would take 153 hours to download the equivalent of a CD-ROM's contents.

This concern primarily applies to smaller datasets covering narrower subject areas (Cox, 1994) as producers of larger resources can spread the costs over multiple datasets on the same web server(s) or licence out the dataset to a resource aggregator.

The second concern for solely web-based information resources is the retention of data following the termination of a contract. For example, if an institution subscribes to 'The Times' on CD-ROM from 2001 to 2005 but then terminates the subscription at the end of 2005, then they will retain the five disks they have already received and can allow users access to them in perpetuity. This is provided, of course, that subsequent advances in related technologies such as client operating systems do not make the

search software or data unusable – a problem that has already been seen with early CD-ROMs requiring the MSCDEX DOS extensions.

However, if an institution subscribes to the same data on a remotely hosted web service the situation when a subscription is terminated is reliant on the initial terms of the subscription. Some Resource vendors will allow the institution subsequent access to the subscribed years only as part of the initial agreement while others will require a recurrent 'maintenance' subscription to retain this access.

A related concern, and one that is the subject of much active debate and research, it that of digital curation. If an institution subscribes in perpetuity to a remotely hosted resource, what will happen if the supplier of that remote resource ceases to trade? In a worst case scenario the data that has been paid for will become entirely unavailable. There are a number of solutions to this such as the Digital Curation Centre's LOCKSS project, the global CLOCKSS initiative and the British Library's Portico Project (Schneider, 2007) all of which rely on variations of centrally or locally cached 'escrow' mirrors of commercial data.

3.4.2. CD-ROMs on the Web.

During this period of the CD-ROM Network's lifecycle some of the major producers of academic databases provided proprietary solutions for making their titles available via the Web. As discussed by Tenopir (1997) two of the most popular of these solutions were Silver Platter's Electronic Reference Library (ERL) and OVID's OVIDOnline.

At the time, Silver Platter were the largest individual supplier of academic CD-ROM titles covering all academic areas. Their solution, ERL, consisted of proprietary optical server software running on Unix. Titles installed on this server could then be access using the SPIRS (Silver Platter Information Retrieval Software) client software that was available in DOS,

Windows, UNIX, Mac and, crucially, Web versions. This software, other than the Web version, was also used to access Silver Platter's standalone and conventionally networked CD-ROMs and was already popular amongst end users.

OVID were in a similar position to Silver Platter in that they had been established in 1988 and were a key provider of medical and scientific datasets both on CD-ROM and on-line. Their solution was to use the CD-ROM as a media solely for the distribution of data from OVID to the customer. Once received, disks would then be installed onto the hard drive of a UNIX (Solaris) web server with OVID's software running searches on the server and feeding results to the user as dynamically generated but simply structured web pages. This solution had the benefit of limiting the requirements of users' workstations to being capable of running the most basic of Web browsers. This was offset, however, by a greater central investment in server hardware, maintenance and administration.

More recently, multinational information services company Wolters Kluwer purchased OVID in 1998, Silver Platter in 2001 and merged the two.

One way of integrating with the Web CD-ROM titles not covered by 'big-name' suppliers own solutions was through the use of 'thin-client' technologies such as Citrix' MetaFrame. This works by creating an 'application server' on which users can run virtual sessions. Theses sessions use the hard drive, memory, system-configuration and network connectivity of the server on which to execute programs. The user runs a simple client application – available as Windows, Mac or Java (to embed within a Web page) applets - on their local machine. Data is transferred between client and server using the proprietary ICA protocol, which sends the users input to the server and returns the changes to the output screen. This requires minimal network traffic for non-multimedia applications.

The benefit of this approach to CD-ROM networking is that the system configuration is handled by a centralised and controllable resource. This is typically the most problematic area when dealing with users' innumerably differing configurations of both software (operating systems, browsers and 'helper' applications) and hardware - especially local storage and memory availability. However, this also means that the CD-ROM networker wholly meets the cost of this resource rather than devolving it to the users.

An alternative solution to integrating Web and CD-ROM technology was attempted in the mid-1990s (Guennette, 1996) with the 'Hybrid CD-ROM'. This used proprietary software to match the bandwidth of the CD-ROM with the dynamism of the Web (Pemberton, 1996) and could be broken down into three types of title. The first type, edutainment (a popular genre of CD-ROM in the 1990s when, according to Gussin (1995), schools and public libraries constituted a large part of the potential market for CD-ROMs) used the disc to provide multimedia content. Updates to current and/or statistical information downloaded from the Web as regular updates. The first edutainment hybrid CD-ROM was Microsoft's "Complete Baseball" in 1994 with the same company's "Cinemania 1996" being the most popular. This update 'subscription' had the added benefit of coercing users into upgrading to newer versions of the software when updates to previous versions ceased.

The second type of hybrid title was the interactive encyclopaedia which was again aimed at the home/school markets rather than higher academia or business. Compton New Media's "Compton's Interactive Encyclopaedia" was the first title in this field with Microsoft's "Encarta" soon after. Unlike the edutainment title's downloading of regular updates to the user's local hard drive, these titles linked directly from the CD-ROM's index to online articles on an ad hoc basis.

The final genre of hybrid title was the online catalogue such as 2Market : a title including content from 25 traders including Sharper Image, Land's End and The Nature Company. Again, the CD-ROM was used for the

interface and multimedia content and was able to work without the web connection as promotional material. In this case, however, the Internet was used to add details of latest pricing, availability and online ordering.

The experiment, however, was short-lived. As internet connection speeds improved alongside better multimedia compression, media scripting such as Macromedia's Shockwave (and later Flash) and the adoption of standards such as PDF for document delivery, the benefits of the hybrid CD-ROM failed to justify the costs of their production. Customer reception was also lukewarm and Hybrid CD-ROMs failed to compete with increasingly powerful Web sites.

3.4.3. DVD-ROM.

In addition to the Internet, CD technology was also being replaced as a storage medium by DVD.

In 1993 two different successors to the CD were in development : Phillips/Sony's MultiMedia Compact Disc (MMCD) and the SuperDensity Disc (SDD) supported by various production and media companies including Toshiba, Time Warner and Hitachi. Fearing a repeat of the disastrous VHS/Betamax format war of the 1980s, IBM united the two formats into DVD – primarily the SDD format with a different encoding system that reduced the disk capacity from the planned 5 Gb to 4.7 Gb. The development of the new format was controlled initially by the DVD Consortium (made up of MMCD/SDD developers) and then later by the DVD Forum whose membership was opened to all.

Incidentally, although it is commonly accepted that DVD stands for Digital Versatile Disc – stressing that the media has many uses - pre-ratification documents referred to the technology as a Digital Video Disc and the official documentation, confirmed by Toshiba's Toshio Yajima

(Parker, 1998), only ever referred to ‘DVD’ and never gave a definition of the acronym.

A DVD disc is identical in physical size to the CD-ROM and fundamentally works in the same way (as previously described in section 3.1.1.). A DVD drive, however, uses a narrower 650 nm wavelength laser as opposed to 780 nm for CD. This means a spot on the media surface can 1.32 µm compared with 2.11 µm for CD. In turn, this means that more data can be stored per track and more tracks can be fitted onto the same surface area.

It is possible to increase the capacity of a DVD to 17.08 Gb by making it double sided (like a vinyl record) and dual layer. Dual Layer disks work by physically stacking two disks together – the join can be easily seen by looking at a DVD edge-wise. The top-most layer is semi-transparent allowing both layers to be read. Early DVD readers took time to realign the laser to the second layer causing a pause, most noticeable (depending on their scheduling) during motion pictures during layer transition.

As with CD-ROMs, initial DVD drives ran at ‘single speed’ although this was actually nine times as fast as a CD’s single speed. Drives quickly became available with up to 20x speed (180x CD-ROM single speed). This removed the layer-transition pause by buffering data and made interactive entertainment DVDs workable.

In the mid 2000s, next generation of optical storage appeared in the form of HVD (Holographic Versatile Disc) by Maxell and the more popular Blu-Ray (Sony/Panasonic) and HD-DVD (Toshiba). Although the latter of these is the official successor to DVD, just prior to submission of this report Blu-Ray has made significant gains and looks to be victorious. Adoption of either has been hampered by both a format war that DVD avoided and by the alternative distribution system of directly downloading content on demand.

3.4.4. DVD vs. CD.

However, while DVDs success as an entertainment medium was unparalleled, within the academic and eResource spheres it was received with a lukewarm response. Information providers had already found that raw text data databases could easily fit onto a single CD-ROM. Those titles that had been made available as multiple-CD titles were usually done so for commercial rather than technical reasons. For example, the full text of daily UK newspapers such as the Guardian and Times were released quarterly on disks that contained, at most, a single year's data. This was done so that subscribers could select which years to purchase and/or mount without restriction.

Indeed these large, commercially popular, text-based resources were the ones that had been particularly easy to migrate to the Internet. The non-web friendly databases (other than those discussed earlier) were the multimedia titles with large volumes of high-quality, that therefore high bandwidth, audio and video. While DVD technology has been used for this it has been in a standalone, non-networked capacity as the use of audio- and video-over-IP in the academic environment has, so far, been limited to low-bandwidth uses.

Despite the advantages of both Internet and DVD technology, the CD-ROM refuses to be fully superseded. It is still a viable and commonly used technology for both data backup and transportation (Dysart, 2000).

Often both DVD and CD are being used in parallel as alternative transportation media depending on the size of the data. For example magazine covermounts and Linux installation disks come in CD-ROM and more feature-packed DVD versions – the former being cheaper to produce or to download as a disk image.

4. Case Study : University of Birmingham.

The University of Birmingham (UoB) networked CD-ROMs between 1989 and 2005. During this time the method for accessing these passed through four phases, each new one being adopted in response to changes in the environment adversely affecting the usage of the previous one.

Prior to their networking, CD-ROMs of four titles were made available in a standalone capacity. The disks were collected from a staffed enquiry desk for use on a cluster of four dedicated PCs (CD-ROM drives were not commonly on PCs at the time). Craft (1996) explains that the popularity of this service – with over 3400 hours of booked time in its first year – led to the establishment of the University's first CD-ROM network.

4.1. The LIN (1989-1997).

As described by Shoebridge and Watson (1994), the use of networked CD-ROMs at the UoB began in 1989 with the installation of the Library Information Network (LIN). This consisted of a dedicated LAN within the university's Main Library including :

- A **file server** to host the CD-ROMs' search software and menu system. This had a 386/20 processor, 2Mb RAM, an 80Mb hard drive and ran Advanced Novell NetWare 2.1.

- An **optical server** to host and share the physical CD-ROMs. This was a 286/20 PC with 4Mb RAM, 40 Mb hard drive, ran OptiNet 1.2 and was directly attached to a tower of 8 Hitachi 3600 CD-ROM drives.

- Seven VGA **workstations** with 286/12 processors and 1 Mb RAM. These were diskless and used remote-booting ROMs to load DOS 3.30

from the fileserver. Four Canon BJ850 inkjet printers were shared between these workstations.

This was purchased from Attica Cybernetics for £27,000 and initially allowed multi-user access to ABI/Inform, Dissertation Abstracts, Science Citations Index and Social Sciences Citations Index from the dedicated terminals located in the subject areas of UoB's Main Library (see fig. 4.1).

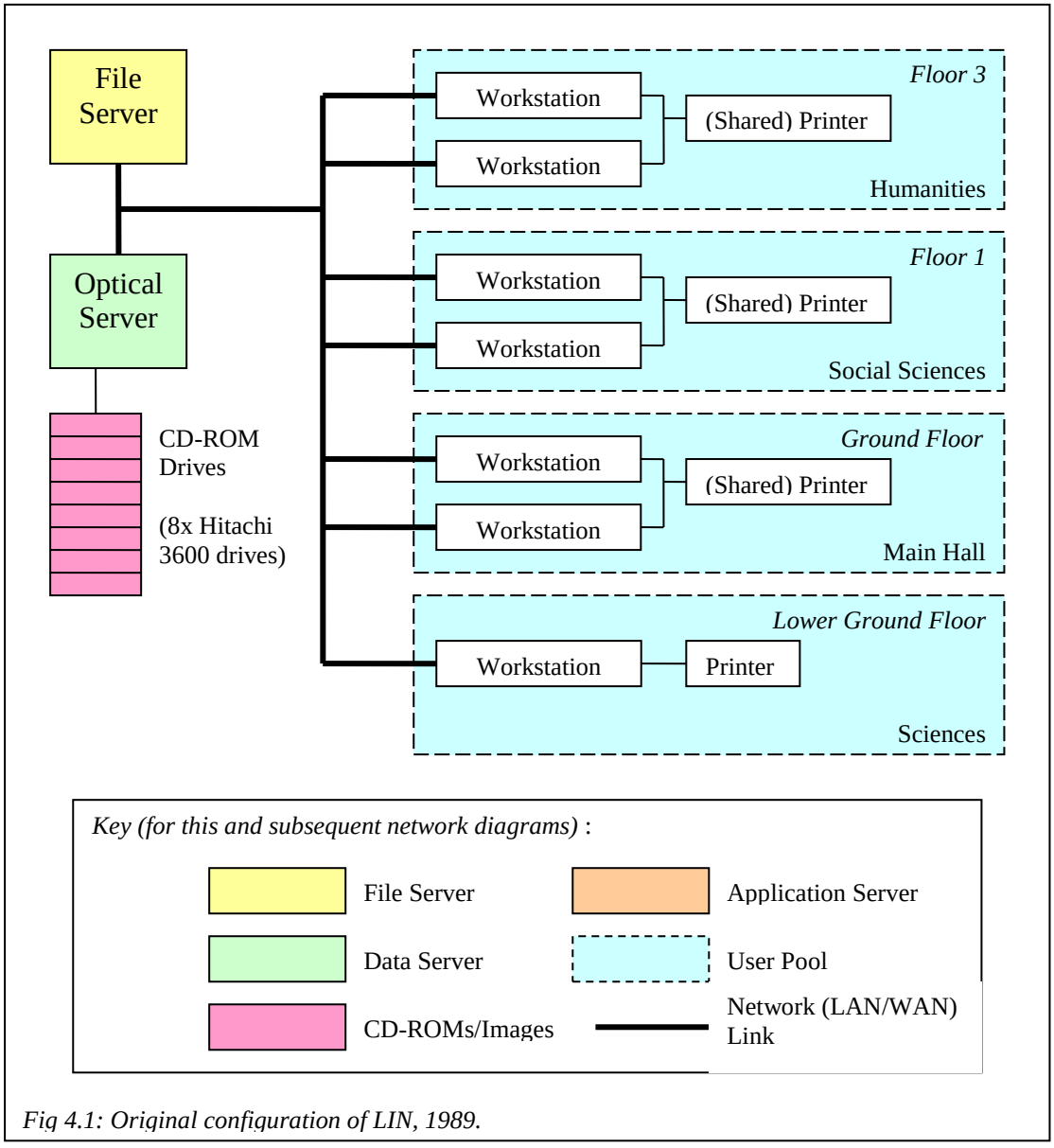


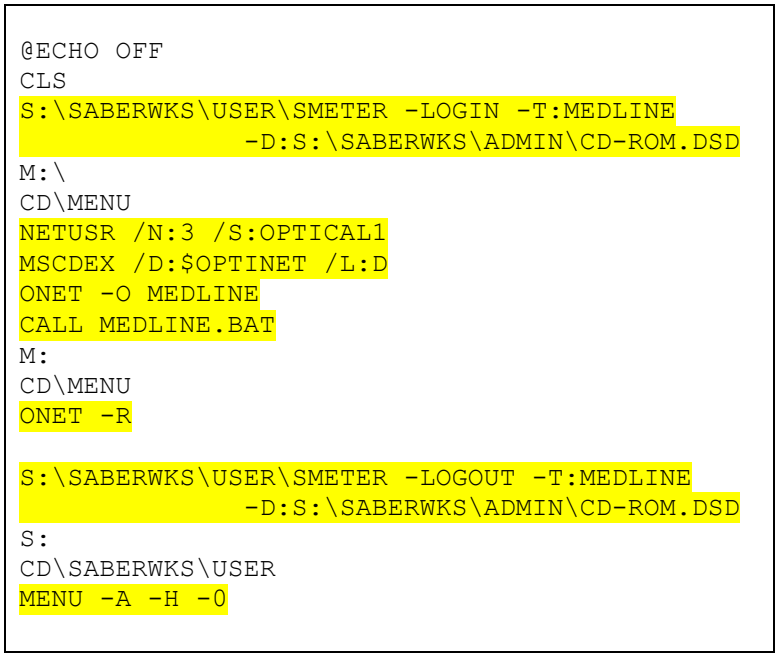
Fig 4.1: Original configuration of LIN, 1989.

The CD-ROMs' search software were presented to the users via a DOS-based interface created with Sabre Software's "Sabre Menu" application. These categorised titles under a single level of eight subject areas that encapsulated the spread of the University of Birmingham's focus at the time : "Art and Humanities", "Bibliographic Tools", "Business and Management", "Conferences and Theses", "Educations and Social Sciences", "Law, European and Official Publications", "Medicine, Nursing and Sports Science" and "Science and Engineering".

Textual help files for each title were prepared by Library staff in each area and presented using Sabre Menu. Sabre included a software-metering component that checked the current level of usage of an individual title against administer-defined limits and prevented access if these had already been reached. This allowed the easy enforcement of publisher-imposed concurrent usage licences.

The usage measuring available via Sabre was found to be inadequate so an alternative was found that processed the usage logs for the OptiNet server and converted them into comma-delimited format that could then be analysed using mainstream spreadsheet software.

Each title selected from the LIN menu processed a DOS batch file of the form shown below. This consists of a combination of OptiNet (ONET, NETUSR), Sabre (SMETER, MENU) and DOS commands to map drives, execute the search software and then unmap the drives afterwards. This procedure will be seen again in section 4.2 for Atlas, the next generation of networked CD-ROM provision at the University of Birmingham.



```
@ECHO OFF
CLS
S:\SABERWKS\USER\SMETER -LOGIN -T:MEDLINE
                -D:S:\SABERWKS\ADMIN\CD-ROM.DSD
M:\
CD\MENU
NETUSR /N:3 /S:OPTICAL1
MSCDEX /D:$OPTINET /L:D
ONET -O MEDLINE
CALL MEDLINE.BAT
M:
CD\MENU
ONET -R

S:\SABERWKS\USER\SMETER -LOGOUT -T:MEDLINE
                -D:S:\SABERWKS\ADMIN\CD-ROM.DSD
S:
CD\SABERWKS\USER
MENU -A -H -0
```

Start software metering for Medline.

Use 3 disks on OPTICAL1 …starting with drive D:. Open database 'Medline'. Run the Medline software.

Remove mapping and drivers. End software metering session for Medline.

Return to the LIN Menu.

Fig. 4.2 – A LIN batch file.

Between 1990 and 1997 the LIN expanded in both availability and capacity. A bridge was established between the LIN's dedicated network and the rest of UoB's High-Speed Campus Network (HCSN) allowing access to the CD-ROMs from other Novell clusters on campus (dependent on the clusters' administrators configuring their setups for LIN compatibility – loading specific drivers, reserving drive letters, etc.) The capacity of the LIN grew to 52 titles (Craft and Haydock, 1996) with the addition of two further optical servers running the same management software but faster NEC SCSI drives. In addition to 47 CD-ROM-based titles, the LIN also provided two titles where the content was installed directly on the Novell fileserver and three online services via the Kermit IP application.

During the period of time during which the LIN was in service the support and management of Library IT was the responsibility of the Library Systems Unit. This eight-person team, responsible for all IT used by library staff and customers, was headed by a Library Systems Manager with responsibility for the long-term, strategic growth of IT within the university's twelve main and site libraries.

Beneath the Systems Manager were two teams of two staff members. The remit of one was primarily the Library Management System – a centralised system handling the central library business of the acquisition and circulation of printed material. The other team covered other areas of library IT including email, office automation (including word processing) and electronic information resources – both networked and standalone. Both teams consisted of one academic-related post of 'Assistant Librarian' managing a support post of 'Professional Librarian'. These counter-intuitive job titles were for historical and political reasons.

The remaining three members of the Library Systems Unit were shift-working support officers assigned to operational tasks for both of the previous teams. These included server operations, staff support and equipment maintenance on an ad hoc basis.

The management of the LIN passed through two of the styles of management described by Ward and Griffiths (previously shown in table 2.5). At its inception the role was that of an 'entrepreneur', gambling the installation cost on the system being a success within the Main Library. Once this was achieved and the ROI (in terms of user contentment rather than financial) improved, the system as expanded to other parts of the university campus. Although this expansion was always a planned intention it can be argued that it was at this point that the management passed from the 'entrepreneur' to the 'developer' stage. It is interesting (although perhaps co-incidental) that shortly after this transition the two members of staff directly responsible for the management of the LIN left the university and their posts were re-filled.

The LIN was used successfully until 1997 when a number of concerns bought about a re-evaluation of the service :

- The growth in locally installed CD-ROM drives conflicted with the device drivers used to network server-installed drives – especially as local drives required the installation of the MSCDEX extensions (see 3.1.2) which

directly conflicted with OptiNet's own device drivers. In many cases the only way to get around this problem was to have users reboot their PCs into an alternative configuration with the local drive disabled before they could use the LIN.

- The majority of CD-ROM titles were becoming available on the Windows platform that could only be supported on the LIN with difficulty. Craft (1996) notes that while it was possible to configure the system so that windows titles were networkable the solution did not work for all users and many of those who successfully used a title complained of problems when leaving the title or trying to use a subsequent title (both traced to OptiNet's unmapping of a disk). At this time Windows CD-ROMs were predominantly demoted to standalone-only usage.
- Users who were locally running Windows needed to reboot their PCs into DOS to access the LIN. As discussed in section 3.2.3, this was acceptable under Windows 3.1 but became untenable with the adoption of Windows 95. At this time Craft and Haydock (1996) note that the University's Information Services Bulletin stated that "Windows 95 is now the recommended PC operating system on campus for most purposes". Some support was provided by the installation of an icon on Windows 95 desktops that would script the shutdown of Windows 95, reboot in DOS mode with a LIN-friendly configuration and return to Windows 95 afterwards - although this was only available on PCs directly supported by the Library Systems Unit.
- The emerging Web-based electronic resources could not be supported by the LIN. Three Web titles were networked before the service was retired which had to run a customised copy of Netscape from a shared drive.
- There was a lack of support for locally installed or networked printers.
- The administration of the links between the LIN and schools' PC clusters which required a degree of hand-holding and individual support was becoming unwieldy.

There was also a 'vocal minority' (Craft, 1996) of non-PC users – mostly using Apple Macintoshes – who were unable to use the LIN at all. While the

LIN's replacement did not directly support non-PC platforms, some progress was made using emulators. These users generally understood that CD-ROMs were platform-specific and were lobbying for their subject's resources (non-PC usage was concentrated within a small number of schools) to be purchased as platform-independent Web resources which the LIN would have trouble providing even to supported platforms.

Alongside the LIN, terminals were provided in each of the libraries' subject areas to host the search software for standalone CD-ROM titles that could not be networked for either technical or commercial reasons. Towards the end of the LIN's usage new titles were being received at a rate of one every three weeks and the majority of these had to be made available standalone. Their handling (issuing to students on request - 5650 sessions in one twelve month period) resulted in a burden on enquiry desk staff. This surpassed the situation - 3400 CD-ROM sessions in 1989/90 - which had originally led to the initial installation of the CD-ROM network. As a result, alongside the replacement for the LIN, new standalone terminals were introduced that hosted the CD-ROM data as well as search software. This was achieved first by CD-ROM jukeboxes and later, when the jukeboxes proved not to be robust enough, the loading of CD-ROM images onto local hard drives.

In migrating from the LIN it was clear that the increased level of sophistication of the metadata required made any automated process of its transition impossible. The arrangement of titles within each subject area gave a starting point but the greater granularity of subject areas (eight in the LIN compared with 55 in its successor) required input for subject specialists. The textual help files were used as the basis for new usage leaflets but needed large parts (accessing the title, downloading, printing) rewritten.

The replacement system to the LIN was designed to use the same hardware with options to replace and upgrade this over time. As well as cost, a benefit of this was that it could be developed in parallel with the live system without downtime or two copies of every disk being needed. Once the replacement

was developed, both systems ran live concurrently for a changeover period of six months.

4.2. Atlas (1997-2002).

In response to the LIN's increasing problems UoB wrote, in-house, a Windows application that provided a two-stage menu as shown in figure 4.3. This was named "Atlas" via an IS staff competition after a number of working titles such as WEIRS and DIRs were dismissed. Users first selected a subject area and were presented with titles appropriate to that subject. The optical servers' software was also updated so that networked disks appeared to the network as Novell volumes.

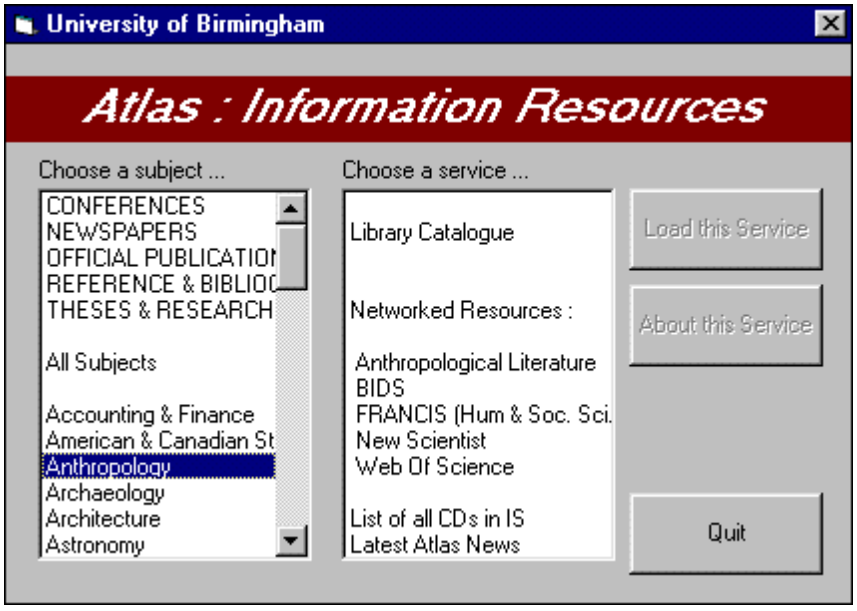


Fig.4.3 : Atlas' main menu screen.

This new service allowed the seamless integration of CD-ROM and web-based titles, the latter launching the user's default web-browser. By spawning an instance of a locally installed browser rather than a centrally installed one a degree of control was lost. This was outweighed, however, by the benefits – particularly access to personalised add-ins, bookmarks and either local or networked printers.

To access Atlas, Windows users on campus needed to download a small (30Kb – the minimum size of a Visual Basic application) application START_ATLAS.EXE and the Visual Basic run-time file VBRUN.DLL. These were made available on the University's technical support ftp site and could be installed either on users' local hard drives or on clusters' shared network drives. This simple installation led one FSCO (Faculty Support Computer Officer) to comment "if you are spending more that five minutes installing it then you're doing something wrong".

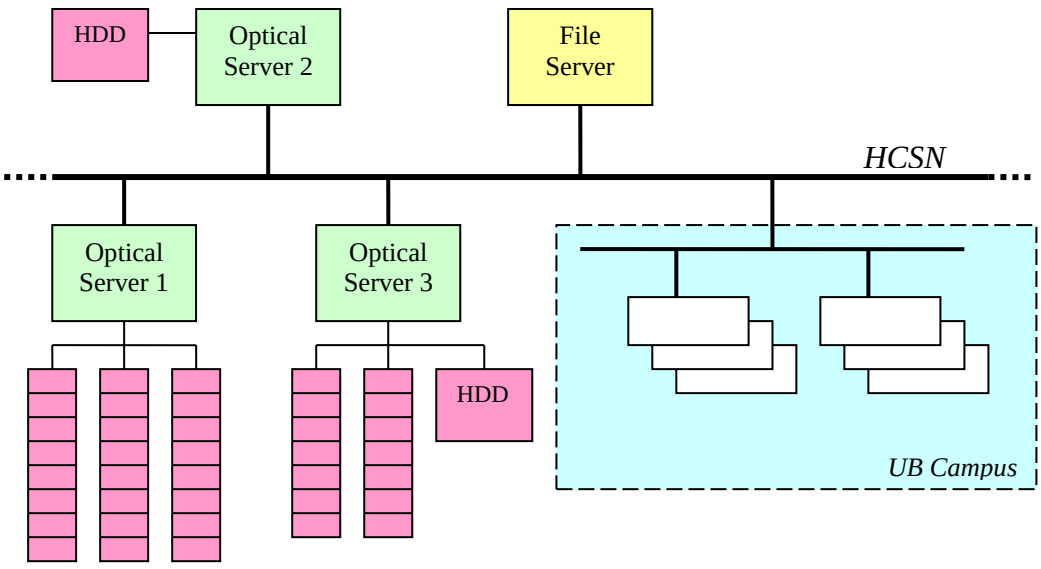
The purpose of Start_Atlas was to map a volume of the service's fileserver (initially a Novell Netware server, later a Microsoft Network server) to the user's local machine and execute the Atlas.exe application stored on it. This application was itself 30Kb, its size making the load time minimal. Atlas.exe would then retrieve configuration details, described below, from the same networked volume. By storing both the application and configuration centrally maintenance to either could be done from anywhere on the campus network.

Atlas.exe could be run in training mode by adding a /t parameter. In this mode the licence restrictions and metering parts of Atlas examined below are bypassed. This was used in the IS training suite for hands-on sessions. Subscription agreements allowed concurrency limits to be waived for training and this method ensured that users in training sessions never received an 'Licence limit exceeded' error message.

The hardware underlying Atlas was based on that used previously by the LIN – initially wholly re-using the existing file and optical servers. During the life of the LIN hardware was upgraded according to pre-determined, usually three-year, replacement cycles. These upgrades were used to bring in replacement software for the optical servers that allowed the pre-caching of discs' data (see section 3.3.1) onto both internal and external hard drives attached directly to the optical servers. These pre-cached titles appeared to users to be identical to networked (physical) CD-ROM but with improved

access speeds – particularly during multiple concurrent use. Using a combination of physical and virtual CDs, Atlas provided a peak of 86 networked CD-ROM titles.

Fig 4.4 : Atlas hardware configuration.



The administration of Atlas was designed to be performed by non-specialists with minimal training. The configuration of the menus was stored in a text file that held a matrix showing which titles should be available under which subject headings. From this matrix was derived a service name which led the system to a script file. As this was parsed by the Atlas application (rather than shelled to a third party program or the operating system) it was fully customisable and could :

- map volumes (either networked CD-ROMs or, later in Atlas' development, images of CD-ROM disks) to drive letters and unmap afterwards,
- launch networked documents or web pages,
- copy files to users' local drives,
- test for the existence of files on users' local drives,
- specify the location of help documentation for titles.

The overall layout of this script file was similar to the DOS batch file used for the same purpose by the LIN (in section 4.1. above) with both having the logical form of : start metering, connect users to CD-ROMs, run search software, disconnect users, end metering. To an extent this is the process that is common to all CD-ROM networking systems.
The benefit of developing Atlas in-house rather than buying in a third party solution was a greater level of control over system functionality. This meant that planned changes to the service – a change from physically networked CD-ROMs to loading images as virtual CDs, a campus-wide move from Novell to Microsoft networking protocols or extensions to the Atlas scripting language – were unhindered by inflexible specifications. It also meant that reaction to unforeseen changes was easier. For example, the introduction of Windows 95 prevented many campus services from working while upgrades were sought from suppliers. Atlas was Windows 95 compatible within a few days of the problems being discovered and its centralised maintenance meant that the updated service was rolled out immediately.

During the life of Atlas the staffing structure changed greatly. In 1995 the University libraries, Academic Computing Service (ACS) and other, smaller, related departments were converged into "Information Services" (IS). By the time of the start of this stage in 1997, the Library Systems Unit's remit had been narrowed to cover only library-specific IT. Gradually support for mainstream office automation was taken over by ex-ACS staff and the three support offices were hived off into a larger pool of IS staff spread across all centralised university IT services.

The LSU system manager promoted to Senior Management within IS and the previous Library Management Systems manager was promoted to team leader, managing the three remaining members of the team.

The management of Atlas was very much that of a 'developer' as indicated in Ward and Griffiths' prediction for a 'Star' period (table 2.5). The use of networked CD-ROMs had established itself with the LIN and was

undergoing expansion in terms of both capacity and functionality. Strategically, the eResource network became seen by upper management as a key IS resource and Atlas' maintenance was a potential problem. Administration was only available to two members of technical staff (causing a workflow bottleneck) and systems development was reliant on a single person. The departure of another member of IS staff in a similar position led senior management to recommend that Atlas' replacement be a third party solution.

Towards 2002, changes to Atlas' operational environment were happening that were too fundamental to be addressed by simple maintenance of the existing system. These included :

- Drive letter assignments. When Atlas was developed it was agreed by university IT staff (both within and without IS) that the DOS/Windows drive letters would be reserved for Atlas' use. This caused a problem when users started to require the drive letters for shared workgroup directories. Although Atlas only temporarily used the drive letters and restored their original mappings afterwards, shared drives could not be used while using a networked title. Also multiple-disc titles started to appear that needed more than three discs at once and so had to be split into multiple datasets.

- Increased need for off-campus usage. Atlas was designed for users who achieved access directly through the University's HSCN (High-Speed Campus Network) LAN. With the rise in distance learners and the spread of the user pool to include satellite campuses this was insufficient. Users attempting to use Atlas from the Cohen Dental Library (located in Aston, Birmingham) found the service slow and those in the Johnson Library (in Stratford) or via a pre-broadband dial-in service found it almost unusable.

- Cross-platform usage. Whilst the majority of UoB users ran a Microsoft platform, Apple Macintosh users were still frustrated by the lack of support.

Access to Atlas was possible though a Mac/Windows emulation package but performance and functionality were both compromised.

It was these limitations that led to the call for a replacement for Atlas that was platform and location independent.

The change management of the Atlas phase of networked CD-ROM provision consisted of two types : intra-phase and inter-phase. The intra-phase changes were within the life of Atlas and were concerned with the ongoing availability of the service. An example was the migration of the optical servers from Optinet to CD-Manager. The change was effected by : creating 'spare' slots on the existing servers, moving CD-ROMs' locations so an entire optical server was empty, upgrading this sever to CD-Manager and moving CD-ROMs onto it to free up another server. This change, initially forced by the need to migrate to Y2K compliant software and typically of intra-phase changes (such as adapting to the spread of Windows 95), was reactive. The inter-phase changes for Atlas – from the LIN to Atlas and from Atlas to its successor (xDirectory) - on the other hand were proactive.

Unlike the transition from the LIN to Atlas, the metadata created for Atlas was adapted for use with the next stage in the provision of eResources. The Atlas configuration files were parsed by in-house programs to create XML files which contained :

- Resource title
- Resource type - web or CD-ROM
- Location - URL (if Web) or disk name(s) (if CD-ROM)
- Location of help file(s) – local or networked
- A list of applicable departments

These provided the starting point for the semi-automated configuration of the xDirectory service, and later the ERD, which are discussed in the next section.

4.3. x-Directory and the eRD (2002-2005).

In 2002 a number of commercial web-based alternatives to Atlas were considered as the trend by IS senior management was to move away from in-house towards generic solutions so that services would not be dependent on key staff members for their future. The chosen solution from Esprit-Soutron (formerly Fenwood) was a combination of xDirectory , Ultra*Net 2000 and Citrix MetaFrame1.8.

Ultra*Net (developed from a previous solution, Fenwood CD) was a client-server system for networking CD-ROMs. Disks for the 56 CD-ROM based titles were installed onto the server as CD images which were then mapped using Ultra*Console, the system administration GUI, to titles. Each title was an object under Ultra*Net which as well as having disks (and the drive letters to which they needed to be mapped) also could be assigned scripts showing which application to run. It was possible to use Ultra*Net on it's own as a solution provided that the administrator has sufficient control over the end-users' systems to prevent conflicts with existing configurations. In that case, the Ultra*Net client would be locally installed which displayed a menu of available titles.

At UoB, rather than distribute the Ultra*Net client software to the end users it was installed on a Windows 200 Server running Citrix MetaFrame 1.8. Citrix is a thin-client server that allows users with Citrix client software to run windows sessions on a server acting as a virtual machine. The processing is performed on the server and the only traffic between the user and the server contains user input and changes to the screen display. The benefits of networking CD-ROMs over a thin-client solution have been discussed previously in section 3.4.2.

As well as the Ultra*Net client, the Citrix server also had installed onto it copies of the CD-ROMs' search software. By doing this, the titles could be run as if local and the correct system configuration (registry settings, directories, etc.) could be guaranteed.

The Citrix client software was freely available as a plug-in for Internet Explorer and Netscape, as a standalone helper application (for all major platforms including Windows and Macintosh) for other browsers or as a feature-limited Java version. UoB users were encouraged not to use the Java version as it did not support functions such as printing or locally downloading.

xDirectory was a web menu system based on MS SQL-Server designed to create directories of resources. This was to create the user interface directing users to networked CD-ROMs and on-line databases. The maintenance was of two levels – customisations (done by systems personnel which defined the record types and look-and-feel) and administration (done by library staff which gave values to the metadata about each resource). As such, the majority of the day-to-day administration no longer needed to be done by the Library Systems staff as it had been under Atlas. If xDirectory had been deployed successfully it would have been possible to expand the system with its sister product that added workflow and helpdesk functionality.

Access to the rapidly expanding range of electronic journals was provided by a completely separate system called TDNet.

Unlike the previous LIN-to-Atlas transition where the two systems shared resources during the handover, the hardware for the new service was a total replacement of the Atlas hardware. This was more costly in financial terms but meant that the two systems could run in parallel while the new service was developed and users migrated with no impact on the existing, live system. This new system is shown in Fig. 4.5.

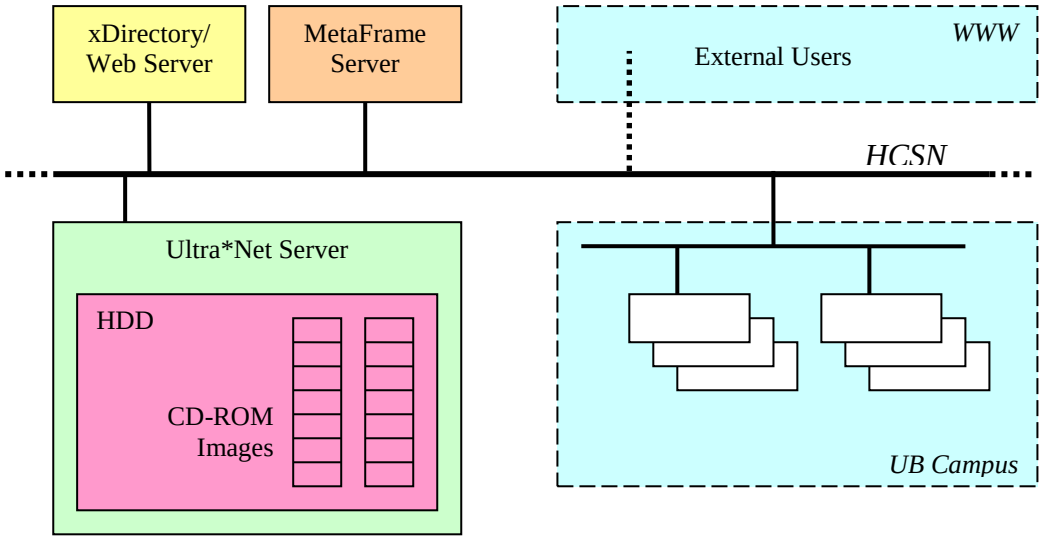


Fig 4.5 : eResources Directory

The use of x-Directory as a front end was not a success due to reliability problems and in 2004 a replacement, interim solution was introduced. The eResources Directory (eRD) was a series of static web pages; batch generated nightly from an XML format export from the eResource holdings of Talis - the BU online catalogue and library management system.

This suite of 165 Web pages consisted of

- a single page for every resource identifying coverage,
- an AZ list of all available titles
- AZ list of titles for each of 55 subject areas. These included a list of 'Favourite' titles for each resource which were identified by IS staff and stored in a manually maintained parameter file for each subject. This list appeared at the head of each subject area's AZ list – as shown in fig. 4.6.

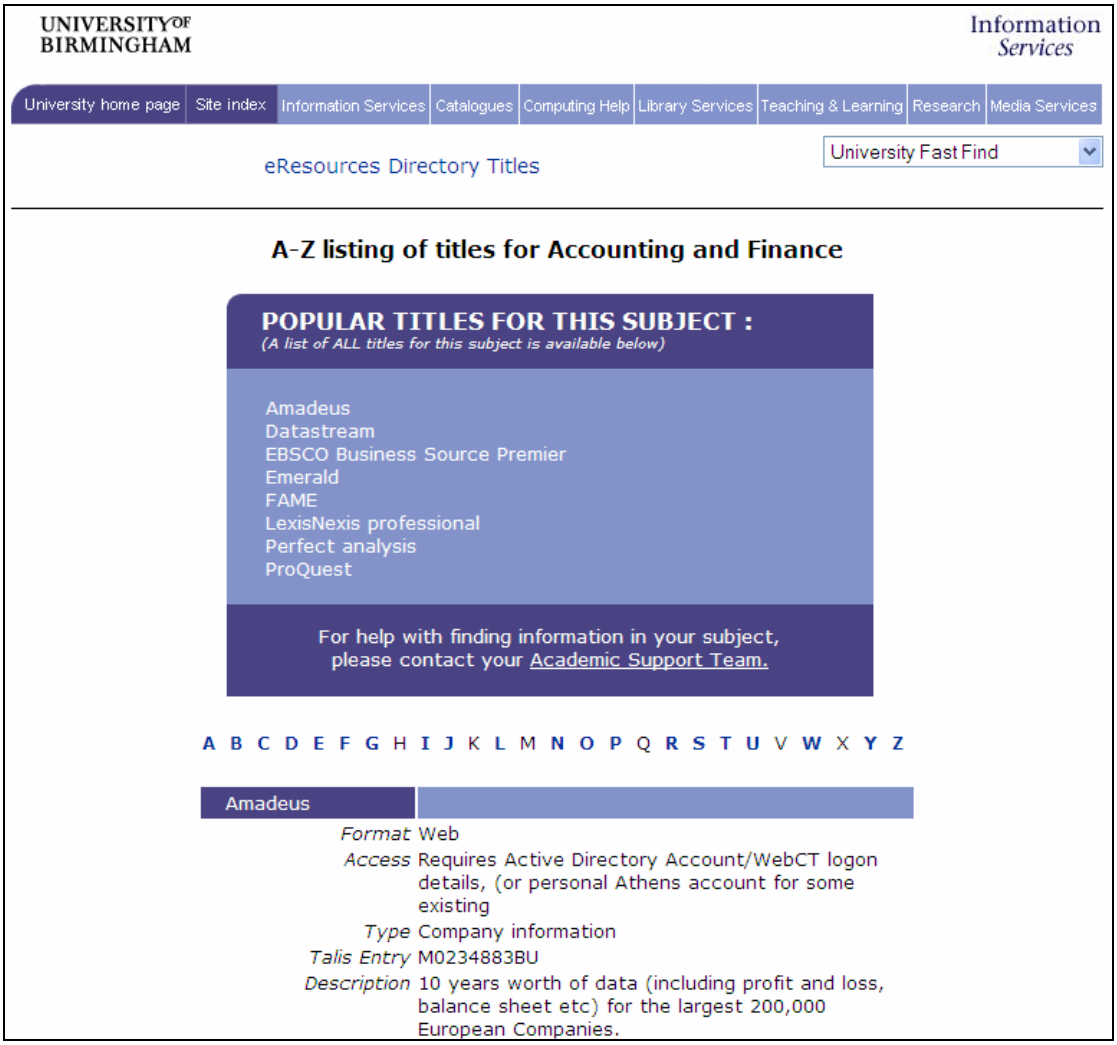


Fig 4.6: An eResources Directory static web page.

The Ultra*Net and MetaFrame components of xDirectory were independent of the database and front end and were retained. Since MetaFrame was a web technology it was possible to produce an URL that linked directly into them. An authentication system linked through to the university's LDAP (Active Directory) service was written in-house that prevented unauthorised use and this was added to the metadata of CD-ROM title under the eRD.

Although the popularity and usage of CD-ROMs seemed to be waning, the actual number of titles remained constant. While the majority of major datasets were being migrated to the Web, their place was constantly being taken by smaller, more esoteric titles that had no web alternative.

During this period there was another change in staffing. One member of staff remained in the team (now called LMERS, the Library Management and Electronic Resources Subsection) with responsibility for networked CD-ROMs/eJournals and also provided a second line of support for other library systems. The administration of standalone CD-ROMs was moved outside of the LMERS remit and was looked after by the same team that looked after other public (cluster) PC services. The LMERS eResources support post that had included this role was reduced to reflect the change in workload and the post returned to a full position by the addition of general cluster PC support tasks.

In theory, this stage of CD-ROM networking should have seen the adoption of a 'controller' management style where the day-to-day administration is delegated to the appropriate systems or library staff. If xDirectory had performed as hoped this would have been the case. In practice, however, the in-house creation of the eRD is an example of another 'developer' managed system which implies that the service was held back from evolving into a true Cash Cow. While the other indicators showed this progression, the management failed to reflect the increased 'value-for-money' that a controller could bring and the independence from reliance on key staff was lost. Despite these managerial problems the eRD was popular with both end users and library staff.

The eRD, though popular, was never intended as anything other than a stop-gap solution and a replacement was soon sought. This process was delayed by the resignation and replacement of the Library Systems manager. Although this post was not directly responsible for the eRD, their departure coincided with that of another member of the LMERS leaving the team understaffed. The electronic resources manager was called upon to provide extra support for other library services at this time and there were insufficient resources to devote to a system replacement.

4.4. eLibrary (2005+).

In 2005 the eRD was superseded by eLibrary, a resource discovery web database that integrated eResources with a database of the University's 15,000 eJournal subscriptions, provided single sign-on to Athens authenticated resources and allowed federated of external databases.

45 CD-ROM titles from the eRD were made available on the eLibrary. These were migrated automatically with the hardware and data remaining in place and the URLs direct to the thin client access included in the migrated metadata.

At this time Citrix ceased support of MetaFrame 1.8 - the version of the thin client software employed by Ultra*Net - and the licensing models of subsequent versions were prohibitively expensive. A new licence would have needed to have been bought for every potential user of the system at an estimated cost of over £25000. As a result it was agreed that the provision of networked CD-ROMs would be phased out by the end of 2005 with the titles either :

- replaced by web alternatives where possible,
- networked on departmental intranets, or
- moved to standalone terminals in the Main Library. Since this time there have been repeated projects to reduce the number of standalone titles by investigating usage statistics and attempting to source direct alternatives on the Web.

During this time the team responsible for library IT, now renamed the Digital library Team and part of IS' Business Systems Team, was reorganised following changes in staff. A single manager was appointed for all systems with particular emphasis on the Library Management Systems and Catalogue. Under them were one full-time staff member for eLibrary (and other library systems such as institutional repositories and swipe card access to library buildings) and a second member of staff who would spend half of their time on LMS work and half on other projects.

A managerial benefit of eLibrary was that the sophisticated web interface for the management of the underlying database allowed the operational maintenance to be performed by non-technical IS library staff. While customisation of the user interface and development of plug-ins for non-standard resources still required technical expertise, the suppliers ExLibris provide monthly updates to an extensive Central KnowledgeBase of popular titles which can be individually activated by inserting institutional configuration details.

By opening up this administration to a wider pool of staff eLibrary enables a limited Web 2.0 implementation. A fuller implementation – by offering users the ability to recommend new resources – is a potential future development. The results of this new functionality include a reduced workload on technical staff, a greater degree of 'ownership' by library staff of the eResources (and by association the eLibrary service) and a greater number of titles (as of writing over a thousand titles).

The CD-ROM management style for this period was that of a 'caretaker' – a characteristic according to Ward and Griffiths (table 2.5) of the DOG sector of the BCG matrix. Certainly the use of networked CD-ROMs was clearly in decline and this had been foreseen for some time.

The key task in managing the networked CD-ROMs during this phase was overseeing the decommissioning of the service. Once the decision of what to do with non-Web titles (outlined above) was made, users were give four months warning of the removal of the service. An expected outcry at this never materialised as the consensus amongst the users was that this was a logical and expected move.

The metadata for titles on eLibrary was changed to reflect the new locations of the information, the links to MetaFrame redirected to an explanatory page and the Ultra*Net server was switched off. UoB's Information Services no longer networked CD-ROMs.

5. Survey.

In the previous sections of this report the case has been made that the BCG matrix is a valid model for the managing of networked CD-ROMs and this has been supported by research (into both management theory and CD-ROM technology drivers) backed up by the UoB case study. Gaining an indication of how typical the case study is of UK universities in general, however, can enhance its value. To gauge this, a survey has been performed of CD-ROM networking throughout the UK.

5.1. Planning.

The questionnaire distributed for the survey is included with this report as Appendix B and consists of :

- Direct questions on the institutional use of networked CD-ROMs (empirical data on numbers networked, date ranges, etc. that could be analysed) and their management (requests for comments to see if experiences match those of the case study).
- A request for details of any papers published by the institution on the subject in the past. This was to highlight anything that had been overlooked in the literature search. However, the only articles that were suggested had already been found and used.
- A request whether the institution could be named in the report or the responder contacted for clarification of any points.

The target institutions were identified by their inclusion on the 2007 edition of The Times list of top-100 UK Universities (TT-100). Other rankings are available either from competing UK newspapers (The Guardian, Daily Telegraph) or from suppliers with other bias (eg. league tables ranking universities based on just teaching or just research). The TT-100 list was

chosen over the more 'specific' lists as this report is interested in the use of CD-ROMs in universities in general (rather than, for example, in research-led universities). Its selection over the other newspapers' lists is partially due to the additional IS-spend data available and the ease of availability of previous years' lists for comparison.

Initially this criteria was expanded to include institutions which had appeared in TT-100 lists over past years. This caused problems ranking those institutions that had appeared on previous lists but not on the latest. In the event, none of these institutions responded to the questionnaire so the 2007-only inclusion criterion was enforced.

The TT-100 list includes annual spend on IS (Library and IT combined) per student. By searching University web sites it was possible to add to this data each institution's :

- Date of inception (including whether it was a polytechnic before 1992)
- Geographical location. This proved not to be meaningful but is something that may be of interest in the future – especially the future effects of the differing funding methods between England and Scotland.
- Size of student population (in fte, full-time equivalents) based on figures published by each institution during the early part of 2007. Although this is by nature a dynamic statistic, taking snapshot of these should be sufficient for comparative analysis.

Immediately we can compare the Case Study, UoB, against other UK institutions on these values. In the last three TT-100 lists for 2005 to 2007, the UoB ranked 28th, 33rd and 23rd respectively. This demonstrates that UoB is a 'typically' ranked institution – that it is not at either extreme.

As well as rankings, the data provided for the UoB can be compared to maxima, minima and means for all institutions on the Top100 list providing the information in Table 5.1. From this it can be clearly seen that the case study is neither extreme nor unusual in these regards.

	UoB	Minimum	Mean	Maximum
Size (FTE)	**16335**	802	**16346**	41660
Year of Inception	**1900**	1096	**1886**	2004
Library Spend	**701**	120	**606.62**	1656
Ranking	**23**	1	**50.5**	100

Table 5.1 : Distribution of results for Top100 list (and UoB)

Although, as Michaelidou (2006) discusses, the adoption of email questionnaires is less widespread than on on-line surveys (and there is therefore less empirical support for their effectiveness) it was judged that this was the most appropriate method for conducting this survey. The user population of UK universities has a longer history of email usage than the general population and deals on a daily basis with their own highly email literate users. Many University Libraries, in fact, have moved from distributing physical overdue and renewal notices for books to email equivalents for cost reasons.

Two waves of enquiries were made. Firstly, a set of emails to universities' general library enquiry desks (or web enquiry forms where available) asking for the details of a contact who may be able to help. To those institutions that did not respond to the first wave within a month, an email was sent to a named Library Systems Manager asking the same question. In some cases this person emailed may themselves be the appropriate recipient.

The full questionnaire (Appendix B) was then sent to the identified member of staff. If no reply was received after five weeks, a follow-up email was sent politely asking whether they have had a chance to look at questionnaire.

A final email was sent as a reply to a completed questionnaire, thanking them for taking part in the survey. This meant that an individual should only have

directly received a maximum of three emails about the survey. This was considered not to be excessive.

5.2. Responses.

Of the 99 questionnaires sent out in the first wave (one place in the top 100 already being taken by the case study), 47 responded to the general email with a named contact for the questionnaire while 1 responded that they would be unable as an institution to take part in the survey.

The 51 remaining institutions were sent the second wave (identified Library manager) email. 19 of these replied with a named contact and 2 declined to take part in the survey.

From these two waves 66 named contacts were identified who were then sent the full questionnaire. In turn 5 of these responded that they were unable or unwilling to provide further information and 27 returned either a completed questionnaire or information that their institution had never networked CD-ROMs (a negative but still valid response). This gave a response rate, discounting the case study from the TT-100 list, of 27.3%.

The spread of the responses received is shown in figure 5.2 which plots the institutions' rankings against their student population, displaying the different responses received. As well as showing that the responses cover the breadth of both axes well, this also incidentally illustrates the lack of a correlation between an institution's size and its ranking.

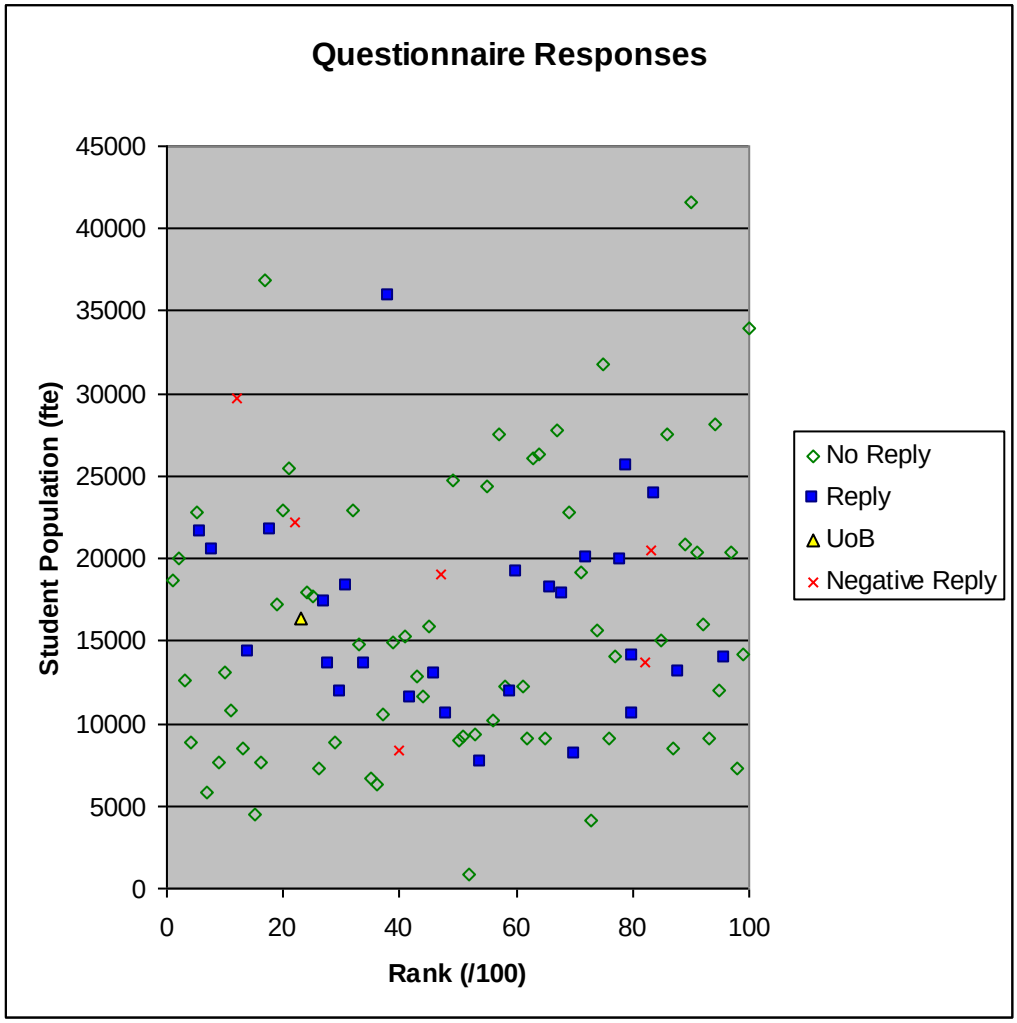


Fig. 5.2 : Scatter-graph of questionnaire responses.

This can also be seen by calculating the maxima, minima and means for the available data for the responses (table 5.3) as we did previously with the TT-100 list in general.

	Minimum	Mean	Maximum
Size (FTE)	7615	**16584.19**	35963
Year of Inception	1495	**1899**	1975
Library Spend	401	**630.96**	1152
Ranking	6	**52.04**	96

Table 5.3 : Distribution of results for Survey Responses.

It is useful to compare these figures with those in table 5.1 above. This shows that the survey responses do not include many Universities with extreme

values but nonetheless have means in every category sufficiently similar to those of the general population to comprise a representative sample.

5.3. Analysis.

From the responses to the survey we can determine a great deal about the use of networked CD-ROMs in UK universities in general as well as in relation to the case study.

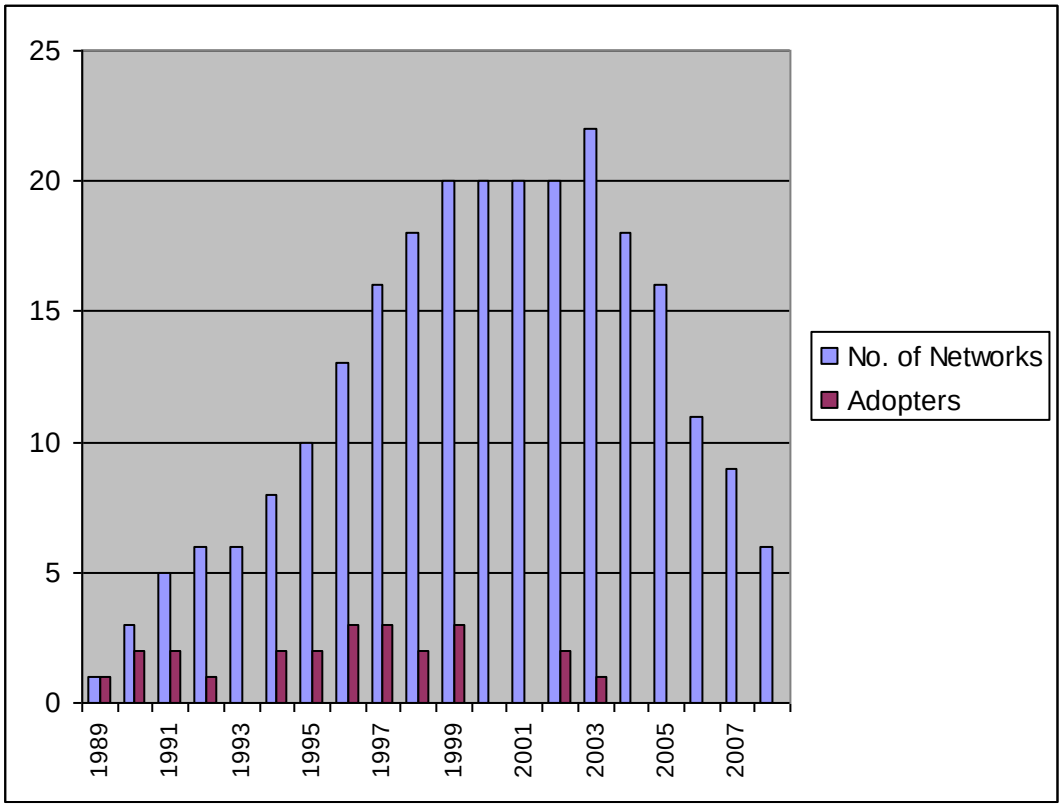


Fig. 5.4 : Graph of total CD-ROM networks (and adopters) by year.

The summary of the dates during which sites networked CD-ROMS (fig. 5.5) illustrates how the technology has risen, been widely popular and is in the process of fading away. This fact that is confirmed by plotting a bar graph (fig. 5.4) of the total number of CD-ROM networks amongst survey responses

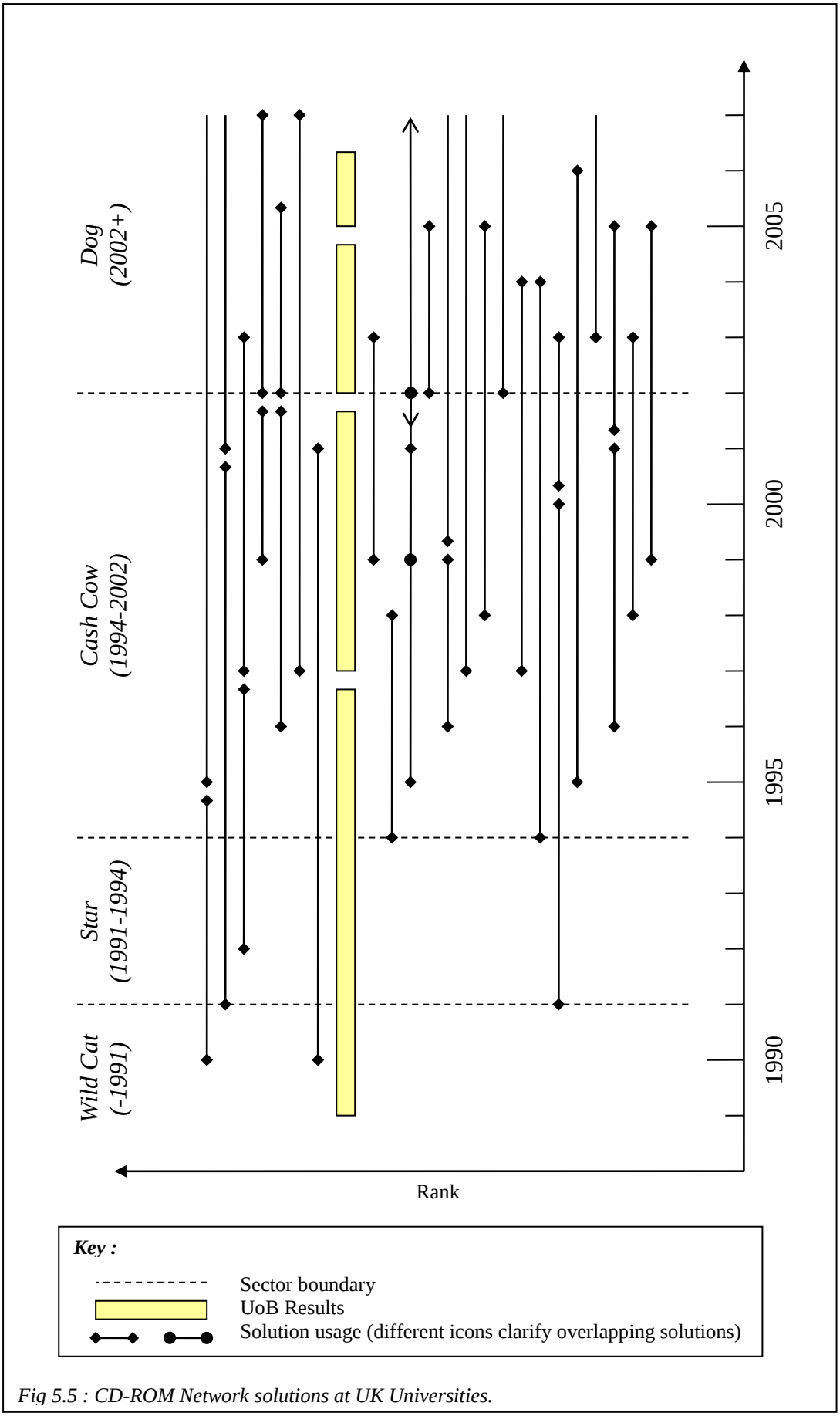


Fig 5.5 : CD-ROM Network solutions at UK Universities.

within any given year. As expected, this produces a normal distribution in which we are currently in the last quartile. It is interesting to note that the distribution is centred around 2001/2 which in our application of the BCG model equates to the latter part of the Cash Cow period. That the maximum usage should be in this period is not surprising but the proximity at the start of the Dog period suggests that some institutions are either less concerned with their return-on-investment (preferring to extend a service into 'unprofitability' for their users' benefit) or that they may have taken a poor strategic view.

This is an example of a key difference between the approaches by the public and private sector to strategic planning. A corporation is largely drive by profitability and may refrain from altruism towards its customer without a financial (or goodwill leading to future financial) incentive. A university as a non-profit organisation can afford to be more concerned with the 'contentedness' of its customers and so in this model may need to measure return-on-investment in different terms.

We can also show on the same graph the spread of adopters - dates when sites first started to network CD-ROMS. The distribution of adopters can be compared with the findings of Rogers (1962) who says that purchasers of new products come in 5 categories : Innovators (making up 2.5% of the subject population), Early Adopters (13.5%), the Early Majority (34%), the Late Majority (also 34%) and Laggards (16 %). These categories and percentages make up a bell-curve symmetrical around the early/late majority boundary.

Considering our graph, the results support this theory well. Innovators fall into the pre-1991 (Wild Cat) period, Early Adopters into the 1991-4 (Star) period, The Early and Late Majorities into the 1994-2002 (Cash Cow period) and the Laggards into the 2002+ (Dog) period.

Regarding the number of titles networked, the case study is not a typical institution. The four solutions used by UoB had peak numbers of networked CD-ROM titles of 47 (the LIN), 86 (Atlas), 56 (the eRD) and 45 (eLibrary). While these figures are higher than the survey average of 37.03 titles, the

individual peak totals (fig. 5.6) are unevenly distributed and the UoB figures are not outside the range of responses.

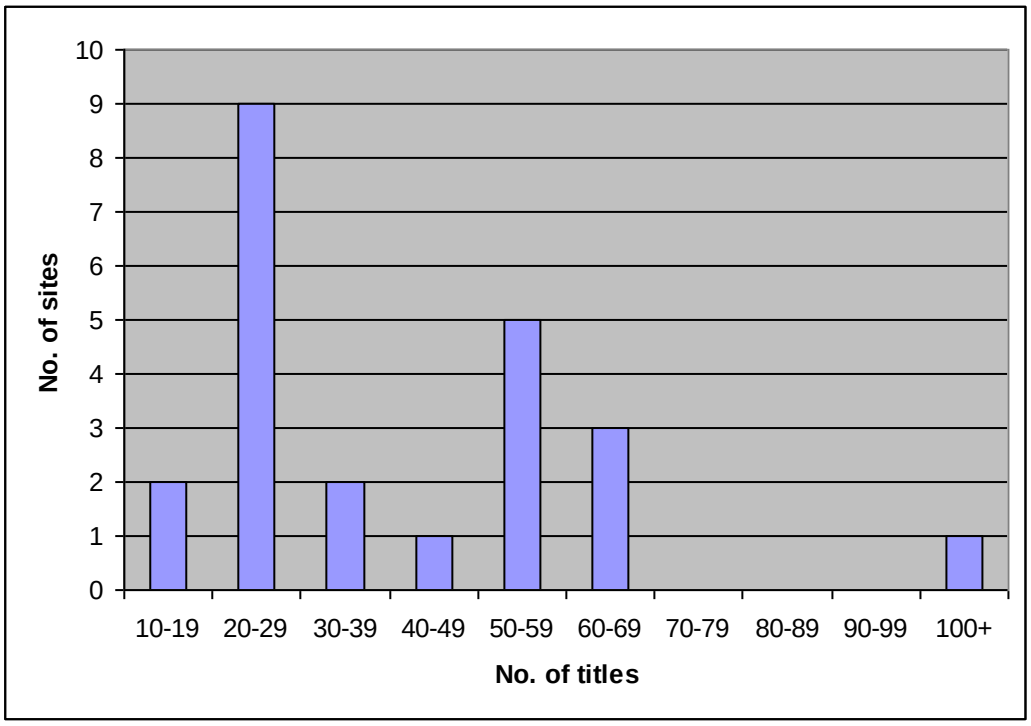


Fig. 5.6 : Peak Numbers of Titles per site.

Survey responses also indicate the popularity of various solutions for networking CD-ROMs. These are shown in figure 5.7 below.

Notes for fig 5.7 :

**1 – Thin Client solutions were mentioned alongside other solution(s)*

**2 – SilverPlatter-ERL – was one of the 'CDs on the Web' solutions mentioned in section 3.4.2.*

**3 - All the other named solutions (Novell AppManager, ZenWorks, Axis Storpoint, UNIX, Avantis and LAN-CD) were only mentioned once.*

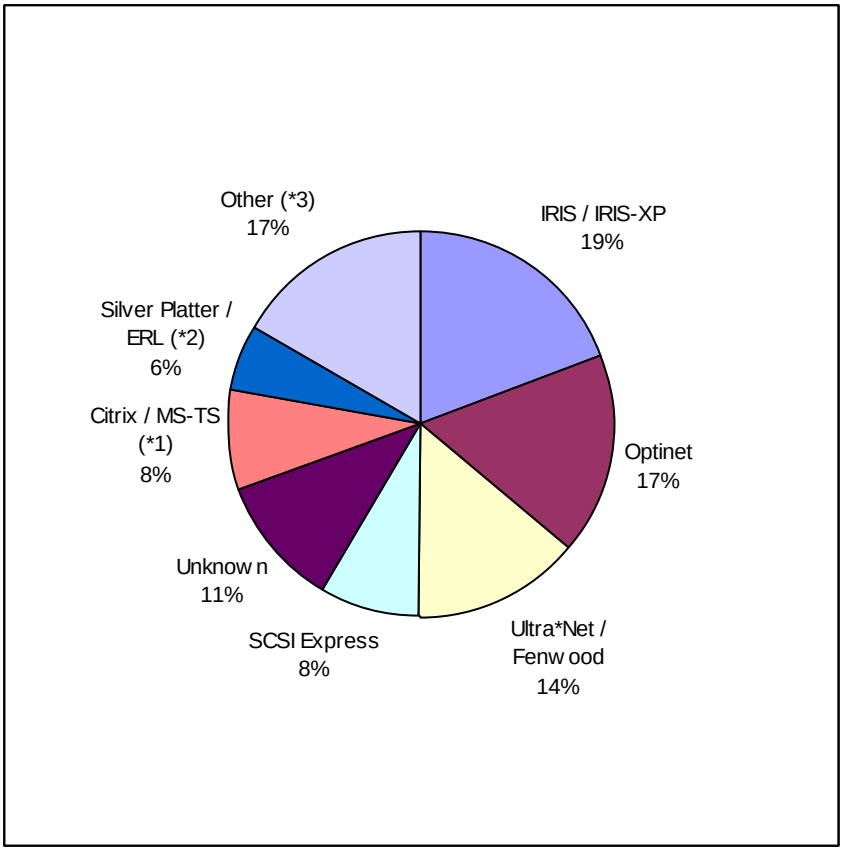


Fig 5.7 : Use of Networking solutions (by name).

While the case study did not use the most popular networking solution in the survey, the solutions that it did use – OptiNet (for the LIN and, along with an OptiNet derivative, Atlas) and Ultra*Net (for xDirectory and, peripherally, the ERD / eLibrary) – were the second and third most popular solutions mentioned. From this it is clear that the solutions used by UoB were not unusual or obscure.

Comparing the comments made in survey responses with the case study also demonstrates the commonality between the case study and other institutions (the site codes used here refer to those used in Appendix D to anonymise the responses) :

In sites without a converged Library and IT department, the management of CD-ROMs was handled by either. Examples of this include Site B5 (where administration was performed by Systems) and Site C7 (by their Library). Prior to convergence at UoB, this was handled by a systems unit within the

University Library rather than their Academic Computer Systems department. Site B9 notes how after de-convergence in 2005, the support for the CD-ROMs was maintained by Computing services while promotion became a Library function. UoB is currently re-arranging its corporate structure so that the Library Services and Computing divisions are separate business units underneath a newly formed 'Academic Services' which will also include such functions a Student Support. The support for the Electronic Resources has always shown an organisation split (similar to site D6) between technical support and acquisition/promotion and so is expected to be largely unaffected by the re-organisation.

At UoB, changes in staffing were achieved through staff being moved to associated posts either during times of re-organisation or staff turnover. Many sites (such as A3, A4, A6 and A8) reported that posts had similarly been lost through wastage and not re-filled. Site D6 in particular summarises a history of changing roles and responsibilities that echoes that of the case study.

The technical issues reported by the case study are also reflected in the survey responses :

The findings of site A1, in particular, show much in common with the case study. They experienced an identical problem with Terminal Services licensing making thin-client distribution uneconomic. Problems with standalone titles being touted as networkable were time consuming with "complexities perhaps not appreciated by liaison librarian colleagues". They also found problems in their early stages of legacy MS-DOS titles not running properly under Windows.

Site A1 also commented on a facilities management service for networked CD-ROMs that was considered (briefly) by Library Management Systems supplier Talis. This would have centralised the hosting of titles at their Birmingham headquarters and provided access from customers across the UK via thin-client. This would have delegated support issues to Talis who would

have also have had cost savings with customers sharing resources. Unfortunately this never progressed beyond the planning stage.

It was suggested by site B6 that typically optical hardware needed to be replaced on an approximately four-year cycle. This cannot be confirmed by the UoB case study where the early optical server hardware lasted considerably longer than this and later servers never experienced a forced replacement as they were on a mandatory three-year replacement cycle.

Examining the data from other institutions (fig. 5.8) however, shows that there may be some validity in this. The peak length for a solution to be in use is 3-5 years and a secondary peak is shown at ten years. It is possible that this secondary peak may be evidence that a solution has already had its hardware replaced once mid-way through its life and is being phased out due to re-assessment at a time of second-generation replacement.

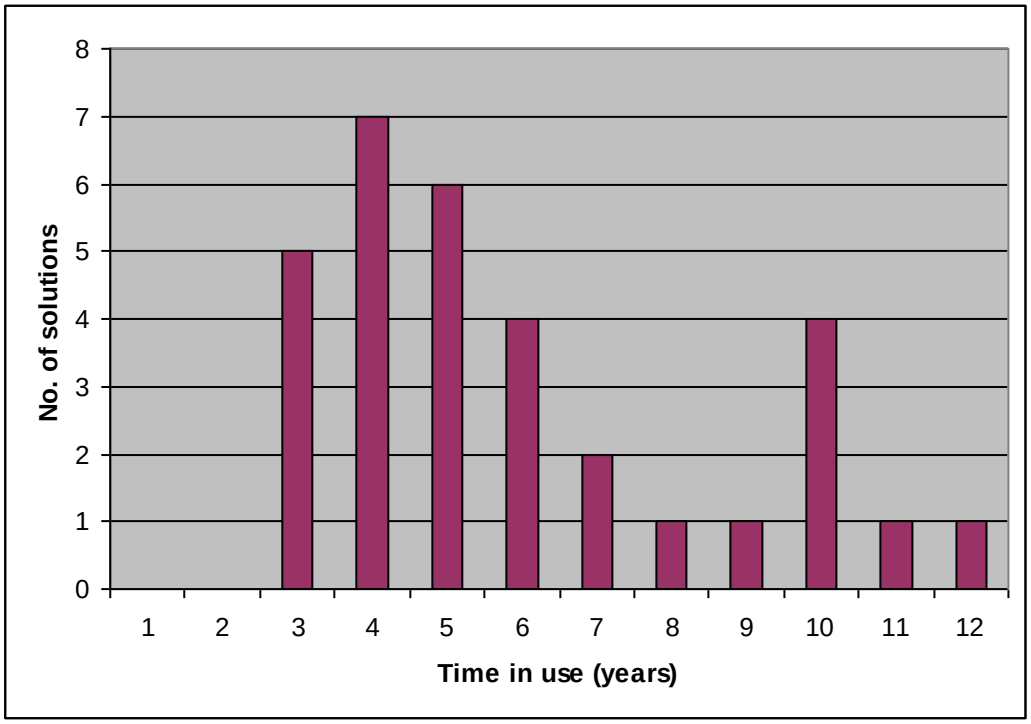


Fig 5.8 : The lengths of the lives of solutions.

In planning this survey, the hypothesis was presented that the lives of individual solutions are, over time, decreasing in duration. This was based on

the experience of the Case Study where the four solutions were used for eight years, five years, three years and 18 months respectively. However, there is no evidence from the survey that this is typical of all institutions. Of the responders that networked CD-ROMs :

- 60.87 % used only one solution throughout their networking of CD-ROMs,
- 17.39 % used two solutions with the second solution being used for a shorter period of time,
- 17.39 % used two solutions but with the second solution being used for a longer period of time, and
- 4.35 % used three solutions but not for decreasing amounts of time.

No survey responses used as many different solutions as the Case Study.

Site B9 noted the changes in user expectations of electronic resources but emphasised this at the time of CD-ROM's replacement by the Web rather than at the time of the spread of local CD-ROM drives and titles (as in section 3.2.3). It stressed how these changes - disappearing native interfaces, federated searches, item-level linking, integration with other university services (such as Virtual Learning Environments) and off-campus access - contributed to the death of the CD-ROM as a networked information resource.

This death was hastened by the fact (repeated by sites B2, C5 and C6) that CD-ROMs failed to remain cost-effective – ultimately the measure of return-on-investment that the BCG matrix shows as an attribute of the Dog sector. The majority of sites cited this as being the ultimate reason for decommissioning their CD-ROM network although one site's (C3) network was decommissioning through hardware failure (and interestingly "restoration of the capability to network CD-ROMs is still something that I would like to do [given the time]").

Site D6 noted that while administration became “technically easier it became organisationally more difficult” and the problems of the administration of CD-ROMs are excellently summarised by site A4 :

> “… From a librarian and/or systems person point of view they were poorly documented, often badly coded, idiosyncratic, would change completely without warning, sometimes didn't work well on a network even if you brought a networked site licence and could have variable quality data in them.”

6. Applications of this information.

This report has concentrated on the application of a single, popular business model to the management of a single, historically popular application – the networked CD-ROM information resource. From this pairing a variety of management information could be produced such as the position of an institution within the lifecycle of networking CD-ROMs or the projected future return on investment (in terms of value-for-money)

The extensions to the BCG matrix described in section 2.3 can also be applied to add extra value to this management information. The current sector, for example, can be used with the McFarlan grid to suggest linking strategies or management styles.

It is also worth considering the applicability of other models – either alternatives to the BCG model as in section 2.2 or other, unrelated business models – to this area. The problem being in knowing the limits of this and at what point a model is so unsuitable that its use is detrimental.

Conversely, rather than applying other models to the same technology, there may be validity in applying the same model to other technologies. The model's application to other information resource technologies is the obvious first stage. The use of the internet-based databases is currently the most popular media for networking information but it is hard to argue that this lifecycle is in the Wild Cat or Star phases. If it is currently a Cash Cow then the planning and management should already have changed to take account of this. Competing technologies or changes in then academic environment should be carefully watched for the rise of factors that could push this technology into the Dog sector.

Similarly, non-database IT technologies may be analysed with this model with the same results. The use of virtual learning environments and web portals are in a position that CD-ROM networking at the turn of the century. The prediction of the

length of their Cash Cow period is key to strategically planning their optimum exploitation and the next stages in their development.

Boone (2006) says that while universities are traditionally seen of as “ivory towers”, they have to become more business-like in their exploitation of research and results. This philosophy can also be applied to universities’ internal business processes of which IS (including the provision of Electronic Information Resources) is an example. The use of this model may prove useful in areas not traditionally associated with either IT or business. If the findings of Boone are extended to support functions then the application of generic business models will become more prevalent.

7. Critical Evaluation.

In evaluating the project critically, we first need to divorce the possible shortcomings of the project – in its aims and methods – from its management. The latter of these is considered in Appendix A below.

The project's shortcomings can be seen by following the same narrative as the report itself :

The argument of the BCG model being too general or simplistic for this use has already been considered in section 2.2 and 2.3.

The subject matter that the model is applied to – the use of CD-ROMs for networking electronic resources - is historical without having the benefit of historical perspective. That is to say, it can be argued that insufficient time has passed to truly look at the subject dispassionately as many of those involved in the area at the time are still working in related areas (particularly in non-CD-ROM electronic resource provision).

Also there are areas in which more time needs to pass before the final results are apparent. Some survey responses noted that while they were still using networked CD-ROMs, they were planning to phase these out within the next couple of years. In a similar way, during the writing of the project the debate was still underway regarding the high-definition successor to DVDs (see section 3.4.3). This has now been decided with the Blu-Ray format emerging successful although the question of physical versus online media-on-demand is still open.

This criticism is indicative of a balancing act that needs to be considered. On one hand the use of a recent technology lacks perspective and may include personal bias. On the other hand, the opportunity to get first-hand input from those concerned is invaluable. Perhaps it may be possible to revisit this subject in the future and re-evaluate it from a greater distance ?

The case study used could be criticised for the narrowness of the view. As the context was the management of the technology rather than the underlying resources, a librarian-centric approach was avoided. This may have given the study another dimension but would have required more experience in librarianship (an esoteric subject of its own) and the additional information would have been at best only peripherally relevant.

The survey can also be criticised for being too narrow. Although a response rate of 27.3% was achieved, this was from a pool of only 99 potential institutions (the TT-100 list minus the University of Birmingham case study). The reasons for limiting the survey to the TT-100 list were outlined in section 5.1 and an attempt to expand this to include institutions that appear in the same list over the past four years did not generate any more responses. The alternative would have been to expand the criteria for the survey to those outside the UK but it was argued that this would have diluted the validity of the survey and introduced the need for the rest of the report (including literature search and, if possible, case study) to include European or global elements.

The Response rate itself could have been improved by more intensive 'encouragement' of potential responders. The danger here is in this being taken as 'badgering'. The contact for the survey was limited to a set number of emails. More responses may have been received by a postal mail shot but this is debatable – certainly the profile of contacts was highly email-friendly professionals. An alternative that was considered was to prepare printed questionnaire that could have been distributed at appropriate user groups. This was not possible, however, as no groups that would accommodate this were available during the time of the survey.

As discussed in section 5.1, the data used as part of the survey analysis was essentially a 'snapshot' of data from the TT-100 list (and associated contemporary data) despite a more up-to-date set of this data becoming available during the analysis stage (see Appendix A). The use of such a snapshot was two-fold. Firstly, the data was used comparatively rather that quantitatively – it was used to rank institutions and consider relationships or trends. Secondly, the response data was

of historical use of resources over the past twenty years. There is no benefit in using a more up-to-date series of data in this case.

The only real improvement in the data currency would have been to determine the same data for the historical period being considered. However, there is no straightforward way of extracting such a pool of data for over 100 institutions for two decades. The closest possible would be to find this information where possible and then interpolate/extrapolate the missing information. It is doubtful this approach would have been suitably accurate and it would certainly have been outside the scope of the project.

While opportunities for improvement can be seen at every stage of the report, to include all the possibilities would have resulted in a report with so wide a scope that a clear meaning would have been lost. I maintain that the reasons for actions taken and choices made in this regard stand up to scrutiny.

8. Conclusions.

In the introduction to this report the key hypothesis was defined as being that :

> The BCG Matrix is a suitable model to use for the management of networked electronic information resources, despite the properties of this matrix (market share, market attractiveness, profitability and return on investment) possibly being either immeasurable or inapplicable.

Throughout this report, this hypothesis has been repeatedly supported.

In considering the pros and cons of the BCG Matrix, criticisms were made of the way the inputs to the model are measured, the reliance on high market share as a success factor and the limit of comparing performance only with similar units in other sectors. However, these criticisms are not directly applicable when the model is applied to networked electronic information resources – although some of the terms need to be re-defined for the non-commercial sector (for example, 'return-on-investment' is better defined as 'value-for-money').

The details added to the model by the extensions are particularly valuable to this application because the new attributes such as recommended management styles and linking strategies are just as applicable for information resource management.

CD-ROM Networking technology was shown to have been pushed through all four sectors of the BCG matrix by factors external to the technology itself. These included managerial and political factors specific to academic computing although the most influential factor was the effect of competing technologies on the field.

In the UoB case study it was shown how the theory of the preceding sections was reflected in real-world experience. Changes in technology were as predicted by the literature search on the CD-RO networking lifecycle and the management of

the resources were changed as predicted by combined BCG/McFarlan grid (summarised in figure 2.5).

The survey of CD-ROM networking in UK universities showed that in almost all regards the case study was a ‘typical’ university and that its experiences were echoed by those elsewhere. The only hypothesis based on the case study for which no evidence was provided by the survey was the diminishing lifetimes of networking solutions over time.

9. References.

ABBOTT, C. and SMITH, N. (1994) Resourcing Issues. *in*
HANSON, T. and JAY, J.M., *CD-ROM in Libraries : Management Issues.* London : Bowker Saur.

BEATH, C.M. (1991) Supporting the Information Technology Champion. *MIS Quarterly,* **15(3).**

BODDY, D. and GUNSON, N. (1996) *Organisations in the network age*. London : Routledge.

BOONE, J. (2006) Universities switch on to business. *Financial Times*. **(27/7/2006)**, p. 3.

BRAINARD, R. (1995) Network Architecture – A Primer. *CD-ROM Professional.* **8(11)**, p. 46.

COLLIS, D.J. and MONTGOMERY, C.A. (1999) Competing on Resources : Strategy in the 1990s. *in*
COLLIS, D.J. et al (1999) *Harvard Business Review on Corporate Strategy*. Harvard Business Review Paperback Series.

CONNOR, D. (2007) Novell NetWare vs. Microsoft networking. *Network World,* **(10/26/07)**.

CONRAD, B. and DEPP, D. (1994) CD-ROM in the age of internet. *DOE Scientific and Technical Information [CONF-9410141—6], 13/12/1994*.

COX, J. (1994) The CD-ROM Market. *in*
HANSON, T. and JAY J.M. (1994) *CD-ROM in Libraries : Management Issues.* London : Bowker Saur.

CRAFT, E.J. (1996) CD-ROM Networking at the University of Birmingham. *in* BRADLEY, P. (1996) *UKOLUG quick guide to CD-ROM networking*. London : UKOLUG

CRAFT, E.J. and HAYDOCK, I. (1996) Living with a CD-ROM Network. *Managing Information (UK),* **3(12),** p. 39.

DEMARAIS, N. (1995) What is the 'CD-ROM Librarian' ? *CD-ROM Professional,* **8(1),** p. 89.

DOERING, D. (1998) How fast the networked CD-ROM ? *eMedia Professional,* **10(1)**.

DOERING, D. (1999) Network storage's DARK side – network storage devices and software lack the marketing needed. *eMedia Professional,* **11(8)**.

DYSART, J.W. (2000) Create a strategy for data storage. *HR Magazine,* **(10/2000)**.

EARL, M. and SCOTT, I. (1999) The role of the chief knowledge officer. *FT - Mastering Information Management*. Part 6, **(8/3/1999),** pp. 7-8.

FRANA, P.L. (2004) Before the Web There Was Gopher. *IEEE Annals of the History of Computing,* **26(1),** pp.20-41.

FREEMAN ASSOCIATES (1997) *Optical Storage Outlook 1997*. Freeman Inc.

GABEL, D. (1999) Netware on the Ropes. *VARBusiness.* **(29/11/1999)**.

GATES, B. (1996) *Career Opportunities in Computing -- and More.* Bloomberg Business News.

GROCHOWSKI, E. and HALEM, R.D. (2003) Technological impact of magnetic hard disk drives on storage systems. *IBM Systems Journal,* **42(2).**

GUENETTE, D.R. (1996) The CD-ROM/Online Connection. *CD-ROM Professional,* **9(3),** p.30-42.

GUSSIN, L. (1995) CD-ROM publishing, education, and boom years ahead. *CD-ROM Professional,* **8(6),** p. 58.

HAX, A.C. and MAJLUF, N.S. (1983) The Use of the Growth-Share Matrix in Strategic Planning. *Interfaces,* **13(1),** pp. 46-60.

HINER, J. (2005) *Tech Sanity Check.* TechRepublic: ZDNet (http://blogs.techrepublic.com.com/hiner/index.php?cat=565). 25/10/2005

HINES, A. (1994) Jobs and infotech. Work in the information society. *The Futurist,* **1994(1)**, pp. 9-13.

IMMINK, K.A.S. The Compact Disc Story. *Journal of the Audio Engineering Society*, **46(5)**.

KLAPP, O.E. (1986) *Overload and boredom*. Westport, WA : Greenwood.

KNIGHT, J. (1996) From the trenches : Networking (Not Working ?) CD-ROMs. *Ariadne,* **1(3).**

LACIE EDITORIAL (2001) LaCie ships new device for sharing CDs across a network. *Telecommunicationwire*, **2001(9)**.

LAMBERT, J. (1994) Managing CD-ROM Services In Academic-Libraries. *Journal of Librarianship and Information Science,* **26 (1)**, pp. 23-28.

LASHINSKY, A. and RYAN, O. (2005) Remembering Netscape : The Birth of the Web. *Fortune,* **152(2),** p.144.

LIEBERMAN, P. (1995) Navigating through VINES and NetWare and the New Software Technologies. *CD-ROM Professional,* **8(11),** p. 30.

McFARLAN, F.W. (1989) Portfolio Approach to Information Systems. *in* BOEHM B. W. (ed.) *Software Risk Management.* Washington DC : IEEE Computer Society Press, pp 17-25.

MCQUEEN, H. (1992) File server-based CD-ROM networking: using SCSI Express. *CD-ROM Professional,* **5(6),** pp. 66-8.

MICHAELIDOU, N. (2006) Using email questionnaires for research: Good practice in tackling non-response. *Journal of targeting measurement and analysis for marketing,* **14(4),** p. 289.

MORRISON, A and WENSLEY, R. (1991) Boxing up or Boxed in?: A Short History of the Boston Consulting Group Share/Growth Matrix. *Journal of Marketing Managemen*t, **7(2)** pp. 105-129.

NATHANS, S.F. (1998) CD-ROM, networks and bottlenecks – problems and advantages of networked CD-ROMs. *eMedia Professional* **11(1)**.

O'CONNOR, M.A. (1995) What will the next five years mean to information publishers. *CD-ROM Professional,* **8(3),** p. 54.

O'DONOVAN, K. (1994) Management Issues. *in* HANSON, T. and JAY, J.M. (1994) *CD-ROM in Libraries : Management Issues.* London : Bowker Saur.

OMAJI, A. (1994) Non-use of CD-ROM databases in an academic environment. *Computers in Libraries*, **14(9),** p. 45.

PARKER, D.J. (1998) Can I buy a vowel? The DVD acronym assault. *eMedia Professional*, **11(2),** p. 60.

PARSONS, G. L. (1983) Fitting Information Systems Technology to the Corporate Needs : The Linking Strategy. Harvard *Business School Teaching Note #9-183-176*, HBS Case Services, Boston, Mass, June 1983.

PEMBERTON, A.C. (1996) Optimizing Digital Assets for CD-ROM/Web : Hybrid Publishing. *CD-ROM Professional*, **9(3),** p. 10.

PENFOLD, S.L. (1999) *Change Management for Information Services*. UK : Bowker-Saur.

PERKINS, T. (1990) BCG matrices in practice in the computer industry. *Competitive Intelligence Review*, **1(1),** pp. 18-19.

PYBURN, P.J. (1983) Linking the MIS plan with corporate strategy : an exploratory study. *MIS Quarterly*, **1983(2)**.

RAINIE, L. (2005) Internet Librarians Own the Future. *Information Today*, **22(1),** p. 42.

REUTERS BUSINESS INFORMATION LTD (1996) *Dying for information ? An investigation into the effects of information overload in the UK and worldwide*. London : Reuters.

ROGERS, E.M. (1962) *Diffusion of innovation.* New York : Free Press.

ROWE, D. (2000) DVD, CDs lead the way in storage revolution – Industry trend or event. *Computer Dealer News*, **2000(4)**.

RUSSELL, R. (ed) (1991) CD-ROM networking on OPTI-NET: the South Bank Polytechnic Library network. *VINE*, **83(1),** pp. 19-24.

SCHNEIDER, K.G. (2007) Lots of Librarians Can Keep Stuff Safe. *Library Journal*, **132(13),** p. 30.

SCHWARZWALDER, R. (1996) Technology online in 1996: Explosive growth of sci/tech on the Web. *Database Magazine*, **19(6),** p. 71.

SCHWERIN, J.B. (1986) *CD-ROM Standards : The Book*. Oxford : Learned Information (Europe Ltd).

SHAAR, M.C. (1996) Waiter, beam me up noodles. *Daily Telegraph Connected*, **(17/12/1996)**.

SHOEBRIDGE, M.I. and WATSON, M. (1994) Case Study : The University of Birmingham's CD-ROM network. *in*

HANSON, T. and JAY, J.M. (1994) *CD-ROM in Libraries : Management Issues.* London : Bowker Saur.

STERN, C.W. and STALK, G. (1998) *Perspectives on Strategy from The Boston Consulting Group*, John Wiley & Sons.

TENOPIR, C. (1997) Beyond the CD-ROM model. *Library Journal*, **122(14),** pp. 129-130.

WARD, J. and GRIFFITHS, P. (1996) *Strategic Planning for Information Systems*. 2nd ed., John Wiley & Sons.

WIEDEMER, J.D. and BOELIO, D.B. (1995) CD-ROM versus On-line. *CD-ROM Professional*, **8(4),** p. 36.

10.Bibliography.

BAINS, S. and RICHARDSON, H. (2000) Linux and CD-ROM networking - An academic library's DIY solution. *ONLINE,* **24(2)**, pp. 54-56.

BIDDISCOMBE, R. (1996) *The end-user revolution : CD-ROM, Internet and the changing role of the information professional.* London : Library Association.

BREEDING, M., MOORE, C. and WHITSED, N. (1994) CD-ROM Networking in Practice. *CD-ROM Professional,* **7(3),** pp154-155.

BRODY, F.E., NOLAN, A.C. and WHITMORE, M.P. (1993) Networking CD-ROMS - An Evaluation With Implications For Improving Service. *Journal of Academic Librarianship,* **19(3)**, pp. 140-143.

CAIN, M. (1993) Simple and Inexpensive CD-ROM Networking - A Step-By-Step Approach. *Information Technology and Libraries,* **12(2)**, pp. 262-266.

CORRALL, S. (2000) *Strategic management of information services : a planning handbook.* London : Aslib/IMI.

HOOD, W. (1992) CD-ROM networking: a technical note. *LASIE,* **22(4)**, pp. 91-2.

KOTLER, P. (1988) *Marketing Management : analysis, planning, implementation, and control 6th ed.* Englewood Cliffs, NJ: Prentice Hall.

LIEBERMAN, P. (1995) CD-ROM networking. *CD-ROM Professional,* **8(11)**, p. 12.

PUGH, L., MACCOLL, J. and DEMPSEY, L. (1999) *Delivering the electronic library : an ARIADNE reader.* Dundee : Ariadne Project.

RIETDYK, R.J. (1990) CD-ROM networking developments in libraries. *Preprints: 2nd International Conference on the Effective Use of CD-ROM Databases*, pp. 34-43.

SAUNDERS, L.M. II. (1999) *The Evolving virtual library : practical and philosophical perspectives.* Medford : Information Today.

WINTERMAN, V. (1991) CD-ROM networking: an overview. *Library Micromation News*, **(33)**, pp. 7-10.

11.Appendices.

Appendix A : Project Management.

This report has changed repeatedly during both its planning and writing. The original (pre-proposal) intention for this report was to first poll all sites on their use of networked CD-ROMs then concentrate of case studies of four universities. A number of sites had verbally agreed to act as supplementary case studies with UoB as a larger, central case study.

While collecting data for the main case study (to test the idea's feasibility) it quickly became apparent that this approach was over ambitious. A re-think of the approach led to the submitted proposal which was adapted, with many changes, from an assignment for a previous course, CP4047. This proposal is included with the report as Appendix B.

Part of the initial proposal was a project plan (also included in Appendix B) which should be compared with figure A.1 below – a revised project plan showing the actual management of the running of the project. From the differences between these two plans it can be seen that :

- After the acceptance of the initial proposal, the project was delayed by 3 months when the literature search and case study proved longer tasks than anticipated. This also led to a changed design of the survey.
- The original two questionnaires (one asking general information and a second asking for more detail) were replaced with a single questionnaire. This was partially to reduce the time needed but it was also felt that the repeated emailing of contacts would have an adverse effect on responses with each new email another chance to drop out of the survey. The ultimate goal of no more that three emails to any one person was a compromise on this.

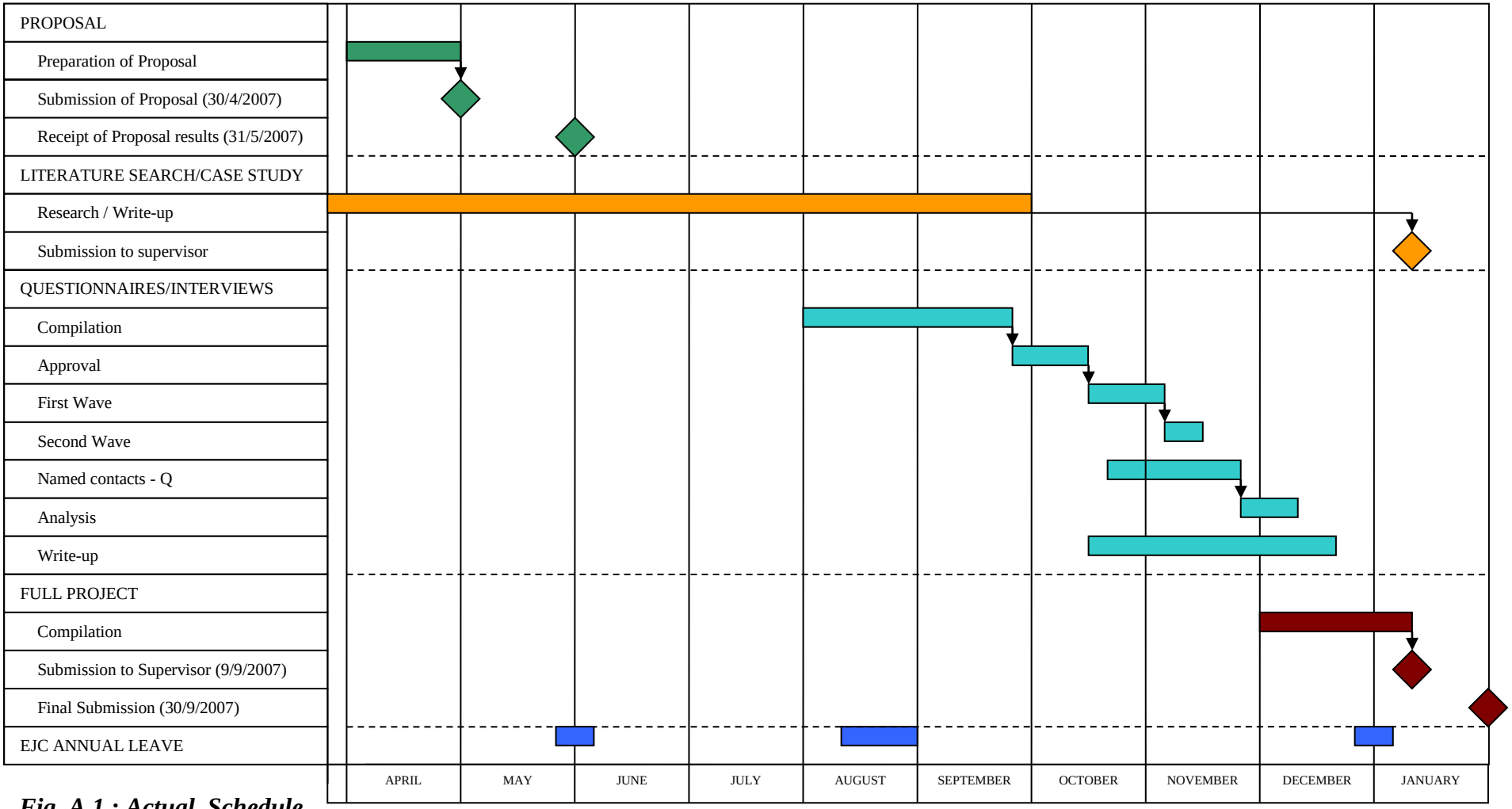


Fig. A.1 : Actual Schedule.

- Although respondees were asked if they could be contacted for clarification on their answers, this was not needed in practice and the contingency time for interviews was abandoned.

- The response rate for the survey was just over 26%. A higher rate would have been preferred given the small population involved and this may have been possible with further time and resources. However, the decision was not to make contact other than by email and subsequent analysis showed that the sample was a representative one.

- Write-up of the survey was begun concurrently with the analysis of the survey results as sufficient content was generated on the survey methodology and the analysis of the TT-100 list so that work could begin.

- The original plan to submit parts of the report to the supervisor on completion was abandoned and the literature search and case study were not submitted until part of the first complete draft of the report in January 2008. This was to allow the results of the survey – particularly the request for citations of further articles on CD-ROM networks – to back-propagate to the literature search. In practice this did not happen as the citations offered had already been used.

In the writing of this report there was a shift of focus away from the Change Management (the management of change) aspect towards the changing of the management style. This, in turn, emphasised the BCG matrix and the McFarlan et al. extension which included the link between matrix sector and management style. The title of the report was changed to reflect this shift and the hypothesis given in the introduction (and conclusion) came to the fore.

Immediately prior to the submission of this report, the 2008 edition of the TT-100 list became available. This was too late for inclusion on the main body of the report and it was felt that to update the figures based on this new information would not add to the report. While the survey was taken in 2007, the responses were about historical data that covered a twenty year period. The rankings were not concurrent with the subject of the survey and it would not be possible to select a single year for which this would

be true. Throughout the analysis theses statistic were used comparatively. The only contemporary figures from outside of the TT-100 list were the student sizes and these were a snapshot of their state in 2007.

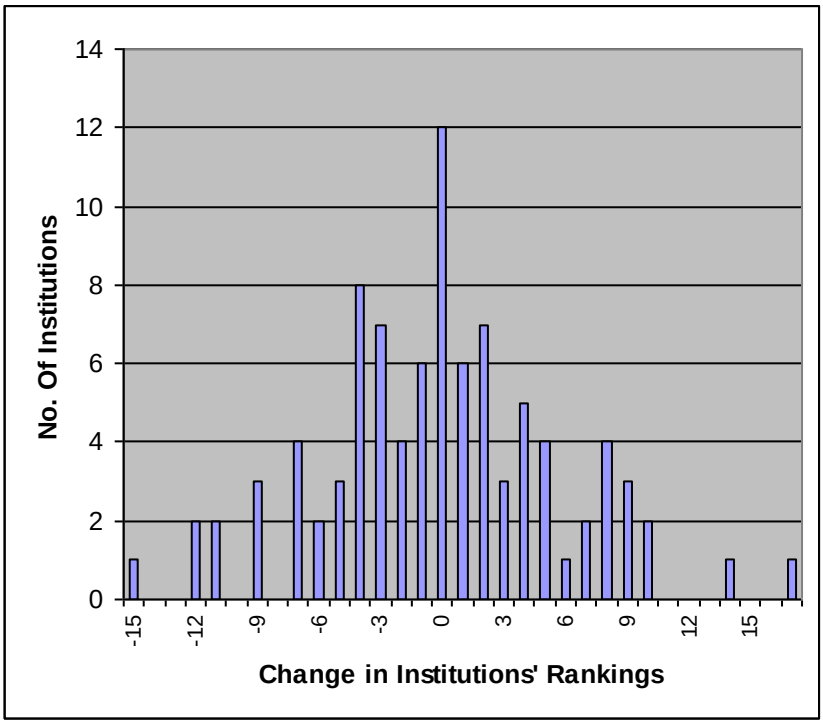


Fig. A.2 : TT-100 changes, 2007-2008.

Analysing the revised rankings of institutions (comparing 2008 with 2007) – figure A.2 - shows that the majority of sites' rankings changed little in this time. Analysis shows that 65% of sites changed their ranking by five positions or less and 86% by ten 10 positions. Of interest, however, is that the case study's ranking rose from 23rd to equal 15th position although this is still not an extreme position within the TT-100 list.

Appendix B : CP4038 – Proposal.

Name. Edward Julian Craft

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Award. MSc (Strategic IT Management)

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~~Xxx xxx~~

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Telephone no(s). ~~xxxx xxx xxxx~~ (day)
~~Xxxxx xxxxxx~~ (eve)

Project Title.

The Changing Management and Change-Management of Networked Electronic Information Resources.

Aim.

To investigate the lifecycle of the use of networked CD-ROMs as an electronic information resource in UK universities.

Deliverable.

A written report including :

- A literature review of the subject
- A case study of the University of Birmingham
- Analysis of results of a questionnaire sent to major UK universities.

Research questions.

The use of networked CD-ROMs at the University of Birmingham has passed through defined stages during its life-cycle. While these stages seem clear from personal experience and are supported by other research, how universal is this approach to the life-cycle of the CD-ROM ?

How well (clearly not a wholly 1:1 mapping) do these identified stages map to the McFarland and Boston Matrices ?

If individual projects can be mapped to points within these matrices, can the same be said for individual, esoteric technologies with directly associated projects ?

What pressures, if any, are presented to administrators by the changing roles (identified by Ward & Griffiths) forced by the volatile nature of technology ?

Are technology lifecycles really shortening, or is the case of CD-ROM technology an anomaly ?

Are these findings equally applicable to other, emerging, technology-driven projects (eg Information Portals, Biometric security) ?

Background

The use of optical storage technology for networked information resources has, from personal experience, passed through four stages :

i) Cutting edge – as a 'Strategic' technology.
ii) Mainstream – as a 'Mandatory' technology.
iii) Peripheral – as a 'Replicable' technology.
iv) Legacy – as a 'Optional' technology.

These stages map onto both the McFarlan Strategic Grid and Boston Matrix. The former identifies the quadrants as High Potential, Strategic, Factory and Support. The latter showing the financial benefits of each of the quadrants as Wildcats, Stars, Cash Cows and Dogs.

Ward and Griffiths (1996) take this further to identify the association between quadrants and their required generic management styles :

McFarlan Grid	Boston Matrix	Management Style
High Potential	Wildcats,	Entrepreneur
Strategic	Stars,	Developer
Factory	Cash Cows	Controller
Support	Dogs	Caretaker

However, in the case of a single technology, it is common (Beath, 1991) for an expert or champion to be identified within an organisation and – as technology lifecycles shorten – this champion is expected to change roles throughout the life of the post (cf. the life/duration of a career).

It is accepted knowledge that the speed of technological change is increasing at an almost exponential rate (although, purely mathematically, there must be a point at which this must curtail) – Moore's Law as applied to IS/IT fields other than just microprocessors (Saran, 2000). If this is truly the case, as the 20-year lifecycle of the CD-ROM appears to imply, then this has repercussions for management of future technologies.

The focus of this project is on the historical aspects of management change throughout a technology lifecycle – specifically CD-ROMs but also touching on older technologies with longer lifespans such as mainframes. However, the literature used for the decline of the CD-ROM seems to me to introduce the replacement technology (DVD, SAN, etc.) in the same manner as CD-ROMs were introduced twenty years earlier.

BEATH C. M. (1991) 'Supporting the Information Technology Champion' *MIS Quarterly* 15(3) 7/1991

McFARLAN F.W. (1989) 'Portfolio Approach to Information Systems.' in B.W. Boehm (ed.) *Software Risk Management.* Washington DC : IEEE Computer Society Press, pp 17-25.

SARAN C. (2000) 'Exponential evolution - Technology Information' *Computer Weekly* 30/3/2000

WARD J and GRIFFITHS P (1996) Strategic Planning for Information Systems (2nd Edition). J Wiley.

Method

i) Informal questionnaire sent to IP professionals with current or prior experience of managing optical storage networking.
   - Identified by
     - inclusion on *The Times* Top 100 UK universities list
     - membership of CDROMLAN and other relevant SIGs
     - contributors to eMedia journals (articles and letters)
     - attendees to eResources exhibitions (if this information is possible).
   - Requesting generalised information and permission for future questioning (see ii).

ii) More detailed questioning of enthusiastic respondents to (i) above to draw out experiences with managerial opportunities and problems.

- Open format questions – for experiences
- Empirical data required for
  - User base
  - Electronic resources
  - Usage data if possible

iii) Where necessary - one-to-one interviews with key eResource networking managers who have indicated openness to this in sections (i) and (ii). Although face-to-face interviews are preferable, IT staff have historically been more open when conversing by email/chat messaging/etc.

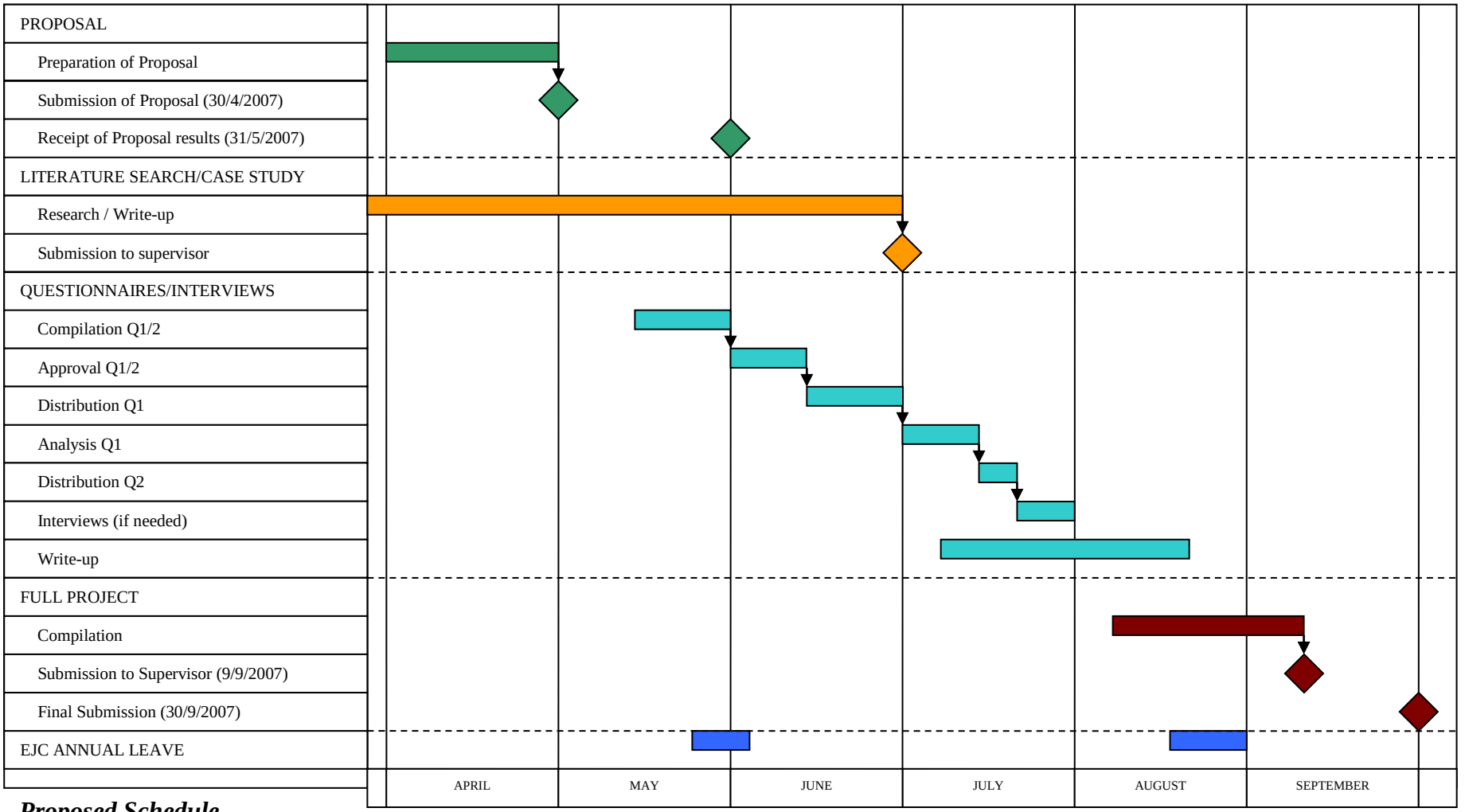
iv) Where necessary - one-to-one interviews with key managers (at levels other than those in previous sections) at institutions identified in section (i). As non- (or less-) technical staff are involved, a more formal face-to-face interview is more likely to be acceptable.

v) Empirical data is required to compare CD-ROM storage costs with those of other technologies. Unless this can be found with accuracy, a spreadsheet of costs of 'new hardware' from back issues of optical storage journals (eg. eMedia, 1988-2004) would be needed.

Evaluation

Production of a complete and accurate report including

- literature searches on theoretical management styles, real-world CD-ROM networking and the correlation between the two,
- case study supporting the same,
- researched and analysed data from multiple UK universities.



Proposed Schedule.

Initial reading list

Books :

BIDDISCOMBE R. (1996) *The end-user revolution : CD-ROM, Internet and the changing role of the information professional.* London : Library Association.

CORRALL S. (2000) *Strategic management of information services : a planning handbook.* London : Aslib/IMI.

HANSON T. and DAY J. (1994) *CD-ROM in Libraries : Management Issues.* London : Bowker-Saur.

PENFOLD S.L. (1999) *Change Management for Information Services*. UK : Bowker-Saur

PUGH L., MACCOLL J. and DEMPSEY L. (1999) *Delivering the electronic library : an ARIADNE reader.* Dundee : Ariadne Project.

SAUNDERS L.M. II. (1999) *The Evolving virtual library : practical and philosophical perspectives.* Medford : Information Today.

Journals :

Title	*ISSN*	*Coverage available*
Ariadne	[1361-3200]	1996 +
CD-ROM Professional	[1049-0833]	1995 +
D-Lib Magazine (Digital Library)	[1082-9873]	1995 +
Journal of Academic Librarianship	[0099-1333]	1975 +
The Electronic Library	[0264-0473]	1999(17)1 +

Electronic Resources :

ANTE - Abstracts in New Technologies and Engineering (formerly Current Technology Database).

CDROMLAN – the archives of the global CD-ROM Local Area Network administrators online discussion forum

eBRARY – electronic books.

Google Scholar.

INTUTE – Science, Engineering and Technology.

LISTA - The Library, Information Science & Technology Abstracts database.

SCIFINDER SCHOLAR

Hardware/software needed.

None.

Supervisor (if known)

Phil Weaver

Client

None.

External contact (external to the school)

None at present.

Will the project require interviewing anybody other than members of SCIT staff ?

Yes – potentially Library/IT staff at other UK universities. Staff at the universities of Manchester, Staffordshire and Birmingham have already verbally agreed to be interviewed.

Will the project be using a questionnaire to gather data or evaluate the software/system ?

Yes – emailed questionnaires as outlined above.

Will the project involve human test subjects ?

No

Will the project involve access to personal information on individuals ?

No.

Appendix C : Questionnaire.

The following section is a copy of the email questionnaire that was sent to identified contacts at UK Universities. The compilation, distribution and analysis of this questionnaire is covered in section 5 of this report and the responses received are included as Appendix D.

COVER MESSAGE.

As part of my postgraduate degree course at the University of Wolverhampton, I am conducting a small research project into the management of networked electronic information resources at UK universities. This project investigates how theories of management can be applied to electronic resources and uses as an example the lifecycle of the networked CD-ROM.

To evaluate how universal the experiences of the project's case study are I am circulating a short questionnaire to all UK universities. This asks general questions about the current and past methods of networking CD-ROMs.

Please note that this questionnaire is intended for institutions that have networked CD-ROMs now or in the past – **even if they no longer do so.** The project includes the de-commissioning of CD-ROMs as information resources and information from past users of networked CD-ROMs is especially welcome.

If you have never networked CD-ROMs, please reply indicating this as this information is also useful !

By investigating the networking of CD-ROMs historically it is hoped that the managerial information may be beneficial both for current and future electronic information resource technologies and for library IT in general.

Many thanks.

QUESTIONNAIRE.

As this is a retrospective on the use of networked CD-ROMs we are interested in how you have networked CD-ROMs in the past – **even if you are no longer doing so**.

If you are unsure of any figures or dates but can give an approximate value please do so (noting where values are approximated). A fictional example reply follows this questionnaire.

1. What networking solution(s) has/have been used at your institution for networking CD-ROMs ?

For the networking solutions listed above, can you tell me :
- the dates/years between which this solution was used
- the peak number of titles networked (if known)
- the range of usage : standalone(dedicated LAN) / networked within library / networked between libraries / networked across campus / networked beyond campus.

2. What non-technical changes (in staffing, management, etc.) have affected the management of the CD-ROM network at your institution ?

3. Do you have any other comments about the management of CD-ROM networks that you think may be useful ?

4. Do you know of any articles that have been published about CD-ROM networking at your institution ?

5. Attribution :
   - I am willing to be identified by institution within the report*
   - I would like to remain anonymous within the report (with the information used for statistical purposes only).*

   Responses will NOT be identified by personal name within the report.

6. Would you be willing to be contacted (by email/phone/letter*) for further details about your answers to this questionnaire ?

Many thanks for your time in completing this questionnaire.

Edward Craft.

(* Please delete as appropriate.)

Example :

University of Ravenholm

1.

1989-1997	Optinet	42 Titles	Within library
1996-2002	CD-Manager	66 Titles	Campus only
2002-2005	FenwoodCD & Citrix MetaFrame	89 Titles	Beyond Campus.

2.
The management was affected by the convergence of Library and IT departments in 2001 during which maintenance duties passed from library staff to the new Library Systems Unit. A further reorganisation in 2004 reduced the Library Systems Unit from 4 FTE staff to 2 : one administering the Library Management System, the other electronic resources.

3.
None.

4.
CD-ROM networking at the University of Ravenholm. CD-ROM Professional. Vol. 92, Iss. 14.

5.
I am willing to be identified by institution within the report.

6.
I would be willing to be contacted by email for further details about my answers to this questionnaire.

G. Freeman
Library Systems Manager
University of Ravenholm

Appendix D : Survey Results.

The following are summaries of the individual replies to the email questionnaire covered in section 5. The wording of all replies has been copied from the original email and has only been rearranged for the sake of clarity.

Institution names have been removed and the responses given anonymous codes (A1, A2, etc.) by which they are referred in the report.

Texts of the original question questions have been replaced by the numbers one to six which correspond with those in the questionnaire (included in this report as Appendix C).

Site : A1

1 :

Solution	Years	No. of titles	Distribution
IRIS with Citrix MetaFrame from ITS (http://www.itsltduk.co.uk/iris.htm).	1998 - 2003	~55	We tried to get all titles networked for both on-campus (multi-site) and off-campus usage, but we achieved off-campus for only about 10-15.

2 : During the period there were two library system administrators / IT Advisors looking after the CDROM network.
Convergence of IT Helpdesk and Issue Counters happened in 2003, but by that time the CDROM network had been decommissioned.

3 : Management incredibly tricky. Each CD-ROM title, being built on different software platforms/architectures had to be treated individually and the best way found to get it up and running with the system. This was very time consuming and the complexities perhaps not appreciated by liaison librarian colleagues. Sometimes titles bought without knowing if they were compatible with the system.

Licencing: Licensing CD-ROMs was the most difficult and time consuming part of the process.

Windows terminal server licence: At the time the Windows terminal server licence would have been needed for the potential total number of users. At the University that would have been 20,000+ users! The company that supplied the cdrom network software refused to give any guidance on this.

User groups: Iris User groups were setup to share the configurarion details for cdroms. However, the groups never developed enough and best practice/advices never shared. Advice

about installing popular titles should have been set up centrally by ITS, but they did not appear to want to do this, leaving it to the clients to create and manage the user groups.

Thin vs Fat client: The University was internally against thin client to the extent that initially the computing department said the fat client would use less bandwidth than the thin client. The opposite was true. The fat client was too difficult to install. Thin client required some work by the end user on a home computer. Getting the thin client program included in the on campus pc install image was very difficult and it was often not available at the start of term (or it would be left off in subsequent image updates).

Old CDROMs: MSDOS based CDROMs became harder to support on Windows based thin client systems. Access to older electronic based media is a growing issue and thin client and emulation could help.

Newer CDROMs: Newer, audio visual based CDROMs became harder to support due to the increased processor need.

Web services: Web based services are far easier to setup and they are more up to date. For regularly up dated service, even though the web version cost more, the web versions slowly took over.

Centralised service: Talis (a library automation company) briefly looked at running a CD-ROM network system centrally from their offices at Birmingham. Public libraries were very interested in this idea. Insitutions could have subscribed to the service, sent in CD-ROMS to network and just run the client on their local computers. This would have avoided mutliple institutions duplicating configuration work. Thin client technology would have worked very well over the internet. The idea never came to fruition but it could still work if an organisation on the scale of the British Library undertook it.

Telephone support: Potentially thin client could help with off campus support as the same desktop could be viewed by the user and tech support at the same time. This was never implemented.

4 : No.

5 : I would like to remain anonymous within the report.

6 : No.

Site : A2.

1 :

Solution	Years	No. of titles	Distribution
Iris CD server	1999 – 2003	~20	Networked across campus.

2 : No longer in use. Replaced by online versions.

3 : None

4 : None

5 : I am willing to be identified by institution within the report*

6 : I would prefer not to be contacted.

Site : A3

1 : Unfortunately, I am not able to supply this information, as it is no longer available to me. I do know that up until about two years ago, we had approx. 3 stand alone PCs in the Main Library which were dedicated to CD-ROM usage.

2 : We have had a major staff restructuring over the last year, as well as major physical refurbishments. With the majority of resources becoming available online now, most of the CD-ROM resources are now redundant, so the space and equipment has been cleared to make way for more group study space, library catalogue PCs and quick 'e-mail' terminals. Also, the staff restructuring meant that we lost our Systems Librarian who used to look after all of these things.

3 : None.

4 : Not that I'm aware of.

5 : I would like to remain anonymous within the report.

6 : To be honest, I don't have much time to spare on this, and I doubt I would be able to give you any clearer answers.

Site : A4

1 :

Solution	Years	No. of titles	Distribution
SCSI Express	early 1990s – 1996/7	21 drives	Networked across campus
OptiNet	early 1990s – 1996/7	6 drives	Networked across campus
LanCD	early 1990s – 1996/7 (*1)	62 drives	Networked across campus
Ultra*Net (*2)	1996/7 – 2002/3	2 drives, but virtualized the CD-ROMs on to hard disc images	Networked across campus (with some playing to allow off campus access that was never shipped to the users as the library's User Group didn't think it was worth committing resources to).

*1 LanCD being the newer of the three (it was originally intended to just be used to two large multidisc civil eng products).

*2 Which was phased out four or five years ago when most of the decent, high usage products offered web versions and we could put the remaining low volume/basketcase products on a standalone Windows PC.

Guesstimate of around 30-40 peak titles (depending on how you define "title" - is it as presented to the user where different years appeared singularly or a logical title irrespective of the years provided). Its a while back now and we've (just!) got rid of all the records about those systems.

2 : I took on the original three networked CD-ROM products (SCSI Express, OptiNet and LanCD) for one day per week when a previous system manager left and CD-ROMs were my responsibility until we finally phased out the networked CD-ROM service (and I still look

after the legacy stand alone CD-ROM machine). By the end of the Ultra*Net service I was spending a lot less than one day per week on them - probably less than half that.

3 : Networked CD-ROMs were the proverbial pain the rear for the most part.
Users liked them because they brought data bases to their desktops (before the web was in widespread use) but from a librarian and/or systems person point of view they were poorly documented, often badly coded, idiosyncractic, would change completely without warning, sometimes didn't work well on a network even if you brought a networked site licence and could have variable quality data in them (eg unreadable or skewed scanned pages, multilingual products with pages marked in the wrong language, etc).

Thankful the web has put pay to that job!

4 : See:
http://www.ariadne.ac.uk/issue3/trenches/
http://www.ariadne.ac.uk/issue14/knight/

for some of the fun we used have in the Good Olde Dayes. :-) The Ultra*Net system made things considerably easier as it worked nicely under Windows (which the previous products didn't).

5 : Its all ancient history now, so I don't mind being identified and we wrote the above articles back when suppliers could be riled (we even had one come and apologise! :-)) so I doubt the institution would mind.

6 : I doubt there's much more I can add - my memory is hazy about stuff I did six weeks ago, let alone six or sixteen years ago!

Site : A5

Declined to participate

Site : A6

1 :

Solution	Years	No. of titles	Distribution
CD-ROM network server	1997 - 2004	~20	Networked across campus.

2 : The network was managed by the Library Systems Manager and IT staff who were located in the same office. The electronic resources librarian made decisions about what was put onto the network and it was her recommendation that influenced the decision to decommission it. This post became vacant at about the same time and was not replaced.

3 : No.

4 : None.

5 : I would like to remain anonymous within the report.

6 : No

Site : A7

1 :

Solution	Years	No. of titles	Distribution

SilverPlatter ERL (but not for networking CDs - the data delivered on CD/DVD is copied to the server filestore and networked from there)	1990?-present	18	All networked across campus and beyond.
a locally-developed solution using Citrix technology. Again, the data is copied to filestore. We have never networked data directly from CD-ROMs	1995-present though almost phased out now; will cease 2008	~30	All networked across campus and beyond.

2 : Option (b) - strategic move to access where possible via a web interface. Staff who maintain the servers etc share work across their section so the diminution of titles hasn't affected any individual's workload (or employment).

3 : Their day is long gone!

4 : None written

5 : I am willing to be identified by institution within the report

6 : Yes

Site : A8

1 :

Solution	Years	No. of titles	Distribution
Axis StorPoint	Pre-2001-2005	5-10	Dedicated workstations in the library. A couple of the CD-ROMs were accessible from another campus.

2 : The management was originally undertaken by a member of library staff. On her retirement (c.2001), my office took it over simply because no-one else was willing to take responsibility.

3 : The CD-ROM server eventually gave up the ghost (c. 2005?) and it was got rid of. Most CD-ROM sources have now been replaced by online versions. The 5 CD-ROMs that remain are kept behind the library enquiry desk but they get used very rarely.

5 : I would like the institution to remain anonymous within the report.

6 : Yes.

Site : A9

Unable to supply information.

Site : B1

Unable to supply information as current Systems Librarian was not at this institution when the CD-ROM network was in place and no records remain.

Site : B2

1 :

Solution	Years	No. of titles	Distribution
CD-ROM tower PCs in each library	Pre-1999	-	Standalone
an earlier version of IRIS software from the same supplier	1999-2002	-	networked across campus (with login),
IRIS-XP (with Citrix meta-frame) from ITS Ltd	2002 - current (though about to be decommissioned	~20 titles at it's peak (now 2)	remote access from 2000 (with login)

2 : Changes in local IT staffing structure meant less resources allocated to the support of the networked CD-ROM service. Therefore it took longer to get CD-ROMs mounted on the network and for access problems to be resolved.

3 : The nature of the network software and the software on the CD-ROMs themselves often lead to incompatibility issues. In these cases we would have to pay for the network software supplier to work with the CD-ROM supplier to provide a solution. This work was charge to us and was very expensive.

Networked CD-ROM usage is very low and costs for supporting the network and network software are very high. Therefore there really isn't a sound business case for us to continue to do this. Many of the CD-ROMs have become available as internet hosted databases, and these integrate with our collection and e-resource delivery and access mechanisms better than the CD-ROM network does (in most cases).

4 : No.

5 : I would like to remain anonymous within the report.

6 : Yes.

Site : B3

1 :

Solution	Years	No. of titles	Distribution
Standard computers running Unix, serving titles by NFS and/or SMB.	1997+	~20	Networked across campus but not beyond.

2 : None really.

3 : Maintaining info about what's actually current isn't easy.

4 : Don't think so.

5 : I am willing to be identified by institution within the report.

6 : ok

Site : B4

1 :

Solution	Years	No. of titles	Distribution
Fenwood CD	1997-2007	30 Titles	Campus only

2 : The general move to online resources giving both campus and off-campus access has resulted in the Cdrom server becoming somewhat redundant as a core service here.

3 : None

4 : No

5 : I would like to remain anonymous within the report.

6 : No

Site : B5

1 :

Solution	Years	No. of titles	Distribution
IRIS CD-ROM	1999-2001	~20	Campus wide
WebSPIRS	199?-2002	~5	Campus wide
Novell Application manager	2001+	10	Campus wide

2 : Initially a grey area between Systems team and Information systems, but now fully administered by Systems team

3 : No solution is perfect – creators of networked CDs need to learn this and start producing web versions!

4 : No

5 : I am willing to be identified by institution within the report

6 : Yes

Site : B6

1 :

Solution	Years	No. of titles	Distribution
Optinet and SCSI EXPRESS	1994-1998	~ 60	networked across campus

I believe peak usage into in the 100's of thousands. Range of usage: we have some old stats: I will attach a sample.

2 : The sudden shift to Online Resources for the majority of widely used titles by the major vendors - meant that local CDROM networks were effectively no longer required.

3 : Note: Local CDROM networks were expensive to intall and administration intensive with updates. Note hardware generally needs replacing after about 4 years. So the shift to Online resources was welcomed.

4 : No

5 : I am willing to be identified by institution within the report.

Site : B7

Never networked CD-ROMs – unable to supply details.

Site : B8

1 :

Solution	Years	No. of titles	Distribution
Optinet	~1991 – 2001	~100 major titles at its peak.	only available on campus. We moved almost wholesale to purchase of E-resources on the internet.
cache cds on our server & use ZENworks snAppShot	2001 onwards	~80 (*)	only available on campus

* There are still quite a lot of networked titles (80 maybe) but these are of far less significance than used to be the case in the 1990s.

The current 80 are more specialised (e.g. includes a large set for the German Dept).

2 : We did have a new Systems Assistant post created in 1998 but this was not specifically connected with the CD network.

4 : We published no articles.

5 : I would like to remain anonymous within the report

Site : B9

1 :

Solution	Years	No. of titles	Distribution
no real networking provided	Before 2003	~25	CD-ROMs were either installed on standalone machines (some very limited networking within individual libraries for a handful of titles), or disk was physically loaned for individual use
Microsoft server running terminal services	2003 onwards	Currently (Nov 2007) 11 remaining titles.	User connects to the remote desktop (across campus) and accesses the CDs through menu application (designed in-house). Usage is very low.

Looking (2007/8) at extending access to this remote desktop to off-campus users via MS SharePoint Portal. After December 2007, only 1 remaining title (the Architectural Publications Index on disc) is likely be maintained as a current and regularly-updated subscription, as IOLIS Law Courseware Consortium moves to Web-based access.

2 : Huge drop in usage of CD-ROMs and demand for off-campus access to e-resources, plus increasing availability of Web-based equivalents means far less attention paid to CD-ROMs.

Deconvergence (in 2005) of previously merged department into separate Library and Computing services means that responsibility for access to CD-ROM network, and promotion and support for CD-ROM contents is split.

Change in subject focus of the University since 2001 (less Engineering; more Media & Humanities subjects) has led to re-examination of e-resources offered.

3 : User expectations have changed - students don't expect to have to learn native interfaces; federated search, item-level linking, integration with VLE and off-campus access far more important -- all contributing to the death of the CD-ROM in HE libraries?

4 : No.

5 : I am willing to be identified by institution (xxxxxxxxxxxx) within the report.

6: Yes - happy to be contacted by email.

Site : C1

1 :

Solution	Years	No. of titles	Distribution
CDROM machines (Samsung, Hitachi and CDPlus) or small daisy chained sets of desktop CDROM towers (SCSI Express/Optinet)	1996 - 2002		standalone
centrally provided service from our Computing services (unsure of make/vendor)	2002-2004/5	~ 20 (*)	

* although we had a temporarily trial with Medline which pushed up the number. We concluded that Medline was too problematic to network for very lone and so we preferred online access right from the start, despite the 50p/minute costs in the early days (pre1992).

After 2004/5 when we completely migrated away from CD databases and received everything online.

Most hardware was purchased from CDPlus or SilverPlatter. We considered but did not purchase the ERL solution. Traditionally our existing microform suppliers went into CDROM hardware and software supply as a natural migration of product range, which predicated some of the supplier choices.

2 : We always appreciated that CDROM was a temporary fix until web access because easier and PCs became more powerful. There were no appreciable impacts from staffing as we always had a low-key low impact operation. Most of the CDs were in the SciTechMed subject area and as the librarians of this period were always technically adept (e.g. fitting CDROM drives into machines etc). Usually no technically support was needed other than the occasional phone call to the supplier. Library use of CDROMS in the period 1985-1995 was usually more advanced than that of the IT department.

3 : Not really - other than the problem of sending disk updates to the IT department for uploading onto the server, only to find that they were lost in transit and not uploaded. This happened from time to time. We had a very expensive genetics CD (cost £3,000) that disappeared when we disbanded the CD networking infrastructure – it was never returned to the library from the IT department.

4 : None

5 : I would like to remain anonymous within the report.

6 : No thank you

Site : C2

"Unfortunately, the member of staff who looked after our CD-ROMs retired a few years ago, and none of our current staff know what techniques used to network our CD-ROMs. This means we will not be able to complete your survey."

Site : C3

1 :

Solution	Years	No. of titles	Distribution
Ultra*Net supplied and supported by Fenwood (latterly Esprit/Soutron)	1995-2006	40-50	Networked across campuses, not beyond

2 : None

3 : In 2004, the IT department introduced much tighter network security. This meant that installing inhouse networked CD-ROM-based databases became technically and politically more difficult as ordinary student users do not have the administrative rights necessary on workstations for installing software (we used Ultra*Net in client installation mode, where the database client is installed locally on the computer, as opposed to application server mode), and technical administration of the CD-ROM network was done by the Library Systems Team who are not based in the IT department.

In 2005/2006, the CD-ROM network server began exhibiting signs of imminent failure. In mid 2006, as the result of a power failure, the server finally crashed and proved irreparable. As by this time there were only one or two active databases on the CD-ROM network (most databases by then were being accessed over the internet), and these were hardly used, the decision was taken not to prioritise the work of restoring the CD-ROM network – and pressure of work has meant that the CD-ROM network remains defunct.

Occasionally, a Subject Librarian will contact me about a database they have purchased on CD-ROM that they want networking. At present, I refer them to the "Desktop Team" in the IT Department, who distribute software (such as Microsoft Office, etc) across the network and have agreed to do the same for networked databases.

However, restoration of the capability to network CD-ROMs is still something that I would like to do, and the IT Department agrees that it would be useful for the Library Systems Team to have this capability. But it's a question of time and resources.

4 : No.

5 : I would like to remain anonymous within the report.

6 : Yes.

Site : C4

1 :

Solution	Years	No. of titles	Distribution
IRIS (supplied by ITS UK Ltd)	1990s? - 2006	50-60	initially networked across campus, then available via the

			web (using Citrix)

2 : None that I can think of (I have been in post since 2003)

3 : Usage of CD-ROMs had declined sharply in the last 3 years (whilst usage of web based resources increased), so supporting CD-ROMs was longer cost effective for the library.

4 : We probably used to have some help sheets available on the web, but those will have been withdrawn at the same times as the CDs.

5 : I am willing to be identified by institution within the report*

6 : Happy to be contacted, although email would be preferred.

Site : C5

1 :

Solution	Years	No. of titles	Distribution
Citrix MetaFrame Client	used for at least the last 5 years and is still in use.	Currently ~ 25.	networked across campus only

We used to have quite a few more than this (don't have an exact figure) but these are being slowly reduced wherever possible.

2 : This has generally been looked after by the person in charge of electronic resources. We have found that many resources have converted (and are continuing to do so) to more accessible online formats (and this is also one of the universities policies to increase access and use of resources). By this we mean available over the Internet so that they can be accessed both in the university and from anywhere off campus. This usually means that the interface is easier to use than the one provided with the CD-ROM. Because of these reasons the number of resources that we provide access through using a networked CD-ROM has reduced greatly over the last few years and we do see the day coming when we no longer need it.

3 : We are currently not adding any new resources onto the Citrix Client. This is because the server is old and requires an upgrade and the university is reluctant to spend the money on this due to the declining use of these resources and the costs involved.

4 : No.

5 : I am willing to be identified by institution within the report

6 : No thank you.

Site : C6

1 :

Solution	Years	No. of titles	Distribution
Optinet	1996-1998	20	Networked between libraries
Iris software (from ITS Ltd).	1998-	52	Networked across and beyond campus (depending on licence).

2 : In 1998 responsibility for networking CD-ROMs was handed to the Library, where it has remained since.

3 : No.

4 : No.

5 : I would like to remain anonymous within the report.

6 : Yes, please send any queries by email.

Site : C7

"Thank you for your e-mail. Unfortunately I am unable to provide details for your questionnaire, due to staff changes, which have taken place since the end of the CD-ROM network. The staff that worked on the CD-ROM network now no longer work at the university."

Site : C8

"Your enquiry has been forwarded to me as the E-Resources Co-ordinator. However, much of the use of CD-ROM databases here at Xxxxxxxxxx is before my time. I've spoken to colleagues about it and have been told that the normal process was for the CD-ROM to be received by our Acquisitions department and sent to the relevant subject floor where it would be loaded onto a standalone PC to be used. I believe that students would then be able to book a session to come along and use the PC."

Site : C9

1 :

Solution	Years	No. of titles	Distribution
?	1990 - 2001	~40	networked on campus network

2 : On-line databases have now replaced most networked CDs. We have a stand alone PC for some CDs.

3 : CD-ROMs were difficult to install and run because of the wide variety of different software applications that were used to get at the data. Most CD software was for stand alone PCs and you needed to work out ways of getting it working on a network.

If possible, get CDs you can view on a web browser, they are easy to setup, even on a network.

4 : No.

5 : Not bother either way

6 : yes

Site : D1

"Unfortunately there is no record of the historical use and administration of CD-ROM-based databases in the Xxxxxxxxxxxx libraries."

Site : D2

1 :

Solution	Years	No. of titles	Distribution
in-house DOS program	1991 - 2000	?	this was networked across all 7/8 campuses, though was limited to on-campus use
CD-ROM networking solution from ITS Ltd	2000-2003	?	Same.

2 : The management and troubleshooting of our network was taking up too much of staff time compared to the benefits it offered students

3 : Since the greater standardisation of web interfaces, and their availability 24/7, in my view the usefulness of CD-ROM networks has diminished

4 : Not too my knowledge

5 : I am willing to be identified by institution within the report.

6 : yes

Site : D3

1:

Solution	Years	No. of titles	Distribution
Name unknown. "but it started IT..."	2002-2005	40-50	both on and off campus

2 : CD-ROM networks are heavy in terms of staff time - and not used heavily enough to warrant the cost. The main reason we ceased offering the service was that the cost of the software/system was prohibitive for such low usage.

3 : Very labour intensive. All CD-ROMs seem to have different formats - and plenty of quirks.

4 : None.

5 : I would like to remain anonymous within the report.

6 : NO

Site : D4

Unable to provide details other than that an early decision was made not to pursue CD-ROMs as an electronic resource media, favouring on-line services instead.

Site : D5

1 :

Solution	Years	No. of titles	Distribution
Ultranet 2	1996-2001	~ 50	Across 4 campuses
Ultranet 2000+Citrix Metaframe	2001-2005	~ 40	Beyond campus (database license allowing)

2 : The system was originally set up by a Library Systems team of 3, consisting of a Library Systems Manager, another member of staff whose responsibility was the CD-ROM network and library staff PCs, and a third person who mainly handled PC support. In 2001 the member of staff who looked after the CD network left and the CD network became the responsibility of the Library Systems Manager while the post was redirected to the support of eresources. In 2002 Library and IT merged and the Library Systems Unit was subsumed into a larger Business Systems team. The CD-ROM network remained the responsibility of the Library Systems Manager until it was decided to switch it off in 2005 as most databases had migrated to the web.

3 : All I can say is that as it got technically easier it became organisationally more difficult. CD Manager was easier than Optinet, and Ultranet better than CD Manager (but significantly more expensive). Varying licenses allowing access to different campuses or beyond made it more difficult to control however. There were always access problems. Web-based databases turned out to be much more effective with better interfaces and by transferrng the storage of the data to the originator.

Ultranet had a fatal flaw in that even in Ultranet 2000 it required a browser plugin on the users PC. Getting that client onto the Xxxxxxxxxx staff and student PC images was a significant challenge due to institutional politics, and one which was never fully achieved. If the client had been browser-based as Winframe should have allowed, the only challenge would have been authentication.

4 : There was nothing published about here.

5 : I am willing to be identified by institution within the report.

6 : I am willing to be contacted by any means for further details.

Site : D6

1 :

Solution	Years	No. of titles	Distribution
Avantis CD-Rom server	1999-2005	20	Across campus

2 : Responsibilities were split. IT services staff handled technical aspects when first installed, connection to the network and some changes to the desktop PC configuration. Learning Resources staff handled the adding new titles and updating. As more titles became available through the web the need for the server declined. The server only offered access to the CD Titles within the campus network. The availability of the titles through the web enabled people to access when off campus so is better for our students and staff.

3 : Once installed there was little need for IT Services involvement.

4 : No.

5 : I am willing to be identified by institution within the report.

6 : Yes - email preferred.
