AN INVESTIGATION OF MUSEUM DATA STORAGE AND ACCESS TECHNOLOGIES INCLUDING CASE STUDIES ON ARCHAEOLOGICAL RECORDS AT THE NATIONAL MARITIME MUSEUM AND VISITOR INFORMATION AT THE SCIENCE MUSEUM

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ABSTRACT
This dissertation investigates the technology for storage and access to data in museums, focusing on requirements for collections management and the information needs of visitors. The various components of museum information systems, including data structures and terminology, recording media, computer software and hardware, manual systems, and management procedures are comprehensively examined through case studies at the National Maritime and Science Museums.

The first case study describes and assesses manual and computer based techniques developed for the storage and retrieval of records in the Archaeological Research Centre at the UK National Maritime Museum. The types of data which the system encompasses were derived from a wide range of sources, including both land based and underwater fieldwork; archaeological, historical and ethnographic research; routine curatorial activities, including conservation; and research into the conservation of waterlogged materials. Further aspects considered included the collection of data in the field, and the development of a framework on which the analysis of boat finds could be based. Archaeological and museum record keeping, and contemporary developments in computer technology are reviewed. The design, development and use of the system are described, and the system is assessed against the initial specification and in the light of users' experience.

The second case study builds on the experience of the first, and examines the requirements for a visitor information system at the Science Museum in London. Sources which are used include an analysis of overall visitor needs, specific requirements for object based information and public interest in information as exhibited through the use of the Museum's World Wide Web pages. Building on these studies and the experience of other museums in providing such a facility, a model system is outlined, including visitor orientation and information points within the Museum and external access to information. The data requirements of this system are tested against the types of information which are already available in the museum. An overall approach to designing the system is described.

In conclusion a comparison is made between the information requirements for collections management and visitor information. Technological issues including data structures and database design are reviewed, and the costs of various options are considered.

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1 INTRODUCTION

This dissertation is concerned with how data is stored and used in museums. Whilst it particularly focuses on collections management and access to information, it examines the full range of components of museum information systems, including data structures and terminology, recording media, computer software and hardware, manual systems, and the management procedures controlling the operation of these systems.

The initial stimulus for the research came from experience with archaeological field records. As a raw volunteer the author was amazed to find that recording methodology was often selected on the whim of individual site supervisors, leading to substantial inconsistencies, even within a single excavation. Although some excavators had developed highly structured systems they were often only appropriate to the circumstances of their own particular excavation and were not more generally applicable.

These inconsistencies and incompatibilities meant that field data had to be reformatted for publication or transfer to an archive or museum. This was an expensive and time consuming process, which allowed the possibility of transcription errors. Overall this seemed to be a waste of scarce resources, to not make the best use of the newly available computerised techniques and to undermine the foundation of the archaeological discipline, based as it is on physical evidence of past human activities. There seemed to be a lack of awareness of why data was being collected, and what form it should be in to facilitate the processes which it would be subjected to.

Several attempts were made to improve this situation, including the author's own work at Maxey (Booth *et al* 1984), and systems developed by the Central Excavation Unit of the Department of Environment (Jefferies 1977), and the Museum of London (Schofield 1980)).

It can be argued that this disjunction between the archaeological field record and its subsequent publication, dissemination and assimilation into a Museum archive still exists (Booth 1995c).

Building on the initial work undertaken on archaeological records, and the work of the MDA and others in museums, the first of two case studies describes the development of a system for archaeological records in the Archaeological Research Centre (ARC) in the National Maritime Museum (NMM) at Greenwich, London, UK. The overall emphasis of this work is towards analysis, curation and publication, and to a lesser extent on data collection in the field. The system had to accommodate the breadth of archaeological records which were required in the museum, and there was also a need to interface with systems used for general museum documentation in NMM.

The ARC study describes the overall requirements, the design and building of the system, and examines the effectiveness of the system, both as completed, and in the light of technological developments since it was first conceived. Chapters 2 to 6 are concerned with describing the need for a comprehensive record system, and the background to developing a prototype. The mission and organisation of the ARC are described, together with together with the specific information needs of the system, including its interfaces both within the NMM and outside. An overview of contemporary archaeological thinking in this area is outlined, and the technical facilities which were available at the start of the project are described. Subsequent chapters in this first section describe the preparation that was necessary before beginning the development phase. They describe a survey of present record and object holdings, the processing of a test batch of data in Petrel, the NMM cataloguing system, and a review of contemporary developments in archaeology and information technology at large. A programme for system development is proposed. The second section, comprising Chapters

7 to 12 describes the development of the various components of the record system for the ARC. To conclude the ARC case study, chapters 13 and 14 describe and assess the operation of the ARC system. Chapter 15 summarises these conclusions, puts them into context, and outlines needs for future work.

The second case study reviews visitor information needs at the Science Museum in London. It takes forward the conclusions of the first study, and focuses on the areas of public access to information, database design, and cost benefits, which were noted in the first study as requiring further investigation.

The first sections of the Science Museum study describe the mission of the Museum and key performance indicators, and reviews the overall visitor profile for the museum. Based on several studies of visitor information needs, the types of information which are needed by the public are collated to develop an overall requirement for visitor information at the museum, and the requirement for remote access to information. Experience at other museums is also used to enhance this analysis.

Following sections describe the definition of a model system for visitor information, including the data required to provide the necessary information, and software, hardware and data communications. The data requirement is reviewed in terms of what is available from existing systems, and where else it can be obtained from. In conclusion a model for a public access system is constructed, together with a definition of the technical requirements.

The final chapter of this dissertation draws together the two case studies and describes the overall conclusions arrived at for information management and access. Further areas for research are highlighted.

2 BACKGROUND TO THE ARC CASE STUDY

2.1 Introduction

A piece of archaeological information is likely to be stored and processed in several different record systems as it passes from initial documentation, to analysis, archive and publication. An archaeological excavation or survey, or the linked items of fieldwork within a particular project, will have a single system for data recording, although it has been known for supervisors responsible for different areas of the same excavation to employ different recording methods. Once fieldwork is complete several specialists will study the different forms of evidence, and it is likely that they will employ their own systems for data recording and analysis. The various strands of evidence will then be synthesised by the excavator, or someone specifically employed to consolidate the archive and publish the site. There may be little communication between the various specialists, and comparisons may not be made between similar material recovered from different fieldwork projects. Furthermore, when an item or archive is incorporated within a museum's collections it may be entirely re-documented.

This first case study is designed to test whether this multiplicity of systems with attendant copying, translation and re-keying of data is necessary or desirable. It consists of the description and analysis of the development of the record system for the Archaeological Research Centre (ARC) at the National Maritime Museum (NMM). It describes the ARC requirements, the design and building of the system, and examines the effectiveness of the system, both as completed, and in the light of technological developments since it was first conceived.

In particular the ARC case study tests:

- whether a single record system for all classes of data will:

- aid communication between workers
- reduce the error rate and costs caused by transcribing data from one system to another
- facilitate comparisons between projects

- whether such a system is capable of accommodating the record of an archaeological item through the stages of:
  - discovery
  - analysis
  - archiving
  - publication
  - transfer to museum collection

- whether a single system can accommodate all types of archaeological record

- what the components of such a record system will be, including:
  - data structures and terminology
  - recording media
  - computer software and hardware
  - manual systems
  - management procedures

- what the characteristics of these components will be

This chapter explores the background to the development of the record system for the ARC. It briefly describes the various strands which were to be taken into account when the system was designed, and the approach adopted for its design. It starts by outlining the overall purpose and structure of the ARC, and the broad requirements of the organisation for information handling. This is followed by an overview of current data holdings in the ARC and elsewhere in the NMM, and the NMM information retrieval facility - Petrel. After reviewing circumstances within NMM it then looks at other work in archaeological recording, developments in museum documentation, and the then current status of information technology. It describes a theoretical model for an archaeological record system which will be used as a conceptual framework for the study. Finally, it describes in broad terms the methodology that was to be used in designing this system.

Chapters 3 to 6 describe the preparation that was necessary before beginning the development phase. They describe a survey of present record and object holdings, the processing of a test batch of data in Petrel, the NMM cataloguing system, and a review of contemporary developments in archaeology and information technology at large. Finally a proposed programme for system development is outlined. Chapters 7 to 12 describe the development of the various components of the record system and chapters 13 and 14 describe and assess the operation of the system.

2.2 Chronology

System design started in 1981, with the majority of the operational elements of the system being in use and documented, by early 1984. A major revision of the software was concluded in 1985, with some minor revisions subsequently. For the bulk of the system, development ceased in 1984, and the first stage of this analysis of its effectiveness is therefore concerned with its state at that time. The second element of the analysis is a critical assessment of the system in the light of its use over several years.

2.3 The Archaeological Research Centre

The ARC was set up in 1974 to study the archaeology of boats and maritime structures and artifacts. It was originally established within the Department of Ships but was subsequently reorganised to become a discrete entity within the NMM, with the responsibility for all material dated to before 1500 AD. Later material remained the responsibility of the Ships Department. When the present study was carried out the personnel consisted of a Chief Archaeologist and Personal Assistant, Prehistoric and Medieval Archaeologists, Underwater Archaeologist (also covering the Classical period), Historian, Ethnographer, two conservators, two scientists concerned with developing conservation methods and environmental studies, and an Information Archaeologist concerned with records management, totalling 12 people in all.

The disposition of ARC staff reflects the several interrelated areas of interest of the department; archaeology, history, ethnography, conservation and scientific research. As a consequence of these several areas of work the department held artifacts which were part of the Museum's collections, objects undergoing conservation, environmental samples recovered from fieldwork, and records relating to archaeological, historical, ethnographic and scientific research. The records held were in various forms, including offprints and xerox, books, periodicals, drawings, photographs, transparencies, and a series of record forms for fieldwork, conservation processing and scientific research purposes.

2.4 The system requirement

The project to enhance the information system within the ARC had two major objectives. The first was to provide mechanisms for the analysis of boat finds (preferably using computer techniques), the second was to increase the efficiency of work within the ARC by improving basic documentation procedures. In practice it was felt to be necessary to achieve an overall improvement in record keeping before attempting more complex analyses.

Whilst the core of the system would operate within the museum it was also necessary to extend it to accommodate fieldwork. This entailed the processing of data by computer outside the Museum (or telecommunications linked to the Museum), and a methodology for collecting data in the field, either by manual or automated means..

2.5 Data holdings within the ARC and NMM

An initial review of the record holdings of the ARC showed that there were records of objects which were stored in the museum, records of objects which the museum did not hold, and objects for which no record had been made. For many of these records there was already a system for their organisation and retrieval. These records comprised part of the overall record holdings which included object records, transparencies, drawings and other graphical material, information files (dossiers), sample records, conservation records, stratigraphic records from excavations, photographic negatives, bibliographic records, and an index of radiocarbon dates.

These systems in the ARC paralleled the procedures within the museum at large for the acquisition and loan in and out of objects, the catalogue of books, periodicals, offprints and photocopies held by the Library and the photographic registers kept by the central negative store. There were also various equivalent records kept by other departments.

2.6 Petrel - the NMM information system

Information retrieval in the NMM had been recognised as a priority as early as 1969 with the appointment of an Information Retrieval Officer. In 1975 Dr. Jonathan Cutbill, who had already completed pioneering work involving computerised techniques at the Sedgwick Museum in Cambridge (Cutbill 1973), was appointed to this post. At NMM a project named

Petrel was established to produce computer generated catalogues of the museum's collections (The petrel is a sea bird which flies in the stormiest of weathers). This project was initiated by a survey of records, and objects (NMM 1976b). Software to support this activity was based on computer programs developed by the Museum Documentation Association (MDA), and an interpretation of the MDA's structure for museum records - the data standard. The initial work of Cutbill at NMM was important to the present project as it provided a survey of practice in museum, and had established computer techniques and record structures for cataloguing.

2.7 Developments outside of NMM

Initially, the use of computers in archaeology had concentrated on statistical analyses of discrete portions of data. However, by the late 1970's the work of Gaines in the USA (Gaines 1974), and of Jefferies and Graham in the UK (Jefferies 1977, Graham 1980b) had shown that it was possible to store the majority of the data recovered from an excavation in computerised form. At first this was to be achieved through the use of terminals connected to remote mainframe computers. There was then a move towards "intelligent terminals", and by 1980 it was possible to perform data capture and initial analysis on a microcomputer. In the USA the major thrust was towards large databases for "cultural resource management", usually held on mainframe computers (eg Scholtz and Million 1981), but in the UK, work by the Central Excavation Unit of the department of the Environment (Benson and Jefferies 1980), at Maxey (Booth *et al* 1984), and at Mucking (Catton *et al* 1982) was developing microcomputer systems for excavation data. The commercially produced software available for the first microcomputers was unsuitable for archaeological data, and it was therefore necessary to write programs specifically designed for archaeological data. Throughout the 1970's Wilcock took the available hardware and software up to the limits of practicality in pursuit of the "Automated Archaeologist" (Wilcock 1978).

In the late 1970's, as part of a more rigorous approach to fieldwork, and perhaps stimulated by the potential of computerised systems, archaeological recording methods were becoming more formalised, leading to the development of "Recording Systems", such as that devised by the Central Excavation Unit (Jefferies 1977), and by the Department of Urban Archaeology at the Museum of London (Schofield 1980). Typically such systems would consist of a set of forms for field recording, and a manual describing how they should be used. Such systems and were widely copied, and by the early 1980's it was unusual to find an excavation recorded through the traditional notebook medium. A related development was the work Harris (1979) on methods for the description of stratification.

In the museum world much work had been done by IRGMA (the Information Retrieval Group of the Museums Association - later to become the MDA) to develop a formalised cataloguing system (IRGMA 1977). This had included the Data Standard (a structure for museum data) (MDA 1980a), software in the form of the GOS program package (MDA 1980b, Porter 1981) and procedures for documentation and collections management in museums (MDA 1981).

2.8 Developments in computing

Between 1970 and 1980 the computer facilities available to museums and archaeologists had broadened from mainframe and minicomputers to include "intelligent terminals" and microcomputers. The microcomputers which were commonly available were either based on the 6502 processor (notably Apple and PET), or on the Z80. The 6502 family usually had proprietary operating systems, but were generally more "user friendly" and less expensive than their more "professional" relatives in the Z80 family which employed the CP/M operating system. Despite the initial attractions of the 6502 family, and some successful early projects using them, the archaeological community was by the early 1980's showing signs of standardising on the CP/M models.

Random access memory (RAM) was a costly component of early microcomputers, which were initially configured with as little as 8 kilobytes. This had a limiting effect on the complexity of programmes, but 64 kilobytes (or k) soon came to be accepted as the norm, although a significant portion of this space was occupied by the operating system, and was therefore unavailable to user programmes. By 1980 reliable floppy disks (in a variety of sizes and formats) had replaced tape cassettes as the norm for data storage, and the (relatively) high capacity of Winchester hard disks was imminent.

Despite the availability of reliable microcomputer hardware, operating systems, and programming languages, there was very little commercially produced software. Archaeological and museum data may be characterised by the need for each item to have quite a complex record, and there being large numbers of items, although only relatively simple manipulations were required. As the available software did not permit large records, and the typical database did not extend over more than one floppy disk, archaeologists had to develop their own software.

2.9 Theoretical structure

This section presents a design for a generalised archaeological record system, capable of accommodating a range of records, and able to support the various analyses which are likely to be required of such a system. It argues that such a system is preferable to the *ad-hoc* facilities which are likely to emerge if development takes place in a piecemeal fashion. A record system is defined as an ordered set of structures and procedures which will facilitate data collection, and allow records to be stored, manipulated and displayed. Typically, such a system will consist of manual and computerised records, and procedures governing their use.

In the case of archaeological data, an excavation or group of excavations, or a piece of non-destructive fieldwork, is likely to form the unit of primary analysis. This "sample" will be biased by pre- and post-depositional events. Retrieved from such enterprises will be evidence for man's activity in the form of structures which will be recorded, artifacts which may be retained, and samples for scientific analysis which will usually be discarded once they have been described. As well as physical remains the fieldwork will yield large quantities of records of many types, including written notes, drawings, and photographs. Subsequent levels of analysis will wish to examine the information concerning several related excavations or pieces of fieldwork, or a particular type of artifact or phenomenon across a wide range of sites.

A central proposition in the design of such a system is that in terms of the records it is to contain, it should be comprehensive in terms of scope and duration:

1 It should accommodate all types of record, and have the flexibility to incorporate new types of record.

2 It should be able to support a record throughout its life.

Archaeologists will produce various types of records. We can predict the types of record, although the precise content of them will depend on the theoretical framework which has been adopted, the type of archaeological find being recorded, and the questions being asked by the archaeologist. The types of record could include text, still images, moving images and sound. It is suggested that records group themselves into three concentric bands, these are shown in Figure 1.

1	**CORE RECORDS WITHIN THE SYSTEM** Salient information about an item, and cross referencing to all other information about it, whether held in the system (2, below), or elsewhere (3, below). Technological constraints at the time when the ARC system was being designed limited the core records in a computerised system to text only.	
2	**PERIPHERAL RECORDS WITHIN THE SYSTEM** Other information about the item, which it is not practical or necessary to keep in the core record. Because of the then prevalent technological constraints this is likely to include all records of a non-textual nature, and text which is felt to be too lengthy to be contained in the core.	
3	**RECORDS OUTSIDE THE SYSTEM** Records referred to by the core record, but outside the system. They could be incorporated within another record system in the same organisation, or in a different institution.	

Figure 1: Three concentric bands of records

The record framework described above is able to be used in the description of archaeological "items" and in their relationships to each other. Various models have been proposed for archaeological data (Clarke 1968, Carver 1979, Moffett 1985), most of which imply some kind of hierarchy. The unit of record (an "item" or "object") may be a conventional artifact, ecofact, or a stratigraphic phenomenon. For practical purposes these often need different kinds of record, but at a theoretical level they can all be described as an archaeological "item". These "items" will have a number of attributes, which will have certain values. Moffett has in addition superimposed a hierarchy of feature, site and region. It is here proposed that Moffett's groupings are not absolute components of the "item" sphere, because they are likely to change depending on the model of analysis which is being employed. The groupings above the item level are for the most part artificial, even where geographical regions are defined. There must therefore be a means within the system for establishing groupings of item, whether by assemblage, site, region or whatever. For this purpose specific attributes may be associated with the item (for instance "Site") and it may be desirable to have a specific record type for such groupings.

The system should be able to contain a record throughout its life. One such approach to defining the life of records was made by Frere (Ancient Monuments Board 1975) with 4 levels; summarised as:

Level 1	The archaeological remains *in-situ*
Level 2	The field records
Level 3	The ordered archive
Level 4	The published report

These can be seen as a life cycle for the record with 1 as the input, and 4 as the eventual output and exit from the system. However an important element of Frere, and latterly Cunliffe (Council for British Archaeology/Department of the Environment 1983), is the concept that the archive (Level 3) needs to be available for consultation. In a museum situation the Level 3 record will be curated, and form an essential part of the information content of the collection. In such circumstances the archive then becomes an active resource, subject to further outputs and inputs as an "item" is further investigated and documented. Level 3 must therefore be able to format data for output to other systems, and to accept input from elsewhere.

The section above has described a conceptual framework into which to fit a system for archaeological records. Complimentary to the conceptual system will be a practical system, which allows such data to be gathered, held, manipulated and output. Such a system will have several constituent components, including standards, recording media, computer facilities and procedures to govern its operation. It is suggested here that for this to operate effectively these components will need to be thoroughly integrated. These elements are described in

Figure 2. Some of the types of records which are likely to be contained in such a system, and links between them have been reviewed in Booth 1978, and are described in Figure 3.

The introduction of a record system, as opposed to *ad-hoc* record curation, will introduce economies of operation, as a new systems will not need to be set up for each project, and should also provide economies of scale in its running costs. It should provide for intra and extra site comparisons, standardisation, and the passage of data from the site via analysis and publication to eventual storage. In designing and building such a system a balance must be struck between the need for a fully comprehensive system which will provide for all record types and all analyses, and the need to provide a working system within a reasonable timescale and budget. By adopting a sound conceptual framework it should be easier to achieve this balance.

2.10 Methodology to be adopted

The approach chosen to develop the ARC record system was to start with a survey of current practice and requirements, and to then design and build an homogeneous, integrated system to fulfil these requirements. In surveying current practice it would be necessary to look at the existing situation within the ARC, Petrel and other NMM developments and current work outside in archaeology and museums. It would also be necessary to examine developments in computer hardware and software. The proposed integrated system would be designed to accommodate all types of record keeping within the ARC. The components of this system would consist of procedures, data standards, terminology control, a numbering system, recording media, software, hardware and systems for operating in the field. It would need to be able to support a particular record throughout its life, including discovery, recording, analysis, archiving, curation and publication.

1	**THE DATA STANDARD** The data standard is the theoretical structure into which all data used by the system may be fitted. It defines types of items described in the system, the types of data about an item, and the relationship between different items of data.
2	**TERMINOLOGY CONTROL** Within each data item it is necessary to control both the structure of the data, and the terminology used for data. It may be desirable to have such control supported by some form of thesaurus.
3	**NUMBERING** A consistent numbering system will be required to identify items, and link them to their records.
4	**MANUAL RECORDS** In conjunction with computerised documentation there will also be a need for manual records, whether because of the large volumes of text, or because they consist of items which may not be stored in computerised form. There may also be a need to have paper records for data capture.
5	**SOFTWARE** To enable this data to be stored and manipulated effectively, computer software will be needed. It must support the data standard (or a subset of it), and whatever means are required for controlling data content. It must also provide for input, editing, processing and output, as required.
6	**HARDWARE** Hardware is required to support the software; it is the last element to be specified (after data standard and software), is a relatively mundane part of the system, but must be effective, otherwise the other parts of the system will not function properly.
7	**PROCEDURES** In order to co-ordinate all these activities it is necessary to have management systems.

Figure 2: Elements of a record system

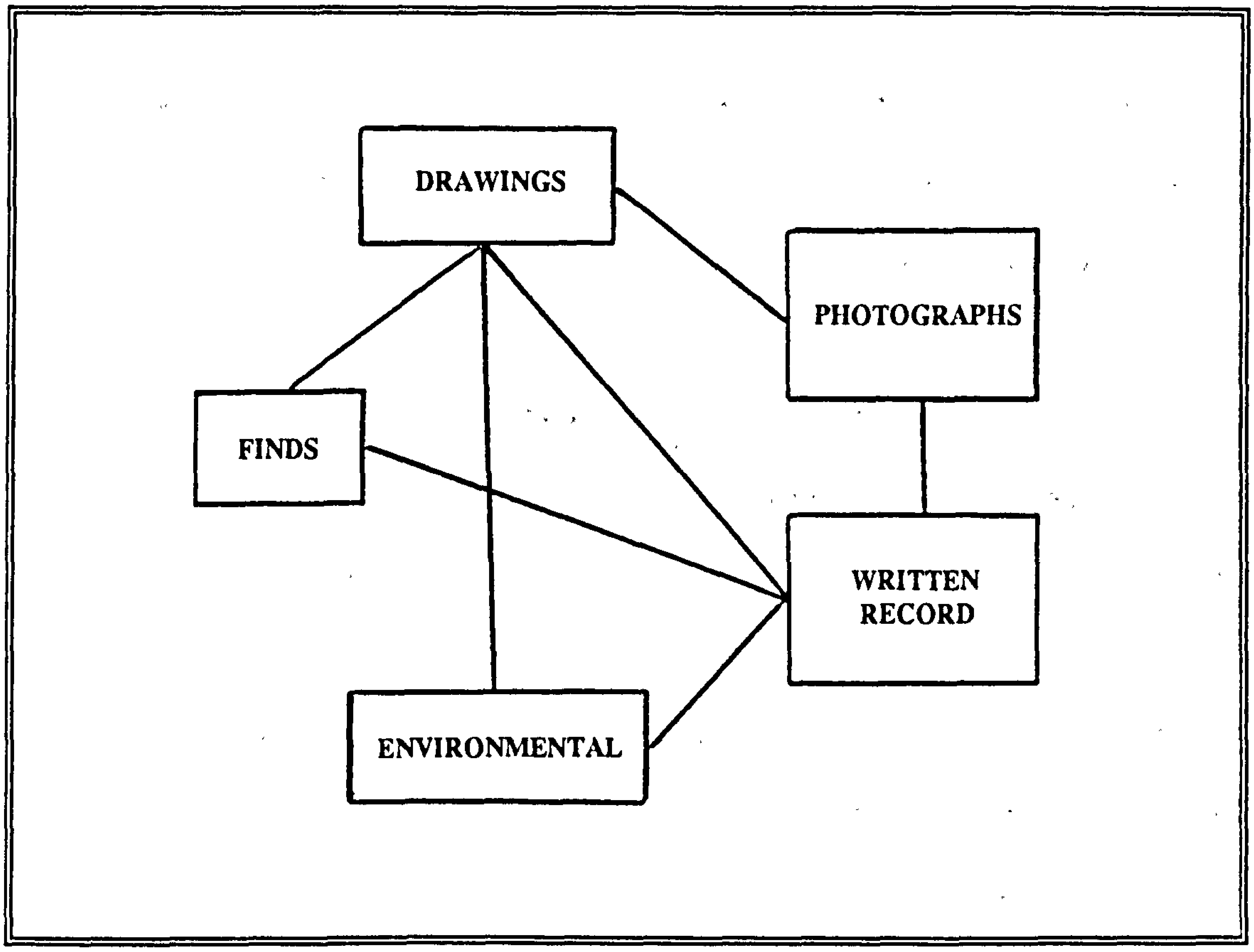


Figure 3: Different types of record and links between them.

The lines indicate many-to-many relationships between different record types. For instance there may be many drawings of a find, or a single drawing may represent several finds.

3 ESTABLISHING THE ARC REQUIREMENT

3.1 Introduction

In preparation for developing the new ARC record system it was necessary to analyze the systems which were already in operation in the museum, and to define future requirements. The already existing systems had been described in a survey by Cutbill (NMM 1976b) and in departmental memoranda setting out record keeping procedures (NMM 1977). To bring these sources up to date, and to broaden their scope, an audit of information sources in the department was carried out. To define future requirements staff were interviewed about their perceptions of the present system, and their future requirements. Their opinions were also sought as the system developed.

3.2 Methodology for the information audit

The survey of the information resources of the museum (NMM 1976b), and the departmental memos describing records (NMM 1977) were used as the basis of the audit. These sources provided a good foundation, but items and documentation had increased in numbers and range since they had been compiled. It was therefore felt to be desirable to bring these documents up-to-date, and to validate them, by conducting a new survey, which can best be described as an information audit.

The survey examined the records held in the department, and the items which the records documented. This dual approach was felt to be essential, so as to (where applicable) check the relationship between the records and the items they referred to, and to ascertain whether there were items for which there were not any records. Annual stocktaking records showed that there were no objects unaccounted for, but it was possible that there could be some objects for which the formal acquisition or loan procedure had not been completed, and which were therefore unrecorded. In order to make sure that nothing had been missed staff were interviewed about their record holdings and the location of items in their care, and a thorough search was made of the department and stores. I am pleased to say that despite the disruption to their work, and the somewhat inquisitorial approach, my colleagues were most helpful and cooperative, and at the end of the process it was possible to have confidence in the outcome.

Because of the Museum's responsibilities for objects in its care (either through acquisition or loan in) particular attention was placed on object records. There were however other classes of item held by the department (such as samples recovered from fieldwork) which were also documented, but which were not subject to the same procedures.

The survey aimed to discover:

1 The nature and quantity of the objects

2 The nature and quantity of records

3 Numbering systems applied to objects, records or storage locations

4 Cross-referencing to other objects or records, both within ARC and NMM and elsewhere

5 Procedures used for object documentation and record keeping

In preparation for the survey the two reports described above were used to provide an indication of the types of "object" and "record" which might be encountered. These are summarised in Figure 4.

1	**ACQUISITION** Single items (such as the Graveney Boat), and collections of items from a single find or excavation. Records consist of: Log (a summary list) — A4 record card Museum "X" and "Y" files — Dossiers Donor index	
2	**INVENTORY RECORDS** Detailed records for constituent items of acquisitions: Timbers — Finds — Samples	
3	**CONSERVATION** Records consist of: Log (summary) A4 card Dossiers	
4	**AUTHOR CARD INDEX**	
5	**SUBJECT CARD INDEX**	
6	**DATE CARD INDEX**	
7	**SLIDES**	
8	**PHOTOGRAPHIC NEGATIVE CARD INDEX**	
9	**PHOTOGRAPHS**	
10	**PLANS, DRAFTS AND DRAWINGS**	

Figure 4: Summary of records identified from Cutbill's survey and from the ARC Memoranda

3.3 Survey results

Ten types of information were identified, in which three classes may be discerned. These classes are:

1 Items for which there is an "object" in the museum's collections, and the documentation for the "object" is also held by the museum. Such items included conventional acquisitions and loans in, and objects undergoing conservation.

2 Items for which the museum holds documentation, but does not have the subject of this documentation in its keeping. Such items included sample records for which the sample had been destroyed, and records of items in other museum's collections.

3 Items for which the museum holds the "object", but there is no additional documentation to accompany it. Such items would include photographic slides, where there is no accompanying documentation.

Despite the variety of records and "objects" it was felt that all classes of items had been detected, and most individual items had been found. Figure 5 shows the types of item recorded during the survey, the number of items (rounded to the nearest 500, except for contexts), and whether there is an object or documentation for them. It also shows whether there are established procedures for the documentation of such items.

There was found to be considerable cross-referencing between items, most frequently to an object, or to an information file. Information files are dossiers containing additional information about an object, or describing a find or site. The extent of cross-referencing is shown in Figure 6. The overall results of the survey are summarised in Appendix 1.

TYPE OF ITEM	QTY.	%	OBJ.	REC.	PRO.	NO.
Objects	1,000	8	Yes	Yes	Yes	Yes
Slides	3,000	23	Yes			
Drawings	1,000	8	Yes	Yes	Yes	Yes
Information files	1,000	8	Yes	Yes		Yes
Sample records	1,000	8		Yes	Yes	Yes
Conservation records	2,000	8		Yes	Yes	Yes
Contexts	100	1		Yes		
Photographic negatives	1,500	12		Yes	Yes	Yes
Bibliographic records	1,500	12	Yes	Yes	Yes	
Radiocarbon dates	500	4		Yes	Yes	
Total:	12,600					

Key:
- QTY. Quantity of items or records
- % Percentage of total of items and records
- OBJ. Whether the item itself was present
- REC. Whether a record was present for the item
- PRO. Whether there were procedures for this class of item
- NO. Whether there was a numbering system for this class of item

Figure 5: Summary of survey of existing ARC objects and records

3.4 Survey of usage

A survey of usage of information was also conducted, and is summarised in Figure 7. This survey was designed to help assess the perceived usefulness of the present records, and to help assign priorities for improvements in the record system. The survey asked each member of the department how frequently they consulted each source of information. This was converted to a figure for the number of accesses a year. The usage survey showed that most categories of records were accessed at least once a day, except for the context records, negative records and date index which were rarely used. The majority of staff had cause to access the information files once, and often more times, a day.

Source Xref to:	o	t	d	i	s	c	l	n	b	C14
Object	x			x	x	x	x	x		x
Transparency		x		x				x		
Drawing	x		x	x			x	x		
Information file	x									
Sample	x		x	x	x	x	x	x		
Conservation	x			x	x	x	x	x		
Context				x	x			x		
Negatives	x		x	x	x	x	x	x		
Bibliographic				x						
Radiocarbon Dates	x			x						

Key:			
o	object	t	transparency
d	drawing	i	information file
s	sample	c	conservation
l	context	n	negative
b	bibliographic	C14	radiocarbon date

Figure 6: Existing cross-referencing between types of information

3.5 Assimilation of survey results

The survey showed the quantity of items, varying from under a hundred (contexts) to over 3000 (slides), and that there was already in existence the beginnings of an information system. Almost all classes of item had some form of record card, half had procedures for the completion of these records, and half had some form of numbering system. There was already extensive cross-referencing between records.

As well as showing the scale of the present system and giving a pointer towards potential future requirements, it had also given some suggestion of relative priorities by quantifying the usage of the various types of record; inaccessible records are however unlikely to be used, whatever their potential usefulness.

Information Staff:	1	2	3	4	5	6	7	8	9	10	11	Total
Object records	w	w	y	w	m	w	n	m	m	n	m	470
Slides	m	m	m	w	w	m	m	y	m	w	m	450
Drawings	w	m	y	w	m	y	y	n	y	n	m	300
Information files	d	d	d	w	w	d	m	d	d	n	d	1,620
Sample records	w	w	n	m	y	n	m	w	d	d	y	760
Conservation	m	m	n	y	y	n	m	m	d	d	y	510
Context	m	m	n	m	m	n	n	n	y	n	m	110
Photographic negatives	y	y	m	y	y	n	n	y	y	w	n	180
Library (author)	m	y	m	d	m	m	m	m	y	n	w	
Library (subject)	m	y	m	y	m	n	m	m	y	n	w	
Library (average)												335
Date index	y	y	y	n	n	n	n	n	n	n	m	50

Key:
- d — More than once a day (scored as 200 accesses pa)
- w — More than once a week (scored as 100 accesses pa)
- m — More than once a month (scored as 20 accesses pa)
- y — More than once a year (scored as 10 accesses pa)
- n — Never consulted

Figure 7: Usage for each type of information by ARC staff

3.6 Users' requirements

At the same time as the information audit was being carried out, staff were asked for their views on what they required from an improved or new system. The comments received mainly concerned the shortcomings of the present system, and focused on the need for better indexing, and for items to be better marked and stored. Some thought was given to the potential benefits of computerisation, but, as most users had little experience of using such techniques, and were not sure what might be possible, they felt unable to be specific about what was needed. At the time when the survey of user's requirements was carried out, it was felt to be undesirable to constrain their choices by presenting only a limited range of options. However, with hindsight it can be seen that a more structured approach to ascertaining users requirements would have been desirable, and they could usefully have been presented with a series of possible options for improvements to the manual systems, and for computerised facilities. Once the development of the system had started it was much easier to conduct a useful dialogue with users, as they were able to comment on the facilities offered, and on what they felt was desirable. It is suggested that there is much to recommend such an iterative approach, particularly when supported by prototyping.

1. PHYSICAL STORAGE

1.1 It must be possible to rapidly retrieve an item once it has been found in a catalogue or index.

1.2 Wherever possible items relating to each other (for instance items relating to a single find) should be kept together.

1.3 To minimise storage requirements, and to aid rapid retrieval, items of similar physical dimensions or form should be kept together.

2. INDEXING AND CROSS-REFERENCING

2.1 Indexing would be required to facilitate the day-to-day retrieval of material in a simple fashion: for instance a specific document or photograph might need to be retrieved.

2.2 Cross referencing should enable related items to be identified. For instance all the artifacts from a single excavation, or all the records (in various forms) concerning a single object.

2.3 The information system as a whole should be able to be used as a research tool; for instance it should be possible to retrieve all references to a particular phenomenon.

Figure 8: Agreed aims for the ARC record system

3.7 Definition of requirements

Taking into account the results of the survey, the stated aims of the project, and users perceptions of their needs, the following requirements could be defined:

1 Each item should be stored in a uniquely identified storage location, from which it may be quickly retrieved.

2 There should be a catalogue which lists each item, with appropriate indexes.

3 There should be cross-referencing between different types of items, so that related items can be identified.

In addition it would be necessary to be able to satisfy "research oriented" questions of the data. These requirements, together with a pointer to the need for field oriented systems were formalised, and agreed in two documents, at the outset of the project (Appendix 2), and when development had been in progress for nearly a year (Appendix 3). These papers outlined the general principles described above, and went into considerable detail about the indexing and cross-referencing which would be required; however, in practice the system was designed to be flexible, and would allow the generation of indexes as required, providing of course that the relevant data was available. Cross-referencing would be possible between all items, again subject to the relevant data being available and having been entered into the computer system. The agreed aims are summarised in Figure 8.

3.8 Requirement for fieldwork

Because of the involvement of the ARC in archaeological fieldwork, it was necessary for the system to be able to operate away from the museum. The primary need was to be able to perform routine cataloguing and indexing functions and some limited analysis at the excavation headquarters, where it was assumed that mains power and a clean environment would be available. When the system was initially being considered it was not certain whether these facilities would best be provided by a terminal with telecommunications links from the excavation headquarters to the museum (in the manner of Gaines 1974), or whether a microcomputer located at the excavation headquarters would be able to carry out all the required functions. At that time other workers were using microcomputers for excavation analysis, and the work by the Central Excavation Unit of the Department of the Environment (Benson and Jefferies 1980), and by the Welland Valley Project (Booth *et al* 1984) were seen as potential models.

A second requirement was for data capture in the field during excavation and survey work. Because of the nature of the ARC's interests, much of this work had to be undertaken in waterlogged conditions, or in the intertidal zone. (The requirements of underwater archaeology were not however considered at this stage). It was necessary to be able to record in wet conditions, thus placing an even more stringent requirement on the usual specification for UK work, which is for whatever system is in use to be proof against the English weather. In the experience of staff in the ARC, a system based on pre-printed (waterproof) forms was felt to be most appropriate, to be supplemented by a notebook as required. There were then several different systems in use in the UK, which are reviewed in section 5.3.9, below. Initial thoughts were that methods used by the Central Excavation Unit (Jefferies 1977) or the Welland Valley Project (Booth 1985a) could be appropriate.

Some consideration was also given to the possibility of taking a portable computer into the field. This novel proposal would have the advantage of avoiding errors in transcription from the paper medium to the computer record, and with well designed software had the potential to make recording easier and more thorough. However, if such an approach was to be adopted it would be necessary to have a computer with sufficient capacity, which could be proofed against a hostile environment, and which could be easily interfaced to the host computer or terminal at the excavation headquarters. Additionally such a portable computer would have to be sufficiently inexpensive for each of the archaeologists undertaking recording to be equipped with one.

3.9 Priorities

In order to satisfy the requirements outlined in 3.7 above, it would first be necessary to physically organise the records, and to produce an inventory or basic catalogue. Further enhancements could then follow. The survey of usage (3.4 above) was used as a guide to which classes of item should be reorganised and catalogued first. Context and radiocarbon dates were shown to be rarely consulted, and were felt to merit a low priority. However the radiocarbon date record was used as the basis of a publication (Booth 1984b), and so was completed earlier than anticipated as part of the preparation for the publication. Both photographic negatives and bibliographic references were the subject of museum-wide cataloguing activities, so it was felt to be better to defer work on these items within the ARC, and await the outcome of the museum-wide initiatives. The holdings of objects would have to be catalogued first, in order to satisfy the NMM requirements for the documentation of acquisitions and loans. Taking into account these various needs, the order in which items should be reorganised and catalogued was agreed as follows:

1 Objects
2 Slides
3 Drawings
4 Information files
5 Sample records
6 Conservation records
7 Radiocarbon dates
8 Contexts

To await the outcome of museum wide projects:

9 Photographic negatives
10 Bibliographic records

The development of field systems would be an extension of systems developed for use within the ARC, and would therefore be undertaken at a later stage.

4 THE NMM INFORMATION SYSTEM - PETREL

4.1 Introduction

The background to the development of Petrel, the Museum-wide cataloguing system is described in section 2.5, above. In order to conform to agreed NMM policy, data in the ARC system had to be compatible with the systems used for the Museum under Petrel, and would need to be eventually exported to Petrel to be incorporated in Museum-wide data banks. By conforming to this standard the ARC system would also achieve compatibility with the guidelines being established by the MDA, as the data structures employed by Petrel conformed to the emerging MDA Data Standard (MDA 1980a). Within the Museum, Petrel appeared to offer a range of established standards; including terminology, data structure, procedures, numbering, and computing systems. In accordance with NMM policy the ARC system would in any case have to maintain compatibility in terms of data structures and procedures for object documentation, and in addition it was felt to be sound practice in general to follow established Museum procedures. Cutbill's survey (NMM 1976b) had noted that like other departments in the Museum, the ARC had collections of objects. However it also undertook fieldwork and research which the Museum system was not at that time able to accommodate. Whilst the Petrel system could be expanded to include this information, Cutbill did not accord this sufficiently high priority for the resources for this work to be found from his own section. It was however decided that a pilot project should be undertaken using Petrel, so as to test its suitability for records in the ARC. The object records were identified as being most appropriate for this trial, as they would in any case have to be absorbed by Petrel. It was therefore decided to process a test batch of 500 objects (4.4 below) to examine the practical implications of using the methodologies developed for Petrel.

An overview of documentation practices at the National Maritime Museum is described by Roberts (1980a), and there is a detailed exposition of the philosophy and history of Petrel in

Cutbill (1986). The background to setting up the Information Retrieval Section at NMM, and to Dr. Jonathan Cutbill's appointment are reviewed in Section 2.5, above. The approach adopted for information retrieval in the Museum was to have a small central team, which would develop data structures, terminology, and computer techniques; the cataloguing itself would be carried out by curators based in their own departments. The required systems in the ARC were intended to fit into this structure, although with the limited resources available to the Information Retrieval Section it was not thought to be possible for the Museum's central team to actively support the non-object based projects in the ARC. In order to provide the necessary technical support within the ARC to progress the development of information systems for research and fieldwork, I was appointed to the post of "Information Archaeologist", based in the ARC.

4.2 Structure and content of Petrel data

Central to the handling of information by Petrel is the data standard, which is most fully described in the NMM Petrel *Manual 9* (NMM 1979b). The Museum's data standard is broadly a subset of the MDA standard, and was intended to be capable of accommodating all the likely forms of data to be found in the NMM. As a starting point its use by ARC would provide a framework for structuring data, and would provide compatibility with practices developed by the MDA. As this had not already been done, it would be necessary to establish the formal relationship between the NMM and MDA data standards, so as to show that the standard to be developed for the ARC would indeed conform to MDA guidelines. A significant feature of the NMM data standard is that, unlike the MDA data standard where all the data items are defined in the data standard, the NMM standard is more flexible; the individual components are defined by the role given to the component, and the role is itself an item of data. This flexibility does however mean that the record structure needs to be explicitly defined, rather than being taken from the data standard. The data standard is discussed in full in Chapter 9, below.

In addition to defining the structure of the records as a whole, the NMM data standard also specified the structure of certain individual data items within records. Amongst those which were controlled through having a specific format are dates, the names of people, organisations and firms, mapping grid references, and acquisition numbers. Certain specific fields related to the maritime interests of the Museum such as ships' names and naval ranks were also controlled. However in the early stages of Petrel there was little attempt at generally standardising terminology itself (rather than the structure); as it was felt that this should emerge from the data after it had been input. The recommended procedure was to enter the data without terminology control; an index of terms was produced, and decisions could then be taken on what the preferred terminology should be. The data would then be edited. Whilst this has the advantage of allowing the terminology to naturally emerge from the data, for its successful conclusion it is dependent on data being edited so as to conform to the preferred terminology. A potential danger with this approach is that once all of the data has been entered, the work could be perceived as having been completed, and resources would not then be made available for the editing which still remained to be done.

Petrel uses GOS, a software package for museum cataloguing developed by the MDA (Porter 1981). The implementation of the Petrel data standard using the GOS program package to control the structure of the data is described in *Manual 12* (NMM 1979c). The build module of the GOS program is a batch processor to convert text to GOS files. It is able to perform checks on the data, and also allows for short cuts in data entry through the use of abbreviations which are expanded by build. Formats for data input are documented in *Manual 13* (NMM 1979d), and *Manual 5* (NMM 1979a) gives the specific formats to be used for object records.

These three manuals document a comprehensive system which on first inspection appeared able to accommodate the ARC object records. The potential record structure did however appear to be extremely complex, and there seemed to be inconsistencies between the several manuals which would need to be clarified. It was felt to be desirable to develop a single comprehensive manual to guide the pilot project in the ARC.

4.3 The computing environment

Initially the processing of Petrel data was carried out using the GOS program (Porter 1981) running on the Cambridge University IBM 370/165 mainframe computer. Data to be processed in Cambridge was input to floppy disk by curators in their departments using Commstor intelligent disk drives, and then transferred via the Information Retrieval Section and EPSS (the "Experimental Packet Switching System" data transmission service provided by Post Office Telephones) to Cambridge. Printed output was returned by post. Latterly GOS was implemented in-house at NMM; initially on a Cromemco 8 bit microcomputer with an Intel Z80 processor utilising the CP/M operating system, subsequently upgraded to a Motorola 68000 16 bit processor, using the Cromix operating system. Cromix was a proprietary operating system produced by Cromemco, which had superficial similarities to the Unix operating system.

It was apparent from data such as the library records, which were already being processed by GOS, that the program was a powerful package which would be able to effectively handle the size and complexity of records which were likely to be generated in the ARC. There were however some doubts about its ease of use, and it appeared to be inconvenient to be reliant on the remote mainframe. However, if technical difficulties could be overcome, the in-house implementation of GOS was planned, thereby alleviating the apparent problems of the Cambridge operation. The experience of using these facilities is discussed in Section 4.4

below.

A further aspect which was identified as requiring investigation was whether GOS would be a suitable programme for use during fieldwork. An initial assessment suggested that there might be problems in having available a microcomputer with the requisite computing power at the excavation headquarters, and the absence of on-line data entry and retrieval facilities was felt to be a serious drawback.

4.4 The pilot project

The aim of the pilot project was to input the 500 Object records which constituted the test data, and to produce a catalogue and indexes. The A4 Acquisition card printed in green (Figures 10 and 11) was used as the source for the records. Data would be input to an intelligent disk drive (Commstor), and transmitted to Cambridge for processing, using the procedure outlined in section 4.3 above. The preliminary stage of the pilot project was to establish the relationship of the raw data to the NMM formats, and to write a manual. Figure 9 outlines the processes involved in the pilot project.

4.4.1 Preparation

The first stage was to identify where the various data categories on the form would fit into the NMM data standard. This was done by reference to the Petrel object manual (NMM 1979a). Figure 12 shows the categories on the form, and their equivalents in the NMM Data Standard. Having matched the ARC data categories to the Petrel object record, tags could be assigned to the ARC data. The tags are necessary to identify the data as it is processed by GOS. Once this mapping of the data to the Petrel data structure was complete a manual was drafted (*Manual 26, Documentation of Objects in the ARC* - Appendix 4). The manual was drafted on the Commstor, using it as a primitive form of word processor. This was a useful exercise in itself, as it was a good way of learning the text editing facilities on the Commstor.

4.4.2 Processing

Using the original Acquisition records (Figures 10 and 11) data was input to the Commstor for storage on 8" floppy disks. The process of data entry involved typing the tag followed by the individual data item. Care was required to ensure that the tags (and sub-tags where appropriate) were correctly typed, and that there were no unnecessary spaces. After a batch of records had been entered they were taken on floppy disk to the NMM information retrieval facility, where using a Commstor equipped with a printer, they could be printed out for proof reading. The records on the floppy disk were then edited on the ARC Commstor.

When the records appeared to be without any obvious errors of content or syntax they were again taken on floppy disk to the Information Retrieval Section for transfer to the Cambridge mainframe. This was achieved using a Commstor connected to a modem, using the GPO EPSS service. Once the file had been successfully transmitted to Cambridge the records could be transferred from text form to GOS using the GOS build facility. For small batches of data such as a trial block of ten records, these operations could be accomplished on-line.

Output from the build process would generally include some error messages, and the data would have to be edited. In addition to editing the data on the Commstor and retransmitting it, there were two types of editing facilities available on the Cambridge computer. The "unbuilt" text could be edited using the edit facilities on the mainframe, or the GOS editing

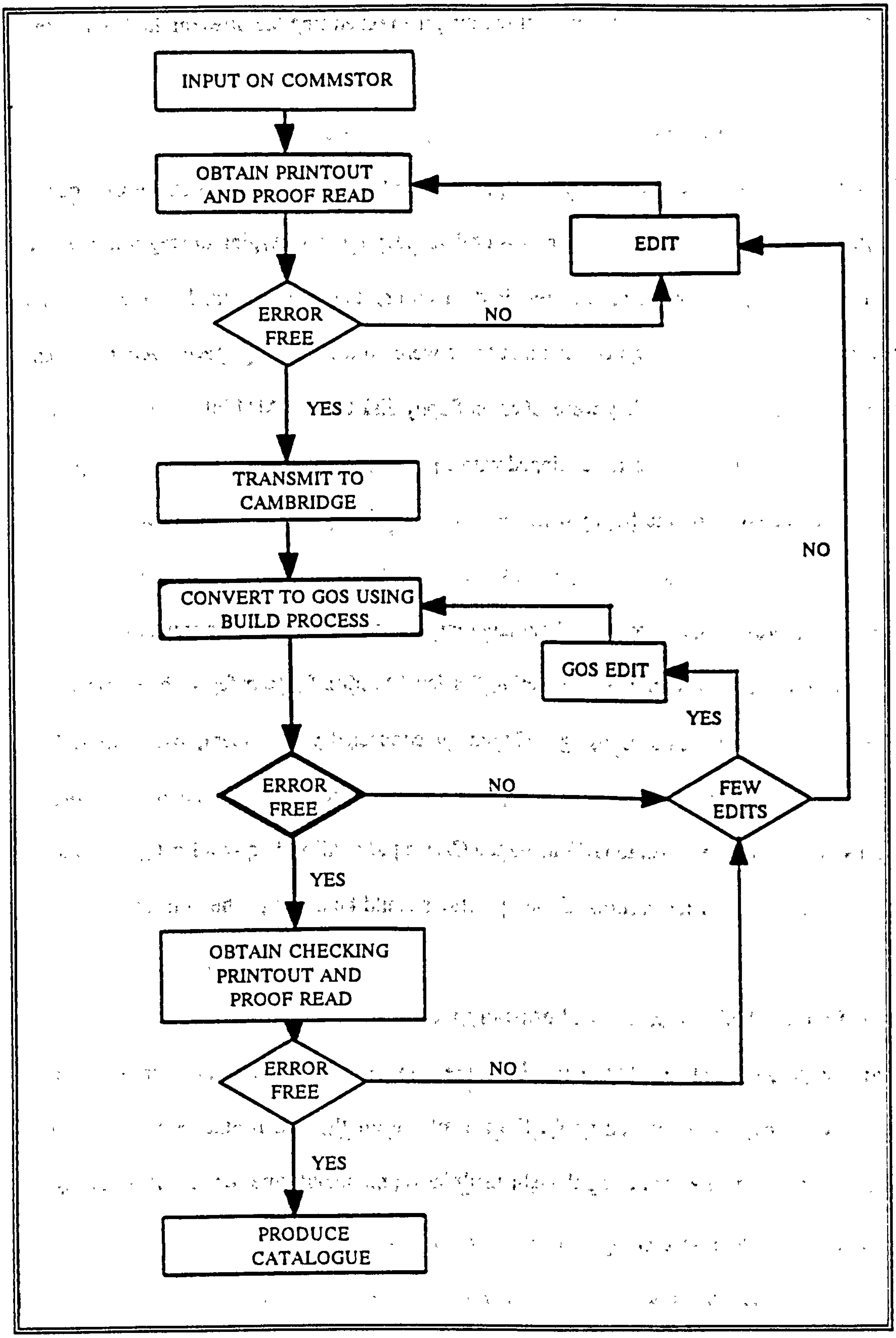


Figure 9: Chart showing processing of test batch of data

ACQUISITION NUMBER ARC 1973 6

GRAVENEY BOAT

Previous Acquisition number

From Ships Dep

SR 70/46

Source of Acquisition

Purchased from Earl Sondes,

After excavation by N.M.M.

Name address donor

Earl Sondes,
Lees Court,
Faversham,
Kent

Description of object

Remains of Graveney boat in pieces

Dated

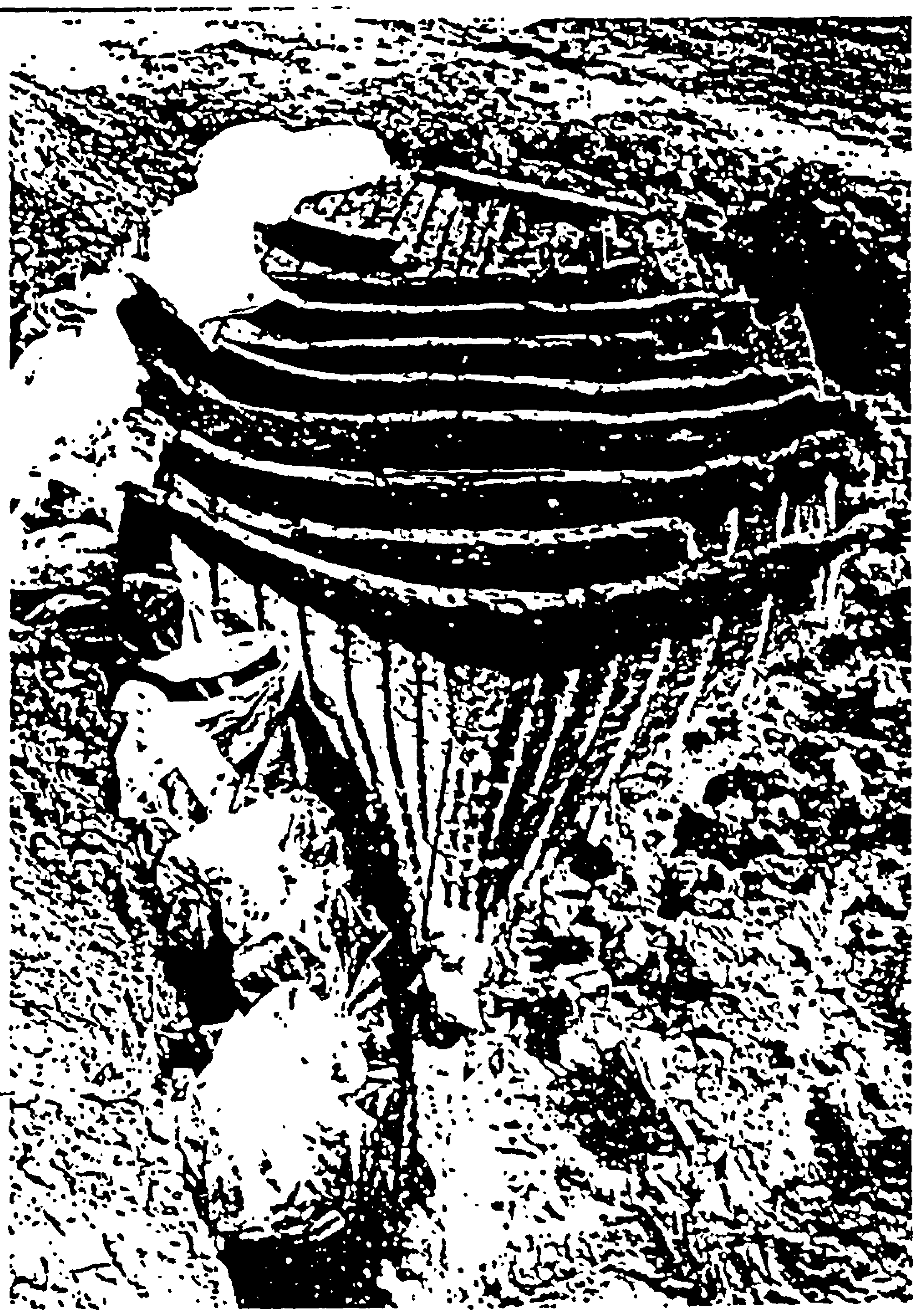
[redacted]

927 ± 2 (den

A.D.

Photograph of object
Ref. No.

B4446/17



Manner of Acquisition

Purchased

Nov 1970.

Cost

£3000

1970

Figure 10: Original ARC object form (obverse)

Excavated Object /

Site Reference No.

Map Reference

Grid Reference

Kidbrooke, conserved in tank in room C10 20.12.76

Studio Negative Numbers

3 4446/17, 4473/17, 4480/3, 6231, 6233, 4447/11, 4478/15, 5181/5 4471/16, 7379,5A, 7579/5A 4472B/6 6640, 6641, 6642

ditto 12.2.78

Ditto 4.4.79

Ditto 15.1.80

" 6/1/81

" 26.1.82 GH

" 11.1.85 GH

" 5.1.84 GH

also some in conservation in tank in FP. GH. 5.1.84

Slide Reference Numbers

Drawing Reference Numbers

Conserved Yes / No

Carbon Date Yes / No

Dated BM660, 1080+40BP(870 + 40AD) BM 956, 1283±51 B.P. (667±51 AD)
BM661, 1064 + 54BP(886+54AD) BM 957, 1126±76 B.P. (824±76 AD)
BM715, 1003+40 (949+ 40AD) BM 1137, 1178±38 B.P. (772±38 AD)
BM 1138, 1095±37 BP. (855±37 AD)

Sample Numbers BM 600, BM 661, BM 715, BM 956, BM 957, BM 1137, BM 1138.

Other Sample Numbers

Related Files

Graveney Excavation A1/1(i)/01
" Replica E6/07
Excavation & Conservation G11/7(ii)01
Research for publishers G17/2/05
Crewing of Replica H71/3315
Restoration & Conservation J9/02
Acquisition X71/047

See also Cards for Acquisition Nos.
N9/73 (Graveney Mould)
N10/74 (Graveney Model)

Publications

V. H Fenwick "The Graveney Boat" BAR 53 (1978) N.M.M. BR Series 3
" "The Graveney Boat" a Pre-Conquest Discovery in Kent" IJNA 1 (1972) p 119-29
C.M. Fenwick "The Graveney Ship", Kent Arch Rev 25 (1971) p 15

Figure 11: Original ARC object form (reverse)

ACQUISITION CARD	NMM DATA STANDARD	
Name of object	Identification	Identification Name Status
	Original	Identification Name Date Where made/found Reference
Acquisition number	Acquisition	Acquisition number
Previous acquisition number	Association	Old number
Source of acquisition	Acquisition	Previous owner
Name and address of donor	Acquisition	Previous owner
Description of object	Physical description	Part Description Dimensions Condition Note
Dated	Production	When produced
Photograph Ref. No.	Reproduction	Reference number
Manner of acquisition	Acquisition	Method
Cost	Acquisition	Cost
Date Acquired	Acquisition	Date
Accepting Officer	Association	Custodian
Excavated object site ref.	Reference	Information File Number
Map reference	Finding	Grid reference
Grid reference	Finding	Grid reference
Studio negative number	Reproduction	Reference number
Slide reference number	Reference	Slide number
Drawing reference number	Reference	Drawing number
Conserved	Museum process	Conservation
Carbon date	Museum process	Dated
Sample numbers	Reference	Sample number
Related files	Reference	Museum file
Storage and Display	Location	Place Date Person
	Display	Place Date Person
Publications	Reference	Reference

Figure 12: Data categories in ARC Acquisition Card, and equivalent fields in NMM Data Standard

```
<co a22
<s i <d boat <d $0u Maplin Boat
<s hf <c Maplin <p Fenwick, V H <d excavation
<s dc <a whole <d material # wood
<d c # fragments
<s hq <t 1 Oct 1973 <d excavation <x aARC1973-19
<s n <r $rNMM File $k A1/2/3
<s hl <t 20 Dec 1976 <x lk <d storage
<s pr <x nB7373/35A <x nB7373/36A
<s z <z seven major pieces, including 4 ribs
*
```

Figure 13: Record in unbuilt text form

```
A22    Ident:   [d boat [d (u) Maplin boat
       Find:    [p Fenwick, $b V H [c Maplin [d excavation
       Phys:    [d [tx material [tx wood [d [tx c
                [tx fragments [a whole
       Acq:     [t 1 Oct 1973 [d excavation [x Acq.no ARC1973-19
       Ref:     [r [jrn NMM file $k A1/2/3
       Loc:     [t 20 Dec 1976 [d storage [x Loc. K
       Repro:   [x Item No. NG B77373/75 [x Item No. NG B7373/36
       Notes:   [z seven major pieces, including 4 ribs
```

Figure 14: Record in checking index form

```
A22 Boat; Maplin boat:
        Found by V H Fenwick, at Maplin, by excavation:
        Material wood; Condition for whole is fragments
        1 Oct 1973: acquired by excavation: Acq.no ARC1973-19;
        ref: NMM file, A1/2/3
        20 Dec 1976: moved to K for storage:
        neg.no.NG B77373/75, neg. no NG B7373/36
        (seven major pieces, including 4 ribs)
```

Figure 15: Record in catalogue form

facilities could be used to edit the GOS file resulting from build. Editing the raw text on-line had the advantage of convenience and immediacy, but for large files requiring much editing it was expensive in terms of GPO costs and computer resources, and it had the added disadvantage that if EPSS failed (a common occurrence) then the edits would be lost. The

GOS editors (either combine or edit) worked by taking a file of edit commands and using these to edit the GOS data file. The file of edits would be constructed on a Commstor, and be transmitted to Cambridge in the same way as data files. The edits would then be run off-line as a batch job.

Once the data was free of syntax errors it could be processed through build to become a GOS file. Printed output in a suitable form for proof reading would then be requested, and was sent by post to Greenwich. After any further necessary editing, a catalogue and indexes were requested, again to be sent by post from Cambridge. Apart from a small batch of 10 records this trial project never progressed to the point of producing finished indexes, but a checking index of all the terms used for all fields was produced for the 500 records, and this was found to be a useful aid to retrieval. Figure 13 shows a record in text or "unbuilt" form, Figure 14 shows the same record in checking index form, and Figure 15 shows it in catalogue form.

4.5 Conclusions from the test batch

This pilot project showed that it was possible to fit the ARC records into the Petrel record structure, and to use the structures for the components within records. It showed the usefulness of the powerful facilities for catalogue, index and checking aid generation which are available from GOS. Also by providing examples of output it began the process of educating ARC staff in the possibilities which could be realised through the computerisation of our records.

Several aspects of the pilot appeared unsatisfactory, and would need to be resolved before the project could proceed. The perceived problems were:

1 Terminology Control

Whilst Petrel provides a structure for records, and for components within records, there was as yet little terminology control. Where terminology control was required for the ARC data it would have to be developed.

2 Commstor Editing Facilities

Data entry and editing via the Commstor was cumbersome, compared for instance with using a word processing package such as Wordstar on a microcomputer.

3 Tags

Data entry in tagged form was prone to error, as mistakes could easily be made with the tagging; a much more satisfactory method would be to have some form of interactive input, either via a form or a "question and answer" session. The method of data entry using tagged text was judged to be too cumbersome and error prone to be acceptable either to a typist, or to curators who would not be particularly familiar with the Commstor or with the tagging system.

4 Need for a local printer

It was felt to be highly desirable to have a local facility for printing out text for proof reading.

5 Use of remote mainframe

The method of transferring data to Cambridge was cumbersome, and EPSS was prone to breaking down in mid-transmission. The mainframe itself was not always operational. Facilities for editing once data had been transmitted were also difficult to use, and lacked the immediacy of on-line full screen editing. Finally, the return of output from Cambridge took several days. Taking all of these problems into account it was felt that a local facility would be desirable.

In the light of the experience gained in the pilot project it seemed that the data structures of Petrel would be adequate for our needs, but further work would be needed to develop terminology control, much of which would be specific to the ARC. In terms of the computing technology which would be used the following options were available:

1. To use the Petrel facilities as currently available (Commstor and the Cambridge mainframe). This option would be economical both in terms of equipment to be purchased, and development work to be undertaken, but it would leave unresolved many of the disadvantages identified in the pilot project. (There was the possibility that GOS would become available on a microcomputer in NMM, but the costs of such a machine made it unlikely that one could be purchased by the ARC.)

2. To obtain a microcomputer for the ARC, on which all our data input and processing would be done. Data would be transferred to Petrel to contribute to the Museum-wide object database, but all other operations would be performed locally. This would provide good facilities for data input and editing, but there were some doubts as to whether the more complex catalogues and indexes could be produced in this way. Software would in any case have to be developed for data capture, and a microcomputer would need to be purchased.

3 A combination of the two options above, whereby data capture, editing and straightforward output would be performed locally, with GOS (initially on the Cambridge mainframe, but potentially on a microcomputer in the Museum) being used for major catalogue and index production.

It was concluded from the pilot project that it was desirable to have a facility within the ARC for data entry, editing, and simple output, probably employing interactive systems for all of these activities, and almost certainly based on a microcomputer. For major catalogue and index production GOS appeared to be the best option if major investment in systems development was to be avoided.

The initial conclusion after the completion of the pilot project was that the packages for large computer systems such as Famulus (Pettitt 1981) needed substantial computing facilities and did not appear to offer any advantages over GOS. The few examples of database software which were available on microcomputers could not accommodate the complexity and size of records that the ARC required. It seemed therefore that the combination of a microcomputer for local data capture, editing and simple outputs and GOS for significant catalogue and index generation, would best provide the facilities which we needed. However before a firm decision was taken on the technical approach other systems in use in museums and archaeology (Chapter 5), and overall developments in computing (Chapter 6) were reviewed.

5 REVIEW OF PREVIOUS WORK

5.1 Introduction

At the outset it was considered to be essential to be aware of what other workers were doing, so as to learn from their experience, and to avoid the needless repetition of development work which had already been undertaken. This review carried out prior to the design of the ARC system examines archaeological information systems, and their integration with museum records. Whilst the survey aimed to be as comprehensive as possible, it did not attempt to look at quantitative analysis, as this would form a second stage of the project, once basic documentation procedures had been implemented.

The survey is arranged in two parts. The first is a chronological overview, which attempts to thoroughly describe developments in archaeological information systems, and related areas. Similar types of application, such as sites and monuments records, or on-site computing, are grouped together. The second section extracts models which are felt to be of use in developing the ARC system; it is arranged according to the different elements (numbering, recording media and so forth) identified as being necessary for the proposed record system (2.8, above). The survey below is described from the perspective of 1981-1982 when the review of relevant work was undertaken as part of the preparatory study prior to developing the system for the ARC.

5.2 Literature review

5.2.1 Syntheses

The published sources contain several syntheses. Wilcock (1973b) describes how the potential application of computers to archaeology can be divided into information retrieval, statistics, the recording and analysis of information from instrument surveys, and graphics; and describes how these can all be incorporated into a "combined system". Gebuhr &

Kampffmeyer (1981) review the types of analyses which can be carried out, including simulation, spatial analysis, seriation, and quantitative analysis. Peebles and Galloway (1981) cover similar ground, but argue that it is essential to have facilities for data management, and procedures for the long term curation of the data, in addition to, and underlying, tools for analysis. Wilcock (1981a) examines the data needs of the archaeologist and museum curator, and requirements for specialist analysis; and common elements between these different constituencies. Graham (1982) reviews requirements for excavation records, analysis and publication, and the separate needs for statistical analysis. Scollar (1982) reviews seriation, data banks, recording and analysis of machine readings, and predicts that the future lies in the visual presentation of data, where outside of archaeology considerable advances are already being made. Overall the conclusion to be drawn from these sources is that archaeological computing applications can be divided into information retrieval, statistics and seriation, and the analysis of machine readings, but that in the future graphics will be very important.

An invaluable resource was the annual proceedings of the "Computer Applications in Archaeology" Conference, which provided a comprehensive account of computing activity in British Archaeology. In the museum field there are numerous publications by IRGMA (the Information Retrieval Group of the Museums Association), and latterly by the MDA and its officers. A volume which promised much was "Data Bank Applications in Archaeology" (Gaines 1981a); it provided a guide by Chenhall (1981) on the overall approach to computerised records, some descriptions of specific projects, and the synthesis by Wilcock (1981a) described above. Surprisingly, although published in 1981, this volume by Gaines failed to anticipate the potential of microcomputers, and much of the work described was already extant in the mid 1970's (Chenhall 1975). The paper by Chenhall (1981) does however make many pertinent observations. It suggests that it may be preferable to use the computer as an index to paper sources, rather than input all of the data. Chenhall also draws attention to the need to define whether the database is to serve as an inventory, or whether it should be a resource for research, arguing that it is not possible to satisfy both requirements at once. Good data definition and control are required. He describes the data files necessary for field recording, post-excavation laboratory analysis, and post-project archiving.

Scollar (1982) provides a review of early projects going back into the 1960's and 1950's, with Gardin's application of seriation (1962) as perhaps the first use of computerised techniques on archaeological data. By the late 1960's several authors had provided proposals on what could be done; with amongst them Chenhall (1967), Lewis (1965 and 1970, Lewis *et al* 1967, IRGMA 1969), Renfrew (1967), O'Connor *et al* (1968), Rogers (1970), and Gardin (1970). However the practical application of computers to archaeology was for the most part to come later. The work of Lewis in the UK lead to the setting up of the Information Retrieval Group of the Museums Association (IRGMA) in 1967. By the early 1970's some workers began to consider "practical" problems of archaeological and related data handling, including Wilcock's work with caves (Wilcock 1971a), and several projects dealing with museum data (Chenhall 1971, Cutbill 1973). The paper by Borillo (1971) and the responses to it provide a debate on how computers could fit into archaeological methodology.

The general principles of database software are described by Date (1981) in his "Introduction to Database Systems", first published in 1975. Of particular relevance to archaeological data handling was the need for the definition of the data structure to be held separately to the program itself, so that changes in the data structure would not necessitate the modification of the program. Cutbill (1974) notes this need for the data format to be independent from the software, with information describing the structure of the data being kept in a separate file.

5.2.2 Sites and monuments records

The 1970's saw the development in the United States of a number of mainly mainframe based projects for what was termed "site survey data". The AMASDA (Automated Management of Archaeological Survey Data in Arkansas) system (Scholtz and Million 1981) incorporated site inventory, land use and project files, being an application of the GRIPHOS package running on an IBM mainframe. Complex coding of the data was necessary. AZSITE, the Arizona State Museum Site survey database used the SELGEM package from the Smithsonian Institution (Rieger 1981). SARG, the system used by the Southwestern Anthropological Research Group (Plog 1981), and Oracle, at Indiana University (Limp and Cook 1981) both made use of the SPSS package for data analysis. Whilst with hindsight these systems appeared cumbersome and not well matched to the needs of their users, they did serve to prompt a consideration of objectives, and of the data requirements and analyses necessary to achieve such aims. This initial enthusiasm for very large databases was declining by the early 1980's as the comprehensive nature of these projects was questioned, and the emphasis shifted from an idealised "catch all" philosophy towards "Cultural Resource Management" (Scholtz and Million 1981). As early as 1976 the idea of the "data bank" was being critically scrutinised, and there was a call for the definition of "realistic and precisely defined needs" (Chenhall 1976, Scholtz and Chenhall 1976).

In the British Isles the possibilities for computer storage of sites and monuments information were seen in the early 1970's. One attempt to test these ideas was the "Birmingham Inventory", a gazetteer for Shropshire and Worcestershire (Laflin 1973a, 1973b, 1980b), which had a separate record for each site. A generalised design which was mostly card based, but with the potential for computer indexing, was proposed by Pryor (1973). The first full scale working systems were the Northern Archaeological Survey, using 6 inch to the mile scale maps and a card index, with computer aided retrieval (Clack 1975); and the Fife

Archaeological Index, which was based on similar principles (Kenworthy *et al* 1975). A system used as a model for many others was described by Benson (1972), with specific advice coming from the Association of County Archaeological Officers (1978), and from the Department of the Environment (Inspectorate of Ancient Monuments 1981). As with the examples above, the system devised by Benson was based on a card index and 1:10,000 scale maps, but considerable thought was given to the content of the record to be computerised. Whilst being archaeologically rigorous, this system which was to become the model for many others, suffered from a lack of information science input to the record structure, which would make satisfactory computer storage and retrieval difficult. This is in contrast to the work of IRGMA and the MDA, which placed great importance on this aspect of record design.

The Council for British Archaeology (1975) examined the role of the intensive and non-intensive record, and a survey of the then current situation was carried out by the Royal Commission on the Historical Monuments of England (1978), both concluding that there was a need for a national policy and structure for sites and monuments records, together with agreed standards for data structure and content. The British Library Board report (British Library Board 1977) examined requirements for bibliographic references for archaeology. These various strands are brought together in the several reports by Copeland (1982, 1983a, 1983b).

The overall the pattern which emerges is of a consolidation and standardisation of practice. Systems are based on the ordnance survey record cards, 6 inch and later metric 1:10,000 scale maps, with data abstracted and indexed according to the scheme devised by Benson and subsequently endorsed by a wide spectrum of bodies including the Association of County Archaeological Officers, the Royal Commission on Historical Monuments (England), and Department of the Environment.

5.2.3 On-site terminals and microcomputers

"On-site" computing became technically possible in the 1970's. In practice this consisted of a terminal housed in a hut or caravan adjacent to the excavation, rather than on the excavation itself. This terminal would be linked to a computer some miles away (often the mainframe of the university sponsoring the excavation), via the public switched telephone network. This approach enabled data to be input and analyzed during the course of the excavation, thus providing an aid to planning the day-to-day excavation strategy, and a means of rapidly processing the records and material recovered from the excavation.

There were several attempts to use such a facility. Gaines (1971a, 1971b) describes how a terminal was linked via the public telephone system to a mainframe computer 300 miles away, thus enabling rapid analysis and searching of the data whilst fieldwork was proceeding. Gaines concluded that such techniques would be useful where the quantities of data were substantial, and there was a need for daily feedback. Graham (1976) argues that the use of tape or a similar medium to record data entered via the on-site terminal, was preferable to the cost and reliability problems associated with using telecommunications. The work of Wilcock (1973a) and Buckland (1973) at roman Doncaster suffered from reliability problems with the teletype machine and telecommunications, but nevertheless showed the potential for comparisons between different strata and artifacts, and for facilitating the writing up process soon after the excavation was completed. The system outlined by Jefferies (1977) made successful use of long-distance communications. The methods used for the Koster Project (Brown *et al* 1981) involved a 3 day turnaround time for processed records, but this was felt to be acceptable. Telecommunications access to a mainframe was also used for the Lubbub Creek project (Peebles and Galloway 1981).

Whilst those using these techniques claimed to have done so successfully, the problems of unreliable telecommunications, unfriendly mainframe software, and the operation of delicate equipment in a hostile environment, meant that these schemes were for the most part experimental, and such methods were not generally adopted. However some pioneers such as Graham (1980b), and Benson and Jefferies (1980) did persist with these experiments, and successfully made the transition to the microcomputer as a replacement for the remote terminal.

5.2.4 Analysis of archaeological data

The Plutarch system devised by Wilcock (1974a, 1974b, 1980) aimed to provide integrated facilities for information retrieval, statistics, graphics and the analysis of geophysical readings, including histograms, pie charts, multi-dimensional scaling and K-means. The system developed at the Winchester Research Unit (Steger *et al* 1978) was able to analyze multi-dimensional arrays, providing totals and percentages for artifacts; for instance it was possible to retrieve all iron objects. The Central Excavation Unit system (Jefferies 1977) was mainly used to compile the archive, but had facilities for producing tabulations of pottery and bone. A program developed by Laflin (1974a) produced tabulations of artifacts. The Plutarch system (see Wilcock above) was used to analyze data from Danebury (Shackley and Wilcock 1974, Shackley *et al* 1976, Shackley 1976). The proposed (but never implemented) generalised system for archaeological data, outlined by Kromholz (1975), was based on a program for the analysis of social welfare data, and included many of the facilities also identified by Cutbill (1974). A systematic approach to post-excavation work was proposed by Bishop (1976), including checking and cataloguing, broad and narrow phasing, the incorporation of specialist reports, the production of phase reports, and the production of the finished report. The problems of describing stratigraphic relationships were being examined by Wilcock (1975a) who developed a context sorting programme in ALGOL 60. In the Netherlands the work in Friesland (Newell and Vroomans 1972, Newell 1975, and a review by Wilcock 1975b) examined a whole range of the problems of excavation recording, and provided a means of recording the large quantities of mesolithic artifacts recovered by excavation in horizontal levels on a site with little observable stratigraphy. In Italy experiments were being undertaken to reassemble sections from measurements taken of the horizontal surfaces of stratigraphy (Fedele *et al* 1979), and the work of Lukesh (1975) was an attempt to distinguish strata through an analysis of the location, and type of artifacts.

Several French prototypes examined specific aspects of archaeological data. The SOFIA project provided for the storage of bibliographic references, and some specific artifact types (Lemaitre 1981); RIDA was a bibliographic package (Lemaitre 1980). At the other end of the spectrum was the potentially massive database of the *Inventaire Generale*, using SATIN 1 (Bourrelly and Chouragui 1981) However the review by Salton 1981) concluded that despite the grand scale and elaborate analyses which were possible, lack of control in data input, and lack of definition of the purpose of the system, made its effectiveness doubtful.

Except for the system devised by Jefferies which was converted to microcomputer operation (Benson and Jefferies 1980) the majority were fairly short-lived prototypes, and should perhaps be seen as the experimental phase of such work. In particular, the graphics content of the Plutarch system was well ahead of what could be achieved with all but the most sophisticated computing installations. A few years later there were further attempts at graphics, at the Museum of London (Flude *et al* 1982) used a codasyl database, whilst McNett (1981) employed a graphics package associated with the SELGEM software developed by the Smithsonian Institution, although once again the failure of these projects to pass beyond the prototype phase may be said to be because the technology was not powerful or robust enough to support a fully operational system.

5.2.5 Microcomputer hardware and software

Before the arrival of the microcomputer in the late 1970's, archaeologists who were fortunate enough to have access to computer facilities had for the most part to rely on university or local government mainframe computers. The level of service they received was often indifferent, as they were usually not "paying customers", and they would therefore be dependent on the generosity and interest of local support staff. Furthermore the facilities available on such systems were not always very suitable for archaeological work. Fasham and Hawkes (1980) describe some of these problems, but nevertheless claim a fourfold increase in productivity, reporting that many of the analyses carried out would have been prohibitively costly to perform by manual means. Whilst the superior capacity and speed of the mainframe still had attractions as a means of secondary processing, development in data capture and initial analysis switched to microcomputers or a mixture of microcomputer and minicomputer, with a handful of such projects, all reliant on "home grown" software, being prominent by 1980.

The system developed by the Central Excavation Unit of the Department of the Environment (Jefferies and Benson 1980) consisted of a suite of programs written in BASIC, running under the CP/M operating system on a Research Machines 380Z microcomputer. The software provided for checking, validation and editing of data, and the production of catalogues and indexes, together with summary statistics, stratigraphic analyses, and finds analysis. It could be used for excavation or sites and monuments records. The software developed in 1980 for the Welland Valley Project (Booth *et al* 1984) was written in BASIC to run on Apple II hardware. It comprised programs for the input, editing, listing and sorting of data for finds and stratigraphy. The data structure was coded into the software. The system developed by Moffett for the post-excavation analysis of data from excavations at Mucking used a program package called DEAR (Data Entry And Retrieval), which through the use of a "question sourcefile" guided the user through interactive input, and provided rudimentary facilities for output (Catton *et al* 1981). The DEAR package was also used for data capture by the Department of Urban Archaeology at the Museum of London (Flude 1980b), with analysis on the resultant comma delimited file being performed on a PDP 11/23 minicomputer through UNIX utilities. Realising the limitations of 80 column punched card input to a mainframe, the Colchester Archaeological Unit (Kenrick 1980) developed microcomputer based software for data input. Software developed by Johnson (1979, 1980a) for hunter gatherer excavation data was transferred from its initial mainframe environment to a microcomputer.

The extent of commercially available software packages is discussed in full in Chapter 6. In practice it was necessary for each project to develop its own software, as the few commercially available database management systems were not suitable for processing archaeological records. Light (1982) examines the potential for using microcomputers for museum documentation. He concludes that whilst their main usage will be for local data entry, they are also likely to be able to provide local processing for the production of indexes.

5.2.6 Excavation recording systems

Formal methods of excavation recording began to be applied by fieldworkers in Britain from the early 1970's. One such system was that described by Hirst (1976). Before setting out her proposed system, Hirst describes how many prominent archaeologists, including Pitt-Rivers (1887), Wheeler (1947, 1954), Atkinson (1946), Kenyon (1952), Webster (1963), Coles (1972) and Alexander (1970) had all written of the importance of records, but had in general said little about what should be recorded, and the methods which should be used. Pitt-Rivers (1887), rather more than others, stresses the need to provide a full record so that others can see how conclusions were arrived at. Browne (1975) stressed the importance of recording, but surprisingly made no mention of the printed recording forms which were by then coming into use. Manuals published in the United States give more prominence to recording (Heizer and Graham 1967, Meigham 1961) but overall the impression gained is summed up by Heizer and Graham as "there is nothing very exciting about techniques for recording - one simply records whatever information there is and that is that". There is a further survey by Stewart (1980a), who again acknowledges Pitt-Rivers, and draws attention to the emphasis placed on recording by Petrie (1904).

Hirst's own system (Hirst 1976), which is based on the concept of features and layers attempts to address these problems; it includes a comprehensive set of pro-forma cards, and instructions for their use. A system which was again based on features and layers, and made use of pro-forma sheets, was that developed specifically for the open area excavations at Fengate by Francis Pryor (Pryor 1978, Appendix 1). Two systems which were widely copied were those of the Department of the Environment Central Excavation Unit (Jefferies 1977), and by the Department of Urban Archaeology at the Museum of London (Schofield 1980, and also Boddington 1978 for a derivative). Both offered comprehensive systems which were applicable to a wide range of sites, and were based on a single numbered sequence of contexts, rather than features and layers. Although both had a wide applicability, the Central Excavation Unit system was developed in rural situations, whilst the Museum of London system was mainly used for urban excavations. The work of Harris (1975a, 1975b, 1979), in proposing a method for describing and interpreting the stratigraphic sequence, seemed likely to be an important influence on the design of recording systems where complex stratigraphy would be encountered.

The several systems in use at this time, appeared for the most part to be pragmatic means of formalising the techniques which had been evolved by workers in the field. In an essay written in 1978 (Booth 1978), I attempted a theoretical overview which itemised the components of an archaeological recording system, including the written record, drawings, photographs, finds and environmental remains, and the logical links between these elements.

5.2.7 Museum documentation

In Britain there had been considerable interest in the development of methodologies for the documentation of museum collections, leading to the formation of the Information Retrieval Group of the Museums Association. As part of this initiative work at the Sedgwick Museum in Cambridge involved the development of the CGDS (Cambridge Geological Data System) program package, which provided facilities to produce a catalogue and generate indexes. This project formed a prototype for future software and data standard developments by IRGMA and the MDA (Cutbill 1973, Porter *et al* 1977). Achievements during the first ten years of IRGMA had included focusing attention on documentation issues, and bringing together interested curators. Multidisciplinary standards and media had been developed, leading to the production of catalogues and indexes, and the Museum Documentation Advisory Unit (MDAU) had been established, shortly to be renamed the MDA (IRGMA 1977). The MDA was initially constituted as a membership organisation with aims including the promotion of museums as sources of information; conducting research and development in the field of documentation; providing training, advice and assistance; and liaising with appropriate bodies (Roberts *et al* 1980). In 1982 a reassessment of the MDA's strategy defined priorities as the development of an overall Museum Documentation System; computer system development (particularly microcomputers); extending the advisory programme; consultancy; and support for users of the MDA's services (MDA Development Committee 1982). Products included the development of a theoretical structure in which museum data may be fitted (MDA 1980a), a software program for manipulating this data (MDA 1980b, Porter 1981), a set of recording media for recording information on museum objects, and guidelines on procedures to be adopted in documenting museum collections (MDA 1981); the whole being termed the

Museum Documentation System.

In his book "Museum Cataloguing in the Computer Age" Chenhall (1975) described how in the United States the computer storage of Museum records was recognised by many as "a good idea", but that there were nevertheless perhaps twice as many sceptics as advocates, and it was difficult to demonstrate cost- effectiveness for these projects of the late 1960's and 1970's. Chenhall reviews the several mainframe systems which were in use, including SELGEM, GRIPHOS, GIS, ELMS, GIPSY, TAXIR, and an unnamed system in use at the W.H. Over Museum. Many of these software packages had archaeological applications, which are described in the volume edited by Gaines (1981a). Chenhall also draws attention to the work of Cutbill in the UK, and the Canadian Inventory of Cultural Materials. The global status of documentation and data standards are comprehensively described in two reviews by MDA staff (Roberts and Light 1980, Light and Roberts 1981), which highlight developments in the US and Canada, and UK. The volume by Orna and Pettit (1981) provides an overall general guide to information handling in museums, including data standards, procedures, and recording media..

5.2.8 Integration of archaeological material and records with museum systems

With the exception of museum-based teams, most excavators had developed recording and numbering systems best suited to the problems encountered in the field, without reference to the museum which would be the likely repository of their finds. In general, they felt that museum systems had little relevance to their needs. However, from the outset, the MDA gave consideration to the needs of incorporating archaeological material in museum collections; through the archaeological object, site and locality cards; and through the generally applicable data standard and GOS program package (Roberts (1978, 1980b). In her in-depth analysis of the difference between archaeological and museum requirements, Stewart (1980a) characterises the differences in approach whereby excavators would establish separate sequences for different classes of find, in contrast to the single sequence favoured in museums. It was usual for a museum to store archaeological material in stratigraphic groupings, but much of the enquiries of the collection would be by artifact type. Problems to be resolved were identified as including numbering, data standards, the storage of the paper archive, and overall the need to establish a "well tempered archive". In order to address these difficulties the MDA developed a set of excavation recording media including site summary, stratigraphic unit, object record and finds analysis pro-forma (MDA 1980c). The MDA excavation cards were not widely used in the field, but demonstrated their utility as a means of incorporating excavation archive material in museum collections (Stewart 1982a, 1982b). Nevertheless this "seamless" means of enabling artifacts from archaeological excavations to be catalogued and integrated into a museum system was rarely employed at the time of this review.

Renfrew (1967) had defined what was required of retrieval from archaeological collections as being similar to requirements for other types of collection, with the addition of the need to access by association, grid reference, and classification by period and type. The application of Chenhall's system (Chenhall 1978) of classification to archaeological objects is examined by Crowther (1981), who concludes that although the lowest level of classification (by artifact name) was better suited to North American artifacts, the first two levels of functional classification were applicable to the UK, and were more useful than the traditional divisions by material.

In parallel with the problems described above in integrating excavated objects with more conventional museum collections, there is also the requirement to curate the archive which is generated during the course of excavation and post-excavation activities. In the Frere

Report (Ancient Monuments Board 1975), Levels 2 (the excavation records) and 3 (the unpublished, consolidated archive), are recommended for deposition in a museum, or in the National Monuments Record curated by the Royal Commission on Historical Monuments (England). The Dimbleby Report (Ancient Monuments Board 1978) urges that the archive must go to the museum where the other remains are kept. Amongst the many recommendations of the Cunliffe Report (Council for British Archaeology/Department of the Environment 1983) is the suggestion that the archive should go to repository able to properly curate it, and a copy of the archive on microfiche should go to the museum holding the finds, amongst other locations. Rhodes (1980) defined the potential types of archive as including those which are uncatalogued, catalogued, or in a constant state of revision. He argued that it was desirable to have an overall theoretical structure for the archive, so as to provide a framework which users would understand. Jefferies (1977) outlines the structure of the archive as including a sorted catalogue of contexts arranged by structure and components, and the artifact catalogue, together with drawings. These should be deposited in the museum in microform. The problems of looking after the material remains are examined by the Longworth report (British Museum 1982), which concluded that it was necessary to define why materials were being retained, and to make proper provision for their storage.

5.3 Selection of relevant work

5.3.1 Overall model systems

Having reviewed the work already undertaken by others, it was necessary to select those examples which could be of relevance to the system to be developed for the ARC. Much early work is very specific in its scope, and seemed unlikely to be of use in framing a general approach. However there are several papers which either address overall problems, or attempt to devise a system which is generally applicable.

The system proposed by the Department of the Environment (Jefferies 1977) comprehensively provided for the storage of all types of textual data from excavations. In its initial stages it was designed to integrate with museum recording systems as proposed by IRGMA (the object record being a subset of the IRGMA archaeological object record). When the software system to support the Central Excavation Unit record was transferred to a microcomputer environment it was enhanced to enable it to support the data required for a sites and monuments record, in addition to the various types of records from excavations which were already stored (Benson and Jefferies 1980). The DOE system therefore provided a useful model both for an entire system accommodating various types of record, and also for specific aspects such as recording media, numbering systems, software, hardware and procedures (see below).

Although the system described by Johnson (1980a) is specifically designed for hunter gatherer sites, many of his remarks are equally applicable to other archaeological data. In particular he sees the need for an integrated approach to data capture and analysis, rather than the recording and analysis of only data which is perceived at the outset of the project as being worthy of such attention. He calls for systematisation in order to facilitate intra-site comparisons. He also seeks to encourage departure from purely numerical analysis; the integration of data recording with the excavation process; and the need for software and hardware to enable the data to be readily re-examined after the initial analysis is complete. He proposes a standard database management system in order to accomplish this. Johnson's initial application of these principles uses a mainframe computer, and only accommodates numerical analyses (Johnson 1979), but he sees the way forward as employing database management software on a microcomputer.

The paper by Chenhall (1981) makes a number of general points concerning what data should be computerised and what should be recorded in other formats. Chenhall draws the distinction between records used for management purposes and research. Data elements, and the data held within them, must be carefully defined and controlled. The realisation of these necessities is seen by Chenhall as a result of a maturing in our knowledge of computer use. In looking at an integrated system Chenhall sees the need to look at the activities to be undertaken; the information needed to support these activities; the data files and categories of data required; and the interrelation between these files. He goes on to define "project field activities", "project laboratory activities", and "post project activities", and the files and data categories required to support these different but related spheres of activity. He describes a possible model for such a system, showing how different files are constructed and related, and how they fit into the pattern of use of the system - files which are linked together are shown, and specific linking data items identified.

A significant requirement for the projected ARC system, was the need for a link from fieldwork to the museum systems. The paper by Brisbane and Thomson (1980) also outlines the need for this, and Stewart (1980a) outlines in depth the problems and possible solutions. In particular, Stewart examines numbering and marking systems for archaeological finds and museum items, and the reasons why they tend to differ; the specific practice with bone, flint, pottery and excavation records are reviewed. Users needs, costs and classification schemes are examined. Areas which must be addressed in order for a solution to be formulated are identified as numbering systems, data standards, archival policy, and the physical transition of finds and documents.

Finally Booth (1978) has briefly described the necessary links between the different elements within an archaeological record system.

5.3.2 Procedures

It was planned that the projected ARC record system should be governed by procedures, which would define how the records should be formed and used. For instance there would be procedures to outline the process of data input, and the various checking processes which needed to be undertaken to ensure that the data was error free to the required level. These were an important part of the system, which in many ways complement the logical links between the data items.

Jefferies (1977) describes the processing of records from data capture in the field, checking, xerox copying, and transfer to paper tape. They are then read via a tape reader or teletype, and transmitted to a computer file in batches of 100 records via the telephone network. After editing, catalogues and indexes are produced in printout form, and there was also the potential to produce microform, or catalogue and indexes in magnetic format. These textual records are complimented by graphic data that is not computerised. Early discussion with the museum where the archive is to be deposited is recommended. By having all data computerised, output in various forms is readily achievable. These ideas were further developed by Benson and Jefferies (1980), when the system had migrated from the "time-sharing" use of a mainframe computer in the United States to a conveniently located microcomputer. It is an underlying principle of their approach that data should not be coded, and that (despite the convenience of having the data available on a microcomputer) that the system should not cater for the on-line exploitation of the data; rather it should facilitate the production of printed catalogues and indexes. The range of desirable outputs is described. Chenhall (1981) is not so precise about the preferred order of events and the specific outputs which are required at different stages, but he looks at how different files will be related and used at different stages of archaeological activity.

The major source for the overall processing of museum records, which serves both as a guide to professional good practice, and a source for other references is *Practical Museum Documentation* (MDA 1981). It describes the features of a documentation system, including initial documentation, acquisition, permanent documentation, numbering, and exit of objects. Such a documentation system should support records for five different types of item, identified as objects, localities, bibliographic items, biographic, and events. Each will have differently structured records, and different procedural controls. In particular it describes the procedures which are necessary to ensure that good documentation procedures are followed. The MDA system is further extended with a set of forms for excavation data (MDA 1980c); these prototypes aimed at providing a system to aid in the writing up of excavations, combining these benefits with a means of fully integrating the excavation archive with the other elements of museum documentation. It was also suggested that these might be used in the field. As well as setting out a proposed set of forms (Site Summary, Stratigraphic Unit, Object Record and Finds Analysis) this subset of the museum documentation system also sets out conventions for the completion of these forms. Some of the issues involving the integration of field data with museum systems are reviewed by Capstick (1980). Booth (1983c) identifies the main concerns as being the need to produce a catalogue and indexes, and the requirement to rapidly assimilate into the museum system the large number of artifacts, samples and records which would result from a single excavation.

5.3.3 Data standard

In developing their data standard (MDA 1980a) the MDA has produced a comprehensive formal description of the data which is likely to be encountered in a museum. Its potential application to archaeology was noted by Wilcock as a framework for all conceivable archaeological data (Wilcock 1981a, and earlier papers); with its specialist sub-sets for objects, localities, events, biographies and bibliographic references. There do not appear to be any serious alternatives to the MDA data standard, and its use as a fundamental basis of archaeological recording is also recommended by Jefferies (1977). Because the MDA data standard provided a comprehensive data standard, which had been demonstrated as applicable to archaeology, and because there did not seem to be any alternatives, this would, if possible, form the underlying structure for the proposed ARC system.

5.3.4 Terminology control

Whilst considerable work had been done on data standards (see 5.3.3 above), at the time when the literature review was conducted there had been no comparable work on terminology control by the MDA; the policy had rather been that it is up to individual groups to define terminology standards within their disciplines (MDA 1980a, p. 63). Models which could be of use were identified as Chenhall's Nomenclature (1978, discussed by Crowther 1981), or SHIC (SHIC Working Party 1983). There were also the specialist maritime and archaeological schemes (eg McGrail 1985).

5.3.5 Numbering and location recording

Practical Museum Documentation (MDA 1981) advises that the system for numbering should be as simple as possible, aimed at identifying the object, and yet containing as little information about the object as possible. However the examples given appear somewhat bewildering in their range and complexity. Jefferies (1977) proposes that the numbering system should contain no information about the object, and explains that this is because of the problems caused when the object is reclassified, and then requires renumbering. The system used by the Central Excavation Unit (Jefferies 1977) gives each site a number, and within that site numbers for contexts start at 1. Therefore for a context the site number and the context number have to be combined to uniquely identify the context. This was felt to be more "user friendly" than allocating a single series of numbers to contexts from several sites.

However, for objects blocks of numbers issued by the Ancient Monuments Laboratory were used. Most other systems seem to assume numbering, and advise that everything should be given a number, but they do not suggest what form it should take (for instance see Schofield 1980). The numbering system is essential for locating any particular object within the collections, and is thus clearly an important element of museum records. However, because insufficient detail was provided in the published guidelines, the format for this data item would have to be developed by the Museum.

5.3.6 Recording media

The MDA provides a variety of recording media for different types of museum object, but advises that where these are not suitable, a record sheet or card conforming to the data standard should be devised (MDA 1981). Although there is an extension of this system for archaeological fieldwork (MDA 1980c), this field aspect had not been extensively tested at the time when the ARC system was being designed.

The published sources describe two major strands in the development of excavation recording media in Britain; that of the Central Excavation Unit (Jefferies 1977), and the system developed by the Department of Urban Archaeology at the Museum of London (Schofield 1980, Boddington 1978). Both were widely used, as they provided a comprehensive range of facilities, which could easily be adapted to specific circumstances. The strengths of the Central Excavation Unit system were more directed towards rural excavation, and had computerisation as an integral part; those of the Department of Urban Archaeology had specifically developed aspects for urban situations. Another system which was felt to be possibly of relevance was that developed by Pryor (1978) at Fengate. The system specifically for computer input developed for Mucking Post-excavation (Catton *et al* 1981) was also of interest.

5.3.7 Computer software

One of the areas which has received most attention is software. Whilst it was possible for James (1979, 1980) to recommend the adoption of "standard software" this was not at all easy in 1980, when there were few commercially produced database management systems for microcomputers, and what packages were available (for instance Superfile and dBase II) appeared unable to support the required record structures. Chapter 6 discusses in detail developments in computing at this time. The limitations of the programming languages available then were also evident; Graham (1980b) felt it necessary to use assembler, and Haigh (1980) also recommends its use in view of the problems with BASIC. As Haigh also points out, even by developing software in a suitable language, it would be difficult to support the whole of the MDA Data Standard on a microcomputer, should this be thought to be desirable.

1	Independence of program from data format, which would be contained in a subsidiary file
2	Flexibility in the data which may be stored
3	Input possible from a variety of devices
4	Data validation at input
5	New files to be built, and existing files to be edited by amending, inserting and deleting data
6	Search, retrieval and indexing of data
7	Report generation to allow analysis, pagination and headings
8	Files should be robust to avoid accidental corruption
9	Password protection
10	Control language should be easy to use

Figure 16: Desirable features of database management software (after Cutbill 1974)

A definition of the necessary features of a database management system was provided by Cutbill (1974). Whilst Cutbill's paper was several years old, it was felt to have much to offer in terms of helping us to select or develop software for the ARC system. It is summarised in Figure 16. A similar set of desirable features are itemised by Kromholz (1975), who describes a system originally designed for social services data, but which could equally well be applied to archaeological requirements.

Available systems at this time include the microcomputer successor (Benson and Jefferies 1980) to the mainframe system devised by Jefferies (1977). It was a batch system, stressing the output of sorted catalogues and indexes, and had specific facilities for stratigraphic and structural analysis, and for finds analysis. On-line retrieval was not provided as it was not felt to be cost-effective. In much the same way the GOS package (MDA 1980a, Porter 1981) had very powerful facilities (as recommended by Cutbill, above), but lacked on-line retrieval or editing. This absence of on-line facilities betrayed the mainframe background to the development of these packages. A feature of both these systems was that they did not constrain the users in the data which may be stored, or the manipulations performed on it.

Johnson (1980a) also saw the need for the software not to constrain the user, and suggests that some data may be stored off-line on tape, with appropriate elements being down-loaded for analysis. The emphasis should be on "data management" rather than "number crunching".

Many of these facilities were also available in the system described by Booth (1980, and Booth *et al* 1984), although the lack of an effective means of sorting and indexing of data (due mainly to the limitations of the floppy disk drives of the Apple II) was a serious problem; this was recognised in a further paper which scanned the processes required during the life of archaeological data (Booth 1983a).

The system in use for post-excavation processing of data from Mucking (Catton *et al* 1982) was mainly aimed at data entry; it allowed the user to navigate through a series of related questions about a data item, and avoided the need for an answer to be given to questions not relevant to the item being described. This process was controlled by a "question sourcefile", a text file which is interpreted by the program.

The system proposed by Flude (1980a, 1980b) for the Museum of London Department of Urban Archaeology appeared to be potentially relevant to the ARC system, particularly as it was integrated with an already established excavation recording system (Schofield 1980). However, at the time when the ARC system was being planned Flude's system for the Billingsgate excavations (Flude 1983b) was not sufficiently well developed to be adopted in its entirety.

Whilst the published sources proved to be well stocked with proposals for systems, and definitions of requirements, the number of fully operational software packages was small. Commercially available software (despite the advantages of professional maintenance, cost-effectiveness etc.) appeared unlikely to approach the requirement, and there were few actually working archaeological examples which could be transported to new environments. It seemed that if an already existing system was to be used, the choice was between the Central Excavation Unit system, the Mucking post excavation system, or the Maxey system, all of which had identifiable deficiencies.

5.3.8 Computer hardware

The hardware which was available during the planning stage for the ARC system is discussed fully in Chapter 6, below. Apple and Commodore had a strong presence in the business world, and these manufacturers had also found some adherents in the archaeological community (for Apple see Booth *et al* 1984, for Commodore see Laflin 1980b). With inbuilt operating systems and BASIC interpreters, and a small but growing range of software, they were able to provide computing for those who were not enthusiasts. However whilst these machines were widely used, and had advantages of economy. and apparent user friendliness, they did not find favour with serious "scientific" users (see James 1980), and with the archaeological community at large, as their lack of standardisation, and limited expansibility was felt to be unsatisfactory.

The recommendations formalised in Stewart 1980b, reiterating those of Graham in the same volume, were to use microcomputers based on the Z80 processor, using the CP/M operating system, preferably programmed in a high level language other than BASIC. Successful systems using this technology were already in use by the Central Excavation Unit (Benson and Jefferies 1980), at Bradford (Haigh 1980), and for Mucking Post Excavation (Catton *et al* 1982). Eight inch disks employing a standard format were recommended, although the industry was already showing a preference for the more conveniently housed 5.25 inch disks, in various non-standard formats.

From an ergonomic point of view the recommendations in Johnson (1980b) are for systems which have sufficiently robust casings and keyboards, and have a purpose-built monitor (rather than an adapted television set). The advantages of having a keyboard separate to the monitor were not recognised at this time.

5.3.9 The field system

The facilities which were identified as being necessary to extend the projected system in the ARC to incorporate archaeological fieldwork, are described in Section 3.8, above. The primary need was for it to be possible to operate a microcomputer (or terminal) with facilities for data capture, editing and simple output at the excavation headquarters (eg Jefferies 1977), or (not essential) in the hut adjacent to the site. A second requirement was to be able to take advantage of the potential benefits of taking a computer (or terminal) actually onto the excavation to facilitate data capture. There were some doubts about the practicality of using computers on the excavation, but Styles (1980) had described a system for biological records which was a possible model. The field system would have to be well integrated with the overall system for ARC records.

The needs of "on-site" computing were recognised by Gaines (1981b and earlier papers), Brown and Werner (1974), Graham (1976), Wilcock (1978), Jefferies (1977, and Benson and Jefferies 1980), Johnson (1979), Hathaway (1980), and Brown (*et al* 1981). The requirement is broadly similar to the overall needs for processing archaeological data, except that in recognition of the limitations of local microcomputers the analyses required in the field are correspondingly scaled down. Whilst Graham (1976), and Gaines (1971b) looked to communications with remote mainframe facilities via the telephone system, by 1980 opinion was firmly in favour of using microcomputers rather than links to remote facilities, and it seemed likely that the ARC would wish to follow the microcomputer route also.

There was some scepticism about whether it was practical to have computerised data capture in the field, as sufficiently portable and robust hardware was not easily available. An alternative method of input which would need to be investigated was optical mark recognition. This method involves the use of a highly structured form, on which the recorder chooses from a range of options. The form is then scanned, and the position of the recorder's marks would be interpreted to mean different values. Text would at this stage have had to be entered in the conventional way. This system was not widely used in archaeology, although Nagle and Wilcox (1982) had done some experimental work.

6 CONTEMPORARY DEVELOPMENTS IN MICROCOMPUTING

6.1 Introduction

The authors own positive experience at Maxey (Booth *et al* 1984), coupled with the conclusions to emerge from the processing of a trial batch of records through the Museum's information systems (Chapter 4, above), suggested that a local microcomputer facility was likely to be required as an integral part of the ARC record system. It was therefore felt to be desirable to survey the facilities which were then available on microcomputers.

It is generally accepted that the specification of computing facilities should start with the application, and then move to application software, operating system, and finally hardware, thus allowing the use to which the system is put to dictate the type of facilities which are obtained. Accordingly this chapter starts by characterising the types of application which the ARC record system would require, and then examines the application software, operating systems and hardware which were available at the time when the system was being developed.

This chapter reviews the microcomputer based facilities which were available at the start of the planning for the new system in 1980, and over the period until early in 1982 when a firm decision was taken on the technological approach to be adopted. It also reviews developments when the system had come into use over the period 1982 to 1984.

6.2 The application

The requirements for the proposed ARC record system are broadly defined in Chapter 3. In the first instance there was the need to produce an indexed catalogue of ARC holdings. In the longer term this would need to be supplemented by specific analyses, both related to the requirements of archaeological fieldwork, and to the requirements for the specific analysis of boat finds. There are thus two application areas. The first may be characterised as a general "database" application (Date 1981), allowing data to be entered, stored, reordered, and output in response to specific queries. It was felt that it could be possible for this first requirement to be met from available commercial software. The second requirement is specifically archaeological, and part of it is further specific to boat finds. Developments in archaeological software have been reviewed in Chapter 5, above.

6.3 Application software

In 1980 there were BASIC interpreters available for most microcomputers, some BASIC compilers, and the promise of other languages such as Pascal. Most microcomputers were supplied by their manufacturers with an idiosyncratic "dialect" of interpreted BASIC. Microsoft BASIC was emerging as a standard for computers using the CP/M operating system, with CBASIC from Digital Research a popular alternative. Both of these had compilers (Lewis 1984a).

The available applications software at the start of the project was however extremely limited. In its first 'Software Buyers Guide' (McDonald 1980a), *Practical Computing* listed 37 packages, of which 34 were confined to specific business applications such as stock control, invoicing and payroll. The remaining three products (eg Commodore Business Machines "Business Information System") were for general purpose information handling, allowing the user to define the categories of data to be stored, and the outputs to be generated. Although there were few programs in this "general purpose" category there was obvious interest in such products, and *Personal Computer World* (PCW) Magazine was able to review several later in the year (Knight 1980). Whilst this review examined the facilities offered, and the equipment necessary to run the packages, it made no mention of the relative capacities of these systems, in terms of field lengths, record size, and number of records permitted in the database. However, subsequent listings in *Practical Computing* (McDonald 1980b, McDonald

1981) show that the number of available products for records management had risen to 25. Typically these were limited to the maximum number of records which could be accommodated on a floppy disk - approximately 1000 in most cases. Where the software package was able to run on a hard disk the limit was usually the operating system file size limit - for CP/M this was 8Mb. There was no mention of the size of record which may be accommodated.

The situation at the start of the design phase of the project was therefore that there were a growing number of "database" products, but the majority of these appeared to be unsuitable for the 12,000 or so records which we would need to store. A further consideration was that at such an early stage it was not possible to see which database packages would be successful enough for them to be supported for any length of time by their manufacturers, and furthermore how much support would be available anyway. This early period in the development of microcomputer software was characterised by there being many products, most of which were shortlived.

By early 1982 much of the design work for the system was at an advanced stage, and the trial batch of data had been processed by Petrel (Chapter 4). There had been a rapid rise in the number of software packages since the early days of 1980, so much so that by January 1982 Personal Computer World was starting a series of articles on microcomputer databases. The first of these, the paper by Antill (1982) attempts some definitions, including the important differentiation between the simple facilities offered by a "file handling" package, and the whole range of features which could be expected from "database management" software. It was at this point (early 1982) that the project would have to commit itself to software procurement or development, and a further examination of the available products was undertaken. Although 16 Bit microcomputers were then available, there was as yet no software which specifically took advantage of these products, and our main interest was therefore in the products available for 8 bit machines. Two database management packages in particular were examined; dBase II (produced by an American Company, Ashton Tate), which was beginning to show signs of becoming a market leader, and had some following in archaeology (Wood 1982); and Superfile, a British made product from Southdata, which promised the flexibility which we had identified as being necessary (Bidmead 1982d).

Developed in the late 1970s, Vulcan was a package designed for rocket experimentation; an improved and repackaged version was launched with great publicity in 1981 as dBase II. It provided a programming environment which allowed the user to manipulate files of up to 65,535 records. Each record could contain a maximum of 32 fields of up to 256 characters, and there was a limit of a maximum 1000 characters per record. The same field could not be repeated within a record. Records and fields were of fixed length, and occupied the same space on disk whether the record was empty or full of data. Indexing of the file on multiple keys was available. Links between two files were possible, and this was seen as a means of providing, via a relational structure (Date 1981), a means of overcoming limitations of record size and the lack of repeated fields within a record. Whilst Dbase II showed signs of becoming a mature and effective package the limitation on the number of fields within a record, and of record length and complexity, made it unsuitable for the ARC requirements.

The philosophy behind Superfile was entirely different; it stored data as "lightly encrypted text", with few absolute limitations on record size and structure. A record could contain up to 256 different types of field, which could be repeated as often as required up to a maximum 20,000 characters record size. Language interfaces were available to allow the user to write input and output routines to take advantage of these facilities. However, the programs which were provided with Superfile (Superforms for input, editing, and on-screen retrieval, and

Supertab for printed output) did enforce certain limitations. Without writing special software to make use of the language interfaces the effective maximum record size was what could be contained in one screen of 80 by 22 characters, and the maximum field length was 77 characters. Facilities for printed output through Supertab were similarly limited. It was concluded therefore, that without making use of the language interfaces, the facilities provided by Superfile were not sufficient to support the record structure which the ARC required.

During the course of developing the ARC system, there were substantial changes in the prevalent microcomputing environment, and in the software which would run on it. Many of the earlier databases (such as Superfile) developed 16 Bit versions, and in particular versions to run under MS-DOS on the IBM PC family of microcomputers. In rejecting dBase II and Superfile the major consideration had been the type of record which could be conveniently supported by the package. The majority of those systems which became available over the period of 1982-4 remained subject to this criticism. However, one product emerged towards the end of 1984, and showed the promise of having the capabilities which were required. dBase III offered a record size of up to 4,000 characters, with up to 128 fields of data per record. Additional memo fields (for free text), of up to 4,000 characters were also permitted, although in this first release they were poorly supported. Up to ten files could be open at once, permitting effective "relational" operation. Viewed towards the end of the development of the ARC system, dBase III had the promise of providing the required facilities for future archaeological and museum systems (Lang 1984, Bidmead 1984c).

6.4 Operating systems

During the period of system development the choice for microcomputers was between the proprietary operating systems which were available on the 6502 family of microcomputers (such as the PET, Apple and BBC), and CP/M, which was widely used on the Z80 based machines. Whilst the proprietary systems were easier to use, the major advantages of CP/M were that it was supported on a wide range of microcomputers, there was a large quantity of software available for it, and its features were more accessible to programmers (Lewis 1984b).

The arrival of the 16 Bit microcomputers lead to the development of a 16 Bit version of CP/M named CP/M-86 (Lewis 1984b), and the now ubiquitous MS-DOS (Bidmead 1984b). Neither of these were in widespread use at the time when we were developing our systems, although with the partnership between MS-DOS and the IBM PC firmly established there were signs that in the longer term MS-DOS could become the standard for single user microcomputers.

The provision of multi-user facilities was provided within the 8 Bit environment by multi-user variants of operating systems such as MP/M (a derivative of CP/M), and proprietary operating systems such as Cromix (a Unix lookalike from Cromemco). IBM announced in January 1984 that Unix (in the form of Xenix) would be supported on its PC range of microcomputers (Bidmead 1984a). Whilst these provided multi-user (and multi-tasking) facilities on relatively standard hardware there were also several individual systems which were able to offer multi-user facilities, with proprietary software which appeared to the user very much like CP/M. One example of this was the North Star Dimension; effectively several computers in the same cabinet sharing disk drives, and using Turbo Dos.

For those who could afford it there was the possibility of adding larger than 64K memory to Z80 based systems by the use of "bank-switching", a means of switching between alternate segments of memory, although the maximum to be addressed at once could not be over 64K. By using this technique such operating systems as Cromix were able to allow multi-user working, or the running of large and complicated programs such as GOS (MDA 1980b). With the arrival of 16 Bit processors (principally based on the Intel 8086/8, and Motorola 68000 families) larger amounts of memory could be conveniently used, making way for such operating systems as Unix to be available on microcomputers. A parallel development was the increase in disk size; this facilitated larger databases, and was in any case necessary for the many 16 Bit operating systems which required several megabytes of disk space.

Proprietary operating systems were supplied with such 6502 based microcomputers as Apple, Commodore and BBC. If the ARC was to follow the 6502 route, the choice of hardware and operating system combined would determine the software we could use; although it was possible to purchase a card to enable CP/M to be used on the Apple II. For single user applications on Z80 based microcomputers CP/M appeared the obvious choice, being widely used, and having by far the largest volume of software available. MS-DOS appeared likely to be important in the future, but was only just available on the Sirius and IBM PC. For 8 Bit multi-user systems the choice was fairly limited; there was MP/M (the multi-user version of CP/M), and proprietary software such as Cromix from Cromemco. For 16 Bit microcomputers of the 8086 family there was Concurrent CP/M-86, and for the 68000 series Unix (and imitators such as Cromix).

6.5 Hardware

At the start of the period of system design the available hardware could be divided into two groups; those microcomputers based on the Z80 family of chips, and those based on the 6502 (such as Apple, PET, Atari and the BBC). In general the 6502 family offered a range of facilities peculiar to the particular machine, a unique hardware configuration and operating system, limited options for expansion, and relative ease of use. In contrast the Z80 family were generally physically based on the S100 bus, allowing a wide range of card based options to be added easily, and also allowing the possibility of upgrading should more memory or a different processor become available. Furthermore, the Z80 based systems generally employed the CP/M operating system, which in turn made a wide variety of software available. IBM had made an early foray into the microcomputer market, with the 5110. It was succeeded by the highly specified 5120, at a weight of 120lb, and cost of £8,500 (Horgan 1980). At double the price of their competitors neither of these were successful.

A glance through the 'Buyers guide' to hardware in the July 1982 issue of Practical Computing (Practical Computing 1982) shows 138 models of microcomputer being available from 85 manufacturers. Of these 82 were based on the Z-80 chip, and 17 on the 6502. There were 8 using the 6800 or 6809, and 28 using a variety including the 8080, and 8085. 16 bit microcomputers had just made their appearance, with two models employing the 8088, and one the 8086. Size of random access memory, and hard disk would be important, with perhaps a minimum configuration for our requirements of 64K RAM, and 5MB of hard disk.

Two new machines became available early in 1982; the Sirius (initially with the CP/M-86 operating system although MS-DOS became standard soon afterwards) followed shortly afterwards by the IBM PC with the MS-DOS operating system (Rodwell 1982, Bennett 1982, Tebbutt 1981). They employed the 8088 and 8086 chips respectively. At the time when hardware had to be acquired for the ARC, these two machines had been in use for so short a time that there was little software available, and there was some debate as to whether standards would develop along the S100 route, or via the proprietary hardware of Sirius or IBM. The choice was therefore between the 6502 family of processors, and the Z80.

With the benefit of hindsight we can see that the major developments for single-user microcomputers would be along the 8086 route with the IBM PC and AT using MS-DOS, and with the 68000 series of chips for multi-user computers using Unix. Multi user facilities were made available on the 8086 family either by using Xenix (a version of Unix from the Santa Cruse Operation (SCO) for the IBM PC family), or via networking. Before having fully effective multi-user operation, more powerful processors, and technological developments in networks were required.

6.6 Conclusions

The first important aspect to emerge from this survey of computing developments in the early 1980s was that there was no database software likely to be able to comfortably accommodate the records which the ARC intended to store, and it would therefore be necessary to consider an effective programming environment in which to develop software, and hardware and operating software to support it. The facilities provided under the CP/M operating system appeared to be best suited to our requirements. The requirement in general terms was therefore for a microcomputer using the Z80 chip, based on the S100 bus. Several were available with 64K RAM, and hard disks of varied sizes. The decision on the particular choice of hardware needed to take into account any potential benefits from compatibility with other microcomputer equipment in the NMM.

7 PLANNING FOR SYSTEM DEVELOPMENT

7.1 Introduction

This chapter outlines the approach which was adopted in developing the system for the ARC. Following chapters describe different aspects of this development.

In the first instance the system to be developed would have to be able to provide for immediate requirements. These had been identified as:

1 To enable objects and records to be easily located.

2 To provide a catalogue of records, and indexes to this catalogue.

3 To enable related records to be retrieved.

In the longer term it would be necessary to provide for the specific needs of excavation recording, archive and publication, and to facilitate research based searches across all records. It was felt desirable that wherever possible these facilities should be accommodated in the system architecture from the outset, rather than having to be added in later, when it would be necessary to change the structure of the data.

The development of the different facets of the system which are listed below is described in following chapters:

1 Procedures for the creation and use of the records.

2 Data structures for the computerised record

3 Terminology control

4 Numbering and location recording systems

5 Recording media (both paper records and computer input formats)

6 Computer hardware

7 Computer software

8 The system for field recording.

7.2 Scope of the system

The survey described in Chapter 3 had identified ten classes of items which could be included within the ARC record system. Photographic negatives and bibliographic records were already the subject of museum-wide initiatives, and it was therefore decided to delay any work on these. The effect of this decision was to place these records outside of the ARC system - they could be referred to, but were not part of it. The items to be included in the system would be:

1 Objects

2 Slides

3 Drawings (and other graphic material)

4 Information files

5 Samples

6 Conservation records

7 Radiocarbon dates

8 Contexts

It would however be necessary to make some provision for both bibliographic records and photographic negatives, as books, offprints and photocopies were physically located in the ARC, and there was extensive cross-referencing to photographic negatives.

7.3 Overall system architecture

For the eight classes of item within the system numerous links were identified between different types of record, and between records of the same type, and there was the possibility that the need for further links would be identified as the system developed. Similarly there was a requirement for several indexes for each type of record, and this might also be expected to grow as the system was used. The two classes of item outside the system would have cross-referencing from the system.

In the short term the requirement for a catalogue and indexes for each class of item could be met simply by constructing a computerised record format for each type of item, and ensuring that indexes were available for appropriate fields. Each class of item would also have an appropriate numbering system, and paper recording media where necessary. Where similar structures could be used for several types of item there would be economies in terms of development effort, and gains in consistency.

The potential extensive requirements for cross-referencing to facilitate the retrieval of related items of the same and different types, and for more complex research oriented enquiries, would however require a more complex data structure than a simple catalogue, with numerous links between records. The computerised system to support these records would have to make available all the required records at once. For instance, an enquiry might call for contexts from a particular excavation, with the artifacts and samples from those contexts, and any related drawings or slides.

Several possible strategies were available in order to take account of this long term requirement to answer queries across the whole range of records:

1 Initially to only build a system capable of providing the required catalogue and indexing. Links between records would be added later.

2 To design and implement a system from the outset which had all the necessary links, and which (as well as producing the required catalogue and indexes) would enable related records to be retrieved across all classes of item.

3 To build a catalogue system, but to include the necessary links between records, so that the fuller system could be implemented in the future.

In the first instance it was not possible to develop a system which would provide for the long term, complex retrieval requirements, as sufficient resources were not available, and in any case the requirement was not well enough defined. However, it would be desirable to include in the data structures for the catalogue and indexes the "hooks" which would enable links to be made between records at a later stage. Therefore it was decided that in addition to any immediate requirements for the catalogue and indexes, each record would have incorporated in its data structure:

1 The facility to cross-reference to any other record (or records) of any type.

2 For records where subject indexing was appropriate (for instance drawings or transparencies) full subject indexing would be available.

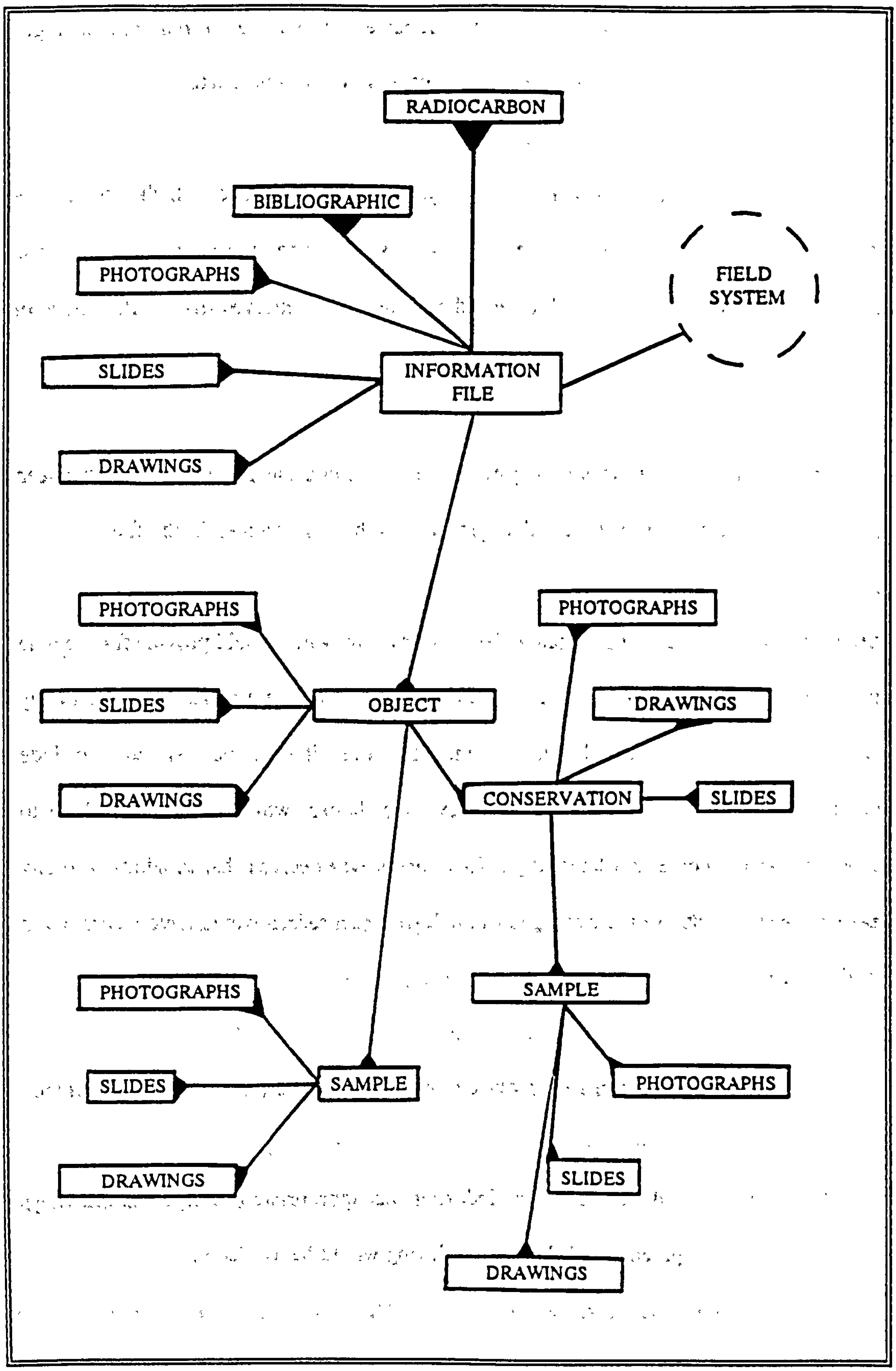


Figure 17: Diagram showing cross-reference links between records for overall system

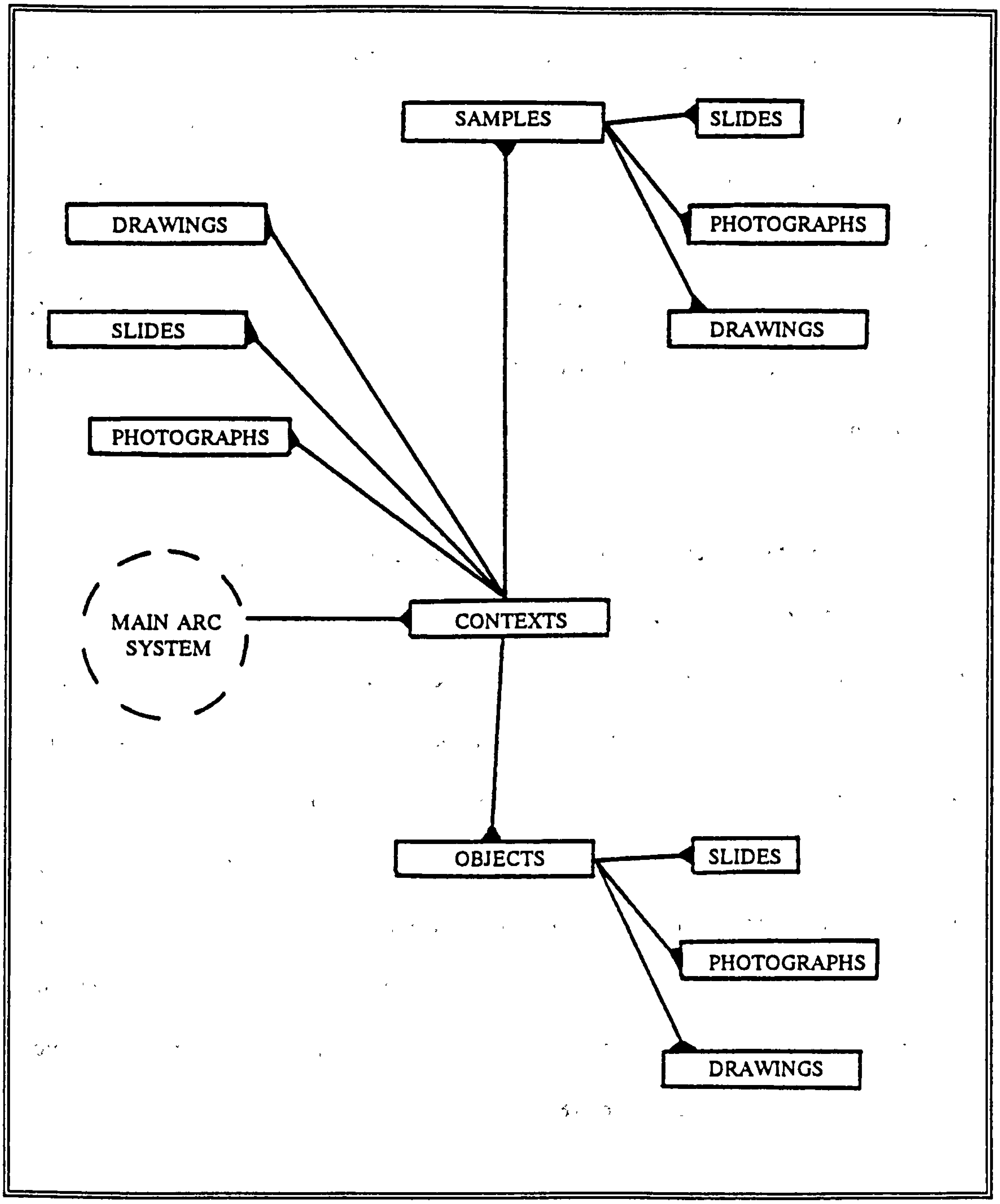


Figure 18: Diagram showing cross-referencing links between records in the field system

The initial survey had shown that most items would either be related to a particular object, or to an information file where a full description of the site or find would be contained. If from the outset full indexing of the object and information file records was possible, and all records were cross-referenced back to their object or information file, then much useful retrieval would be possible with little cost in terms of data compilation or software development. In addition to any other cross-referencing which might be desirable, the initial plan was therefore to have all items cross-referenced to the object or information file. The records for the object or information file would themselves be as full as possible, to facilitate retrieval on a variety of attributes. By using the full indexing on the object and information file, and the links to other records, all items would be readily retrievable in a variety of ways.

In its simplest form the selected form of architecture was to have a separate computerised catalogue, with indexes for each class of item supported by manual records as required. Each record within the catalogue would be cross-referenced to either an object or an information file record, to provide the necessary basic retrieval mechanisms. In addition fields would be available to permit the cross-referencing of the record to any other records, and for subject indexing where this was appropriate. Whilst the system would provide for cross-referencing between all types of record, the most likely requirements for cross-referencing had been identified during the survey carried out in Chapter 3 (Figure 17). For the field system the requirements for cross-referencing centred on the context record, with the information file acting as the overall site record (Figure 18).

7.4 Programme

Overall priorities for the development of the ARC system were outlined at the end of Chapter 3, with the first requirement being to establish the system for object records. An initial inspection of the data structures and related facilities required for the object record suggested that (with some extensions) it would also be able to accommodate the other classes of item. It was decided therefore to first develop the system for objects, and extend it as required for other classes of item.

8 DEVELOPMENT OF PROCEDURES

8.1 Introduction

The projected ARC record system was to consist of several elements, some manual, and some computerised. The creation of these records, and their subsequent use involved a number of related activities, all of which had to be closely co-ordinated. Guidelines needed to be provided to ensure that all necessary procedures were followed, and to set out what should be included in the records. This chapter describes these procedures for the documentation of objects, and for other items acquired or loaned to the Museum. These formed the basis of procedures for other classes of item. Subsequent chapters describe the development of individual elements of the ARC system, and the operation of the whole is described in Chapter 13. Detailed procedural guidelines for each class of item are described in the manuals in Appendix C. Procedures may be divided into three groups; those concerned with the arrival of an item in the Museum (or its creation if for instance it is a model made in the Museum's workshops), those concerned with the maintenance and use of the record concerning the item when it is in the Museum, and the exit of an item from the Museum. Figure 19 shows the categories of procedures within each of these groups.

The Museum already had well defined procedures for certain areas of curatorial activity, including the acquisition, loan in, and loan out of objects, and these formed the basis of practice within these areas. In addition to the NMM wide procedures for acquisitions and loans, there were also general guidelines for documentation which had been formulated by project Petrel - these needed to be tailored to ARC requirements. *Practical Museum Documentation* (MDA 1981) had been identified during the review of current work as a compendium of good practice over the whole field of museum documentation, and would be used to provide guidance where NMM practices had not been developed. Other sources were drawn upon for specific areas as necessary.

1	**ACQUISITION/LOAN OR CREATION**	
	1	Acquisition
	2	Loan in
	3	Numbering and labelling
	4	Storage
	5	Creation of information file
	6	Formation of paper record
	7	Input, checking and editing of computer record.
2	**COMPUTER RECORD**	
	8	Data storage
	9	Local data output and use
	10	Transfer to central systems
	11	Central output and use
	12	Dissemination and publication
3	**EXIT**	
	13	Loan out
	14	Disposal

Figure 19: Groupings of procedures

8.2 Procedures for acquisitions and loans-in

8.2.1 Introduction

The existing procedures for acquisition and borrowing were designed to record the process whereby the item came into the Museum's keeping. For an acquisition it was essential to record the previous owner, and to have evidence of the transfer of title to the Museum. For borrowed material the conditions and length of the loan had also be recorded, together with the value of the item. An agreed value was needed as the Museum would offer to indemnify an owner against loss or damage of objects loaned to the Museum. In addition the Museum was required to regularly report on the total value of the indemnities offered.

1	Custodian opens Museum file (Potential Acquisition - prefix V).
2	Head of Department obtains approval for purchase at appropriate level
3	On arrival custodian checks condition of object when it arrives
4	"V" File returned to Registry, for issue of "X" (Acquisition) File.
5	"X" File returned to Head of Department.
6	If a gift, the Head of Department drafts a letter of thanks, for signature by the Director.
7	Acquisition slip (Form NMM 35) completed in duplicate by Custodian, and returned to Registry with the "X" file.
8	Custodian documents and stores object

Figure 20: Summary of acquisition procedure

8.2.2 Acquisition

The procedures for the acquisition of objects to the collections of the NMM were set out in the permanent memoranda of the Museum (NMM 1976a). These had to be incorporated within the ARC procedures, with additional explanatory notes as required. As well as applying to conventional museum objects (such as artifacts recovered from an excavation), the acquisition procedures could also be applied to records (such as drawings, photographic prints, negatives, transparencies or notebooks) relating to fieldwork, or to items in the collections. Material disposed of after analysis (generally classified as samples) was not formally acquired in this way, although samples for destructive tests could be taken from items which had been acquired. The acquisition procedures are summarised in Figure 20. An example of the acquisition slip (Form NMM35) is at Figure 21. Although not explicitly stated in the acquisition procedure, it was important to obtain the signature of the donor, so that the Museum would be able to prove ownership of the item.

NATIONAL MARITIME MUSEUM	ACQUISITION No.
MASTER RECORD OF ACQUISITIONS	DATE OF ACQUISITION

DESCRIPTION OF OBJECT(S)

ACQUIRED FROM

ADDRESS

DEPARTMENT	DEPTL REF No.	NEGATIVE No.	FILE No.

HOW ACQUIRED	PRICE

REMARKS

Bas 74131/B113 10m 2/80 TP

FORM NMM 35 (REV)

Figure 21: Acquisition slip (Form NMM35)

8.2.3 Loans-in

The procedure for borrowing was similar to that for acquisitions, except that it was necessary to establish the value of the item (for the Museum's indemnity liability) and to exchange form NMM 2 with the owner, agreeing the duration of the loan, and establishing the conditions (standard or otherwise) attached to the loan. Previously some loans-in had been accepted for long periods, or without an agreed return date, or the loan was termed "permanent". These practices had been outlawed, and the maximum length of time for which a loan could be accepted was five years in the first instance. For a loan to be extended for a further period of up to five years the loan-in procedure had to be repeated as if for a new loan. The loan-in procedure is summarised in Figure 22.

1	Custodian opens Museum file (With prefix Y).
2	Head of Department sends potential lender a copy of form NMM2A, outlining the procedure and conditions for the loan.
3	Lender responds with conditions, length of loan, and value of item.
4	Head of Department completes and signs three copies of form NMM 2a. One is retained, and two sent to lender.
5	Lender signs both copies of Form NMM 2a, and returns one to Head of Department.
6	If the value of the loan is over £3,000 the Director and Deputy Director are informed.
7	Acquisition slip (Form NMM 35) is completed in duplicate by custodian, and sent to Registry with the "Y" file.
8	Custodian documents and stores object

Figure 22: Summary of loan-in procedure

8.3 Numbering and labelling

The assignment of numbers to items, and their labelling with these numbers, formed an essential part of the documentation procedures, as they served to identify the item, and link it to its records. In order to uniquely identify an item, it was given an "Item number". The development and form of this numbering system is described in Chapter 11. The item number was assigned as soon as the material entered the Museum, from the next available number in the register of item numbers.

If the item had been formally acquired or loaned to the Museum, it was also given an acquisition number, to link it to the process of acquisition or loan. Acquisition numbers followed the established practice in NMM, they are described in Chapter 11. The acquisition number was assigned from the next available number in the acquisition number register, as soon as the object or other item entered the Museum.

Once the item number, and acquisition number (if applicable) had been assigned the item was labelled. For objects and other classes of item which had been acquired by the Museum, and for items on loan, a clearly visible detachable number was attached. For items which had been acquired a permanent number was also applied. The development of guidelines for labelling is described in Chapter 11.

8.4 Storage

The requirements for the storage of items are defined in Section 3.7, above. In order to facilitate the retrieval of items, a numbering system for storage locations was required. The development of this system is described in Chapter 11, below. The general guidelines to emerge from the user requirement were that items relating to each other should be kept together, and to minimise storage space, items of similar size, dimension, and form should be kept together. For objects, samples, and items undergoing conservation, the eventual storage location was the concern of the responsible curator, scientist or conservator. Procedural guidelines had to be defined for the storage of records.

8.5 Creation of information file

The information file was a dossier containing details about a find, site or object; it was necessary for it to be comprehensively indexed to enable retrieval of the site or find by various criteria. The information file was both a type of item within the ARC record system, and a means of grouping related items together. As defined in the overall system architecture (section 7.3, above), it was a central element in the logical links between different types of record. Items in the ARC system were either related to an object in the Museum's collections, or to a particular site, find, or ethnographic boat type. Where there was not a detailed object record, then the information file record provided as full and comprehensive a record as possible, so as to avoid the need to record the site details with each item from the particular site. Where there was not already an information file one would be created, with appropriate paper and computer records.

8.6 Creation of paper records

The development of the various forms of paper record is described in Chapter 11, below. For all types of item except slides, it was necessary to complete a paper record. In certain cases this was necessary because the paper record acts as a supplement to the computer record, for instance where a signature, photograph and valuation were recorded on the object photo, muster and valuation card. The form was also used to collect data for subsequent computer input, and it could also have on it material such as sketches which it was impractical to store by computer. The forms were designed to enable the recording of a fairly full record. However, certain categories in the record were mandatory, so that as a minimum the item could be identified, located, and its provenance known. It was also necessary to record any necessary conservation action. Figure 23 lists the mandatory groups of data.

A form was used for data capture if it was not convenient to have the item adjacent to the computer for input, or if the information about the item needed to be gathered from several sources. The general approach adopted (as per Petrel) was for the curator responsible for the item to compile the record and perform data input; if it was desirable to have a form they would complete it, and then use this as an input document. If the intermediate paper record was not necessary then it could be omitted, and the data was entered directly at the keyboard. In general, large and complicated items (for instance objects) had a form; small simple items (for instance slides) were entered direct to the computer.

1	Identify the item (Number, any special name)
2	Document acquisition history (if acquired)
3	Document location
4	Condition/conservation requirements
5	Description (brief)
6	Cross reference (Information file mandatory)

Figure 23: Steps in completing record

8.7 Creation of the computer record

The final element in the procedures for a new item was the creation of the computer record, followed by checking and any necessary editing. Data was either entered directly at the keyboard (for instance when recording a slide), or from a previously completed paper record, using the MAXARC software. Once a batch of records had been entered they were printed out, proof read, and edited. Data about an item could enter the computer system in one of three ways:

1 By direct input at the keyboard

2 By input from a form

3 By direct transfer from the field system

Where data is received from the field the transfer would be automatic but it could be necessary to enhance the record by adding further information.

Both form, and data entry software, would act as an *aide mémoire* to the curator; the form has a series of boxes where data may be entered, the computer prompts the user with questions, which may be answered, or passed over. For most items it was possible to complete a very full record but this was not always necessary. The priorities when completing the record are summarised in Figure 23.

Printed output for checking in preparation for editing needed to be in two forms; a simple catalogue for proof reading, and indexes ("wordlists") of selected fields so that inconsistencies could be easily spotted. These could either be for a whole file of data, or for a range of records within a file. For instance, it could be convenient to print out all records input by a particular curator between a specific range of dates or item numbers.

Proof reading of the catalogue and checking indexes was necessary. The most efficient method was to read the checking indexes, and mark the catalogue with the corrections; all the corrections to a single record could then be made at one time. The catalogue itself was also proof read in the normal fashion, and any further corrections were recorded. Corrections which had been marked on the catalogue were then be made, either by editing individual records, or by using the facilities for automatic editing of the whole file or a range of records. When all edits had been made the catalogue and checking indexes was produced again (if required) and checking and editing repeated.

8.8 Data storage

This section describes how data was stored by the computer system, (data entry having been described in section 8.7 above), and the methods used to prevent its loss by program, user or hardware error; or through damage to the computing facility by fire or flood. Data recovery from backup and archive storage is also described.

When data was entered it was stored by the MAXARC software in random access records on the "hard" (Winchester) disk of the Cromemco CS-1H microcomputer. This was achieved automatically when the user was satisfied that a record is correct. Once so stored the record is "date stamped" with the date entered, and the identity of the user who entered it. Subsequent alterations to the record can only be made by the person who originally entered it, or by the user designated "file manager". These random access files had the advantage of quick access to data for viewing or editing, but required larger quantities of disk space than sequentially stored records, as each record occupied the same predetermined space, whether it was empty, contained little data, or contained the maximum volume of data possible. In order to document activities on the file a log file was automatically kept by the software, detailing the activity performed, the user, the date and the records affected.

Backup of data was required to guard against accidental erasure or alteration of the data, and software or hardware errors. Whilst backup to a second file on hard disk would have been sufficient to guard against mistaken alteration or erasure, disk space, and the need to also guard against disk failure meant that it was necessary to copy data to floppy disks. In order to accomplish this the MAXARC facility for producing sequential files was used. This facility read data from the random access file used generally by MAXARC for data storage, to a sequential file. The sequential file occupied less space as records consisted only of fields which have data, and tags to identify those fields, and there was no padding to make the record up to a standard length. This was a compact method of data storage, significantly reducing the amount of disk storage required for backups. Three copies of such data were produced, in rotation at monthly intervals. In order to guard against natural disaster such as fire or flood, one copy (in rotation) was kept at another site.

In the event of a disaster data could be read back from the most recent backup (or from the most recent intact backup if the most recent backup had become damaged). By using the printout of the log (regularly produced) it would be possible to see which records had been altered since the last backup, and to re-enter or edit them as required.

Because of the hard disk size limitation of 5 megabytes, it was not possible to keep all data on-line at once; to make extra space files which were rarely consulted or edited could either be kept in compact form on the hard disk (requiring unpacking before use), or be kept on floppy disk (requiring transfer from floppy disk and unpacking before use).

8.9 Local data output and use

Local data usage consisted either of the *ad-hoc* retrieval of a specific record or records, either in printed form, or on the screen, or the production of printed catalogues, either routinely, or in response to a specific request.

In order to anticipate routine enquiries of the data certain catalogues were regularly produced. These would typically be available for all items of a particular type, or divided up by the person responsible for the item. A complete catalogue including all data fields was printed out indexed by item number. For routine collections management activities the following indexes to the objects catalogue were produced:

1 Acquisition number
2 Donors name

3 Storage location

4 Type of item

5 Information file

6 Curator responsible for item

7 Date of renewal (for loans)

Ad-hoc printout was required either as a means of easily reproducing part of one of the catalogues itemised above, or in order to answer an enquiry could not be answered by the catalogue and the routinely produced indexes. In some cases it was only necessary to view a particular record on the screen. Experience showed that *ad-hoc* printouts were most often required for items from a particular site (retrieved by information file number), items at a particular storage location, or items loaned or donated by a particular donor.

8.10 Transfer to central systems and use centrally

For more complex catalogue and index generation, and for integration with other Petrel data, records could be transferred to the central information retrieval facility. The process involved the extraction of data from the MAXARC database, adding of tags so the data was ready for processing via the build program into a GOS file, and the physical transfer of the data, on floppy disk. It was convenient to do this with volumes of data which fit easily on a floppy disk. The planned frequency of transfer varied for different item types, depending on the increase in numbers of a particular type of item, or the frequency of changes to data.

Central use of the data within the Petrel system had two purposes:

1 Collections management activities which needed to be carried out from an overall Museum perspective, where it was felt to be more cost effective and thorough to compile information centrally. These included stocktaking, loans

management, indemnity reporting.

2 Public uses of the data for research and education, where it was felt to be desirable to be able to provide information from across all the Museum's collections.

For the collections management tasks similar indexes were needed to those kept and maintained locally. Examples include the location of items, donors' and lenders' names, indexes to indicate when loans need to be renewed, and statistics of the value of loaned in items for which NMM is responsible. Details of the condition of the item could also be required for central conservation monitoring. At this level it is necessary to know what the item is, where it came from, where it is kept, and what condition it is in.

For public use of the data the information which was required was concerned with the type of object, its provenance, use, and relationships to other items. This is different to the collections management requirement, and might also include other types of record in addition to the object records. A range of different enquiries could be anticipated, from the general public enquirer with a broad query about a type of craft, geographical area or period, to the scholar with a very specific and detailed query. Information file records were anticipated to be one type which would be required, with pointers to other types of records.

Transfer of data to the central facility for collections management purposes was likely in the first instance to be limited to records for objects, rather than for other types of item, and only a limited subset of the data might be required. For public enquiries a different subset of the object record was required, and the information file records were also needed, together with cross-referencing to other sources of data. It was uncertain whether these two quite different requirements could be satisfied by a single regular transfer of data, or whether different subsets of data would need to be transferred at different frequencies. Although it was intended that this transfer should take place regularly, no data was transferred to Petrel. The design of the formats for the transfer to Petrel is outlined in Section 9.7, and the potential of this (unused) facility is further discussed in Section 14.6.

8.11 Dissemination and publication

There were two routes whereby data could be disseminated, and formally published; either from the local ARC facility, or from the central Petrel databanks. The local facility allowed selected records to be output to a file for further editing (if required), for subsequent transfer to the publisher, either in paper form or on floppy disk. This method was used for the production of the "A Handlist of Maritime Radiocarbon Dates" (Booth 1984b). Use of the central facility was anticipated when more sophisticated facilities were required (for instance the production of computer generated microfiche) or when the publication would draw on data from a number of departments. Either means allowed the database to be used to quickly compile an ordered catalogue, with indexes as required, which may then be further edited (either with a word processor or programmable editor), and then output to the appropriate medium.

8.12 Loan-out and disposal

During the period of the development of the ARC system only a single item was on loan to another institution, and no items were disposed of. Because of the infrequency of these events, it was therefore felt not to be worthwhile to develop comprehensive procedures for the ARC. The ARC would in any case follow established NMM procedures for loans out, and ARC records would be amended to show the location outside of the Museum. The NMM procedures for loan-out are summarised in Figure 24.

Loans Out Action

National Maritime Museum

Initial procedure

Registry

- Send ephemeral file to Curator and Loans Officer ☐

Curator

EITHER

- Proceed - advise applicant of available material and ask for a formal request ☐

OR

- Do not proceed - notify applicant ☐

Signature	Date

Loans Officer

- Request received - acknowledge and forward *Environment Check List* and *Conditions for Loans*
- Put on Director's Loans Committee agenda

Signature	Date

Curator

- Arrange for condition report
- Complete *NMM 1 Recommendation* section 1

Signature	Date

Conservator

- Condition report
- Complete *NMM 1 Recommendation* section 2

Signature	Date

Loans Officer

- Director's Loans Committee

EITHER

- Approved - proceed ☐

OR

- Not approved - notify applicant ☐

Signature	Date

Loan arrangement

Loans Officer

- Complete *NMM 1 Recommendation* sections 3 and 4
- Convert ephemeral to Z file
- Forward *Loan Agreement*

Signature	Date

Security Officer

- Consult National Security Advisor
- Complete *NMM 1 Recommendation* section 5

Signature	Date

Curator

- Send Conservation work request

EITHER

- Send Neg. Nos. to Loans Officer ☐

OR

- Request Photography ☐
- Send catalogue/technical details to Loans Officer

Signature	Date

Loans Officer

- *Loan agreement* returned
- Arrange transport, packing, escort, customs
- Check insurance/indemnity
- Security clearance received
- Trustees' Loans Committee

EITHER

- Approved - proceed ☐

OR

- Not approved - notify applicant ☐
- Complete *NMM 1 Recommendation* section 6

Signature	Date

Dispatch

Loans Officer

- Dispatch loan and send *Receipt* to borrower
- Start *Loans Out Index* card
- *Receipt* returned
- Reclaim costs
- Send file to HOD and Registry

Signature	Date

Revaluation/Extension

Loans Officer

- Send file to HOD
- Revalued - send *Revaluation/Extension* form to borrower
- Extension recommended - arrange inspection or condition report
- Director's Loans Committee agenda

EITHER

- Approved - send *Revaluation/Extension* form to borrower ☐

OR

- Not approved - notify borrower ☐
- Form returned - amend *Loans Out Index* card

Signature	Date

Return

Loans Officer

- Arrange transport, packing, escort, customs
- Loan returned - ask Curator and Conservation to check condition

Signature	Date

Curator

EITHER

- Loan received in good condition ☐

OR

- Condition unsatisfactory - Loans Officer notified ☐

Signature	Date

Loans Officer

- To borrower - acknowledge receipt and termination of *Loan Agreement*
- Reclaim costs
- Amend *Loans Out Index* card
- Send file to Registry

Signature	Date

Notes

NMM 1C 1984

Figure 24: Loan out procedure

9 DATA STRUCTURE FOR RECORDS

9.1 Introduction

In designing the ARC record system it was necessary to provide links between records of different types within the system, to link records to records elsewhere in the NMM, and to also provide links to the outside world. As has been discussed in the overall system architecture (Chapter 7), there should be specific links from all types of record to either object or information file records, with the possibility of more general cross referencing between records. It was felt that this could best be achieved by having a consistent overall structure for all records in the ARC system, or "data standard", which could be adapted for individual item types. Three aspects of the overall record structure would need defining; the data definition language (defining the syntax for the composition of records); the data standard (defining the structure of the record in terms of data categories and the relationships between data categories); and standards and conventions for the data itself (defining the data which may be contained within the data categories). For each class of item there needed to be a record structure conforming to the data standard, and a computer format for input to the MAXARC software package (Chapter 11).

The need to conform to overall NMM procedures, and the advantages and disadvantages of Petrel are discussed in Chapter 4. In order to make use of the powerful cataloguing facilities available with Petrel, and to ensure that records conformed to the NMM and MDA data standards, a decision was taken to base the ARC record structure on the NMM data standard, which is based on that of the MDA; the ARC data standard would be a subset of the NMM standard, with extensions as required. It was therefore necessary to formally establish the relationship between the NMM and MDA data standards, so as to guarantee the foundation provided by the NMM standard. The MDA and NMM data standards are reviewed here as they form the foundation for the ARC work; the section below describes how the NMM data standard is related to that produced by the MDA, the relationship of the ARC data standard to the NMM data standard is then described, and the structuring of the record for each type of item. Terminology control is discussed in Chapter 10.

9.2 Data definition language

As has been outlined above, the data definition language is the syntax which governs the composition of the records defined by the data standard. This section describes the MDA data definition language, and the NMM variant. There was a published definition of the MDA data standard (MDA 1980a), and the NMM variant had been defined in *Manual 12* (NMM 1979c). The NMM data definition language was almost identical to its MDA precursor, except that the "Role" component was termed "Context", the "Note" component was termed "Detail", and the components had to occur in a particular order. Figure 25 describes the basic components of the data definition language.

STATEMENT	a group of information
Containing:	
ROLE/CONTEXT	the role of the statement within which it occurs
TEXT	an item of primary information, worthy of indexing and retrieval
NOTE/DETAIL	an item of secondary information, not worthy of indexing or retrieval.
XREF	a cross reference to one or more other statements.
or STATEMENT	Another statement
	(NMM term follows if different to MDA term)

Figure 25: The MDA/NMM data definition language

The rules governing the use of the NMM data definition language required that each statement must contain the following components:

ROLE	one
TEXT	zero or more
STATEMENT	zero or more
XREF	zero or more
NOTE	zero or more

The MDA data definition language required that the components should occur in the following order:

ROLE

NOTE

TEXT

STATEMENT or XREF

NOTE

The data structure represented in tree and indented forms, and an example statement containing data are shown in Figure 26. Complex records could be built up in this way, as the structure is used recursively. The following section describes the MDA data standard, which is constructed using the data definition language.

1 STATEMENT IN TREE STRUCTURE

Statement

ROLE | NOTE | TEXT | XREF | NOTE OR STATEMENT

2 STATEMENT IN INDENTED FORM

STATEMENT

> ROLE

> NOTE

> TEXT

> XREF OR STATEMENT

> NOTE

3 EXAMPLE STATEMENT

STATEMENT

> ROLE "Maker"

> NOTE

> TEXT "Lees, J"

> XREF or STATEMENT

> NOTE "made at NMM"

Figure 26: Data definition language in tree and indented form, and example statement

9.3 MDA data standard

The MDA Data Standard was designed to accommodate (as far as is practicable) all possible museum data, using the data definition language as the basic structure (MDA 1980a). This section describes how the MDA data standard was organised. The NMM data standard is described in section 9.4, below. The MDA data standard permitted the following five types of record:

object

event

locality

person

bibliographic item

Of these the object subset of the data standard was the best developed. Whilst the data definition language provided a flexible means of constructing records, the data standard gave the majority of statements a defined role, and therefore created records which have a precisely defined structure. Within the data standard each major agglomeration of data was termed a "division", the next level down within the division was termed a "group". Figure 27 shows the outer (division) level of the MDA data standard; Figure 28 shows the second (group) level. The majority of data was contained within the part division, where there are groups of data for different aspects of the item being described, such as "ownership history", or "process".

```
record
> TEXT
> XREF
> TYPE DIVISION
> identity division ->
> part division ->
> record management division ->
> notes division ->
> authority division ->
> documentation division ->
> NOTE

( -> indicates further statements)
```

Figure 27: Outer level grouping (division level) of MDA data standard

```
record
> TEXT
> XREF
> TYPE DIVISION
> identity division ->
> part division
> > TEXT
> > TYPE OF PART DIVISION
> > part name ->
> > identification group ->
> > preproduction history group ->
> > production process group - >
> > field collection group ->
> > association history group ->
> > ownership history group ->
> > administration history group ->
> > identity number history group ->
> > access history group ->
> > valuation history group ->
> > copyright history group ->
> > storage history group ->
> > display history group ->
> > form description group ->
> > interest description group ->
> > process group ->
> > series group ->
> > note group ->
> > standard number group ->
> > part division ->
> > authority ->
> > documentation ->
> > NOTE
> record management division ->
> notes division ->
> authority division ->
> documentation division ->
> NOTE

( -> indicates further statements)
```

Figure 28: Second level grouping of MDA data standard

Within each group there were further statements, until the data was encountered. Figure 29 shows as an example the storage history group. The MDA data standard defined the precise role and content of each statement. This had the advantage that conformity was guaranteed, provided that the defined structure was not altered. However, should something additional be required it was necessary to amend the data standard itself. A second disadvantage was that because the structure was contained in the data standard, rather than defined by the data itself, to support the entire data standard in a computer system imposed a considerable storage overhead.

```
> Part Division
> > Storage history group
> > > Location
> > > > desc   (the location)
> > > > authority
> > > > documentation
> > > > NOTE
> > > date
> > > > dim
> > > > desc
> > > > authority
> > > > documentation
> > > > NOTE
> > > authority
> > > documentation
> > > NOTE
```

Figure 29: Portion of MDA data standard showing the storage history group, within the part division

9.4 NMM data standard

The NMM data standard, whilst supporting a similarly structured record to the MDA standard, was differently implemented in that the control of data was achieved via the permitted statements and sub statement roles, and the role of the individual components, rather than via the data standard itself. This allowed a more flexible approach, with simpler data structures for computer storage. It was implemented in a way that abbreviations could be used for the different statements, sub-statements and components, so as to reduce the amount of typing at data entry, and reduce errors. Strict control of the data was however necessary to ensure conformance to the data standard. Potentially the maximum size of record was greater for the NMM data standard, as the number of levels of nested statements was in certain cases unlimited. The NMM data standard was described in full in *Manual 12* (NMM 1979c). The following record types were permitted:

object

named vessel

biographical

bibliographical

event

locality

general subject

The named vessel and general subject record types were additional to those permitted by the MDA Data standard (see 9.3, above). Like the MDA data standard the NMM standard was constructed using a data definition language. Figure 30 shows the statement level listing without sub-statements; Figure 31 shows the NMM data standard with the permitted one level of sub-statements. Figure 32 shows the permitted statements and sub-statements.

Within each statement or sub-statement there were a range of components which could be used. With the exception of the descriptor (which could have as many levels of sub-descriptor as required), and the reference, only one level of sub-statement permitted. The components are shown at Figure 33. The record was therefore composed of statements and sub-statements, which contained individual components; with the data itself being located within the components. Figure 34 shows the NMM data standard using the permitted statement and sub-statement roles. The complete listing of the NMM data standard, including all statements, sub-statements and components is in Appendix A. An example sub-statement (the location sub-statement of the history statement) is shown in Figure 35.

9.5 Concordance with the MDA data standard

The NMM data standard has been described as "based on a scheme produced by the MDA"

(NMM 1979c), although at the time when the NMM systems were set up the MDA data standard had yet to be published. Given that the ARC data standard follows closely (and has a formally defined relationship with) the NMM data standard, it was felt necessary to define the relationship between the NMM and MDA standards, so that the ARC data standard could be fitted into the framework defined by the MDA.

```
record
> collection code
> type
> function
> STATEMENT
> > statement role
> > person ->
> > organisation ->
> > firm ->
> > vessel ->
> > place ->
> > time ->
> > descriptor ->
> > dimension ->
> > inscription ->
> > reference ->
> > document ->
> > cross reference ->
> > part ->
> > sub statement ->
> note
```

Figure 30: Top level listing of NMM data standard

The preceding sections in this chapter have described the data definition language and the MDA and NMM Data Standards. The data definition language for the NMM data standard was very similar to that of the MDA, except for the MDA insistence on the correct ordering of elements within a statement, and the differing terminology for the Role (context for NMM), and Note (detail for NMM) components. The NMM data standard permitted two extra record types, "Named Vessel", which is of particular importance to a maritime museum, and "General Subject", a "catch all" for which the need is arguably not so well defined. From a superficial perspective it can be said that the two data standards are similar.

record
> collection code
> type
> function
> STATEMENT
> > statement role
> > person ->
> > organisation ->
> > firm ->
> > vessel ->
> > place ->
> > time ->
> > descriptor ->
> > dimension ->
> > inscription ->
> > reference ->
> > document ->
> > cross reference ->
> > part ->
> > sub statement ->
> > > sub statement role
> > > person ->
> > > organisation ->
> > > firm ->
> > > vessel ->
> > > place ->
> > > time ->
> > > descriptor ->
> > > dimension ->
> > > inscription ->
> > > reference ->
> > > document ->
> > > cross reference ->
> > > part ->
> > note
> note

Figure 31: Statement and sub-statement level of NMM data standard

- **statement**
  - **sub-statement**
    - **sub-classification**

- identification

- description
  - physical
  - inscription
  - condition
  - machinery
  - armament

- history
  - location
  - production
  - finding
  - acquisition
  - association
  - disposal
  - original
  - publication
  - exhibition
  - name of entity
  - transfer
    - new owner
    - previous owner
  - ordering
  - action
    - side 1
    - side 2
    - result
  - use
  - event

- process

- subject

- cataloguing

- reference

Figure 32: Main statements, sub-statements and sub-classifications of the NMM data standard

```
person
> context
> text
> detail

organisation
> context
> text
> detail

firm
> context
> text
> detail

vessel
> context
> text
> detail

place
> context
> text
> code
> detail

time
> context
> date
> text
> detail

descriptor
> context
> text

sub-descriptor
> text
> detail
> > context
> > text

sub-descriptor ->
> > Detail
> detail

dimension
> context
> text
> detail

inscription
> context
> text
> detail

reference
> context
> document
> > type
> > person
> > time
> > title
> > journal
> > text
> > detail
> detail

cross-reference
> context
> text
> detail

part
> context
```

Figure 33: Complete range of components available to NMM data standard

```
record
> collection (identity group)
> type (object, etc)
> function
> identification statement ->
> description statement
> > physical description ->
> > inscription ->
> > condition ->
> > machinery ->
> > armament ->
> history statement
> > location ->
> > production ->
> > acquisition ->
> > association ->
> > disposal ->
> > original ->
> > publication ->
> > exhibition ->
> > name of entity ->
> > transfer ->
> > > new owner ->
> > > previous owner ->
> > ordering ->
> > action ->
> > > side 1 ->
> > > side 2 ->
> > > result ->
> > use ->
> > event ->
> process statement
> > museum process ->
> > reproduction ->
> subject statement ->
> cataloguing statement ->
> reference statement ->
note
```

Figure 34: NMM data standard with statement and sub-statement roles

As the particular role of any statement, sub-statement or component was defined through the data by the NMM data standard, it was theoretically possible to structure the NMM data so that it was directly compatible with the MDA standard. In order to ascertain the degree of compatibility a concordance was constructed between the NMM and MDA data standards. The concordance is shown in Figure 36, at the statement and sub-statement levels, with the equivalent MDA data categories. Because the role of an NMM component was defined by the data in the context element of the component, the NMM standard had the flexibility to mirror the MDA standard, provided that the contexts are equivalent to those embedded within the MDA standard.

```
> history statement
> > location sub-statement
> > > time                      (date moved to location)
> > > > context
> > > > date
> > > > text
> > > > detail
> > > cross-reference           (code for location)
> > > > context
> > > > text
> > > > detail
> > > person                    (person seeing or moving item)
> > > > context
> > > > text
> > > > detail
> > > descriptor                (reason for move)
> > > > context
> > > > text
> > > > sub-descriptor
> > > > detail
> > > detail                    (note on move)
```

Figure 35: Portion of NMM data standard showing the location sub-statement within the history statement

The conclusion to be drawn from mapping the NMM data standard onto the MDA data standard was that at the top two levels it was possible to say that a direct relationship could be shown from the NMM to the MDA standard, and that the NMM standard broadly conformed to the MDA standard. At a more detailed level precise conformity depended on the control which was applied to the context data element of the NMM standard. However, whilst the data definition language employed for both was similar, there were structural differences. As has been noted above, the NMM had two additional record types (named vessel and general subject). There was also a significant difference in approach, in that the form of the NMM Standard was essentially derived from the data rather than from a pre-determined structure. If, in using the NMM data standard, the MDA data categories were employed, it would have been possible to form a record identical to an MDA structured record. However in practice the records were structured differently, as the NMM usage did not precisely follow the MDA data categories. Many of the groups contained within the MDA's part division occurred at a higher level in the NMM standard, in the form of the history, description and process statements, and so on. The conclusion therefore is that whilst the NMM structure can be demonstrated to be indeed "based on the MDA data standard", and it is possible to map the NMM standard onto the MDA standard, there are differences in structure which would make direct transfer from one to the other a complex process.

9.6 ARC Implementation of the NMM data standard

9.6.1 Introduction

From the outset there was a presumption in favour of using accepted NMM standards, and this was confirmed when the trial batch of object data was processed, showing that the NMM data structures were appropriate (Chapter 4). The strategy which was adopted was to develop a structure for object records (based on that used in the ARC Petrel trial), and then extend it to other classes of item. The ARC data standard would therefore make use of a subset of the permitted statements, sub-statements and components contained within the NMM data standard. The object record structure was required to incorporate data on the ARC acquisition card (Figure 77 & 78), some of which was duplicated in the master record of acquisition (Form NMM35). Figure 21 shows an example of form NMM35.

The first stage in developing the subset of the NMM Data Standard for the Object record was to establish where the data contained in the acquisition card fitted into the subset of the NMM Data Standard used for objects (NMM 1979a). This was done as part of the study outlined in Chapter 4. Figure 12 shows the data categories on the ARC acquisition card, and their equivalent data categories in the NMM data standard. A formal definition of the record is contained in *Manual 26 - The Documentation of Objects in ARC* (Appendix 4).

NMM	MDA
record	record
> collection	identity division
> type (object, etc)	type division
> function	(NMM usage obscure for this statement)
> identification statement ->	part division identity group
> description statement	part division form description group
> > physical description ->	"
> > inscription ->	"
> > condition ->	"
> > machinery ->	"
> > armament ->	"
> history statement	part division storage history group
> > location ->	"
> > production ->	production & pre-production history group
> > finding	field collection history group
> > acquisition ->	ownership history group
> > association ->	association history group
> > disposal ->	ownership history group
> > original ->	pre-production history group
> > publication ->	documentation division
> > exhibition ->	display history group
> > name of entity ->	(NMM usage obscure for this sub-statement)
> > transfer ->	ownership history group
> > > new owner ->	"
> > > previous owner ->	"
> > ordering ->	(for purchase of bibliographic items)
> > action ->	interest description group
> > > side 1 ->	"
> > > side 2 ->	"
> > > result ->	"
> > use ->	process history group
> > event ->	interest description group
> process statement	process history group
> > museum process ->	"
> > reproduction ->	"
> subject statement ->	interest history group
> cataloguing statement ->	authority & record management divisions
> reference statement ->	documentation division
note	note division

Figure 36: Concordance of NMM data standard and MDA data standard at statement and sub-statement level

The overall approach to developing the record formats, and means of data capture, involved the following stages:

A Decide on data categories to be collected

B Design paper form to collect data (where applicable)

C Design MAXARC format to collect and store data

D Establish relationship with Petrel formats

The selection of the data categories to be collected, and the development of paper and computer formats, are described in detail in Chapter 11. The sections below describe the development of the structure for individual ARC record types, and the development of the overall ARC data Standard and its relationship with the Petrel standard.

9.6.2 Record structure for objects

Having established the design of the pro-forma cards for collecting data, and the computer format for its storage in the MAXARC software developed in the ARC, it was necessary to establish a formal relationship to the NMM Data Standard, so that data could eventually be transferred to Petrel. The record structure was based on the established use of the NMM data standard for objects (NMM 1979a), as developed for ARC data (*Manual 26* - Appendix 4). Whilst much of the data was fairly standard, the "Find" statement for field collection had not been implemented before in the NMM data standard. A full structure for recording both stratigraphic and grid reference locations was required. Figure 37 shows the record structure for ARC object records, expressed in terms of field names, grouped within Petrel statements and sub-statements. The formal relationship between the ARC object record and the Petrel standard is described in detail in the ARC objects manual (Appendix C).

9.6.3 Record structure for slides

For slides the main requirement was to describe the subject depicted in the slide, and to cross reference it to related items. Data would be input directly to the computer record, without a pro-forma for data capture. The record structure for transparencies was based on the ARC object record, with the addition of a full subject statement. Other statements were mostly in skeleton form, but the record does provide for a description of the transparency, its location and manufacture. Figure 38 shows the record structure for transparencies. There is a formal description of its relationship to the NMM data standard in Appendix C.

9.6.4 Record structure for drawings

The record structure for drawings was similar to that for slides, as the main emphasis was again on what was depicted in the image. As with slides, the record was designed for direct data entry without an intermediate pro-forma, although some salient details about the drawings were kept on a card index arranged by subject. Figure 39 shows the record structure for drawings. There is a formal description of its relationship with the NMM data standard in Appendix C.

9.6.5 Record structure for information files

In some aspects the information files constitute a "Sites and Monuments" record for boat finds, and consideration was therefore given to whether the locality record type would be appropriate. However, the use of the locality record was not developed either by NMM or the MDA, and as many of the files refer to specific objects, or boats, and many of the sites are mainly concerned with a specific boat find, the object record type was felt to be most suitable. In addition it was felt that there were advantages for the homogeneity of the ARC record system if all records were of the same type within the NMM data standard. The two aspects stressed in the information file record are the find or object to which the file relates, for which the subject statement was used, and the cross-references to other records. Figure 40 shows the ARC information file record arranged according to NMM statements and sub-statements. There is a formal description of its relationship to the NMM record in Appendix C.

- Item Number
- Identification
  - Object type
  - Boat type
  - Boat part
  - Specific type
  - Unique name
  - Status
  - Identification Note
- Description
  - Physical description
    - Risk item
    - Quantity
    - Material
    - Material note
    - Colour
    - Length
    - Width
    - Height
    - Weight
    - Scale
    - Description note
  - Condition
    - Condition
    - Completeness
  - Inscription
    - Inscription note
- History
  - Association
    - Custodian
    - Old number
  - Cataloguing
    - Date catalogued
  - Finding
    - Find Area
    - Find Place
    - Site name
    - Sub-division
    - Context
    - Grid type
    - Grid square
    - Easting
    - Northing
    - Depth/level
    - Date found
    - Finder
    - Excavation/find method
    - Find note
- History (continued)
  - Manufacture
    - Maker
    - Area of manufacture
    - Place made
    - Period of manufacture
    - Date made
    - Radiocarbon date
    - manufacture note
  - Acquisition
    - Acquired from
    - Address of donor
    - Date acquired
    - Acquisition number
    - Acquisition file
    - Acquisition method
    - Return/review date
    - Value/cost
    - Acquisition note
  - Location
    - Broad location in NMM
    - Specific location
    - Location outside NMM
    - Date at location
    - Reason
    - Location note
  - Original
    - Original note
  - Transfer
    - Transfer note
  - Use
    - Use note
  - Exhibition
    - Exhibition note
- Reference
  - Publication
  - Museum files
  - Information files
  - Drawings
  - Conservation numbers
  - Samples
  - Objects
  - Slides
  - Contexts
  - Reference note
- Process
  - Reproduction
    - Museum negatives
- Note
  - General note

Figure 37: ARC object record arranged in NMM statements and sub-statements

Item Number

Identification
- Identification note

Description
- Physical description
  - Colour/Monochrome
  - Size
  - Description note

History
- Manufacture
  - Maker
  - Date made
  - Manufacture note
- Acquisition
  - Acquisition note
- Location
  - Broad location in NMM
  - Rack number
  - Place on rack
  - Date at location
  - Location note
- Original
  - Original note
- Transfer
  - Transfer note
- Association
  - Custodian
  - Association note
  - Old number
- Cataloguing
  - Date catalogued
- Exhibition
  - Exhibition note

Subject
- Broad area
- Specific place
- Site name
- Sub-division
- Context
- Person
- Period
- Date
- Radiocarbon date
- Type of object
- Type of boat
- Part of boat
- Specific type
- Unique name
- Object number
- Object material
- Manufacture note
- Process
- Material
- Equipment
- Process/material/ equipment note
- Subject note

Reference
- Publication
- Museum files
- Information files
- Drawings
- Conservation numbers
- Samples
- Objects
- Slides
- Contexts
- Reference Note

Process
- Reproduction
  - Museum negatives

Note
- General note

Figure 38: ARC slide record arranged in NMM statements and sub-statements

- Item Number
- Identification
  - Identification note
- Description
  - Physical description
    - Quantity
    - Material
    - Medium
    - Size
    - Scale
  - Description note
- History
  - Manufacture
    - Maker
    - Date made
    - Manufacture note
  - Acquisition
    - Acquisition note
  - Location
    - Broad location in NMM
    - Type of storage
    - Specific location
    - Date at location
    - Location note
  - Original
    - Original note
  - Transfer
    - Transfer note
  - Association
    - Custodian
    - Association note
    - Old number
  - Cataloguing
    - Date catalogued
  - Exhibition
    - Exhibition note
- Subject
  - Broad area
  - Specific place
  - Site name
  - Sub-division
  - Context
  - Person
  - Period
  - Date
  - Radiocarbon date
  - Type of object
  - Type of boat
  - Part of boat
  - Specific type
  - Unique name
  - Object number
  - Object material
  - Manufacture note
  - Process
  - Material
  - Equipment
  - Process/material/equipment note
  - Subject note
- Reference
  - Publication
  - Museum files
  - Information files
  - Drawings
  - Conservation numbers
  - Samples
  - Objects
  - Slides
  - Contexts
  - Reference Note
- Process
  - Reproduction
    - Museum negatives
- Note
  - General note

Figure 39: ARC drawing record arranged in NMM statements and sub-statements

- Item Number
- Identification
  - Identification note
- Description
  - Description note
- History
  - Manufacture
    - Manufacture note
  - Acquisition
    - Acquisition note
  - Location
    - Broad location in NMM
    - Specific location
    - Date at location
    - Location note
  - Original
    - Original note
  - Transfer
    - Transfer note
  - Association
    - Custodian
    - Association note
    - Old number
  - Cataloguing
    - Date catalogued
  - Exhibition
    - Exhibition note
- Subject
  - Broad area
  - Specific place
  - Site name
  - Sub-division
  - Context
  - Person
  - Period
  - Date
  - Radiocarbon date
  - Type of object
  - Type of boat
  - Part of boat
  - Specific type
  - Unique name
  - Object number
  - Object material
  - Manufacture note
  - Process
  - Material
  - Equipment
  - Process/material/ equipment note
  - Subject note
- Reference
  - Publication
  - Museum files
  - Information files
  - Drawings
  - Conservation numbers
  - Samples
  - Objects
  - Slides
  - Contexts
  - Reference Note
- Process
  - Reproduction
    - Museum negatives
- Note
  - General note

Figure 40: ARC information file record arranged in NMM statements and sub-statements

9.6.6 Record structure for samples

The sample record was designed to describe the provenance of the sample, its physical description, and to provide a summary of processes the sample has been subjected to. It also included cross-references to other samples and records. The record structure is consequently similar to that used for objects, with the addition of an extensive museum process sub-statement. It was designed as an index and summary to the full record which was held on paper. Figure 41 shows the ARC sample record arranged by NMM statements and sub-statements. There is a formal description of its relationship to the NMM record in Appendix C.

9.6.7 Record structure for conservation records

During the initial stages in the development of the ARC system, it was felt to be desirable to test the record structure for samples, before designing a format to accommodate conservation records. The development of the conservation record format was therefore delayed, pending the trial of the sample format.

9.6.8 Record structure for contexts

The context record was intended to store all of the data about a context. Data would be captured in the field on a printed pro-forma, with some additions at the field centre or museum if required. The record stressed the description of the context, where it was located on the excavation, its relationship with other contexts, and its interpretation. Stratigraphic relationships were recorded in the association sub-statement; manufacture and use were used for the interpretation of the context. Figure 42 shows the ARC Context record arranged by NMM statements and sub-statements. There is a formal description of its relationship to the NMM record in Appendix C.

- Item Number
- Identification
  - Identification Note
- Description
  - Physical description
    - Material
    - Material note
    - Length
    - Width
    - Height
    - Weight (wet)
    - Weight (dry)
    - Scale
    - Description note
  - Condition
    - Condition
- History
  - Association
    - Initiator
    - Date initiated
    - Old number
  - Cataloguing
    - Date catalogued
  - Finding
    - Find Area
    - Find Place
    - Site name
    - Sub-division
    - Context
    - Grid type
    - Grid square
    - Easting
    - Northing
    - Depth/level
    - Date excavated
    - Excavator
    - Excavation
    - Find note
  - Location
    - Broad location in NMM
    - Specific location
    - Location outside NMM
    - Date at location
    - Reason
    - Location note
- Process
  - Museum process
    - ID person
    - ID Date
    - ID Result
    - X-ray person
    - X-ray date
    - X-ray note
    - Draw person
    - Draw date
    - Draw note
    - Cons person
    - Cons date
    - Cons note
    - C14 person
    - C14 date
    - C14 result
    - Other analysis type
    - Other analysis person
    - Other analysis date
    - Other analysis note
    - Process note
  - Reproduction
    - Museum negatives
- Reference
  - Publication
  - Museum files
  - Information files
  - Drawings
  - Conservation numbers
  - Samples
  - Objects
  - Slides
  - Contexts
  - Reference note
- Note
  - General note

Figure 41: ARC sample record arranged in NMM statements and sub-statements

- Item Number
- Identification
    - Identification Note
- Description
    - Physical description
        - Length
        - Width
        - Depth/Height
        - Soil texture
        - Soil organic content
        - Soil structure
        - Soil consistence
        - Munsell
        - Munsell note
        - Soil moisture content
        - Soil inclusions
        - Structures matrix
        - Structures constituents
        - Description note
- History
    - Association
        - Custodian
        - Recorder
        - Date Recorded
        - Old number
        - Finds Summary
        - Part of
        - Contains
        - Same as
        - Above
        - Cuts
        - Below
        - Cut by
        - Uncertain
        - Butts
        - Butted by
        - Bonded to
        - Relationship note
- History (continued)
    - Finding
        - Find Area
        - Find Place
        - Site name
        - Sub-division
        - Context
        - Grid type
        - Grid square
        - Easting
        - Northing
        - Depth/level
        - Date excavated
        - Excavator
        - Excavation method
        - Find note
    - Manufacture
        - Period
        - Date
        - Method of dating
        - Radiocarbon date
        - Phase
        - dating note
    - Use
        - Function
        - Interpretation note
- Reference
    - Publication
    - Museum files
    - Information files
    - Drawings
    - Conservation numbers
    - Samples
    - Objects
    - Slides
    - Contexts
    - Reference note
- Process
    - Museum Process
        - Note
    - Reproduction
        - Museum negatives
- Note
    - General note

Figure 42: ARC Context record arranged in NMM statements and sub-statements

9.6.9 Record structure for radiocarbon dates

The record for radiocarbon dates provided a description of the sample from which the date was obtained, the date itself, publication details, and cross-referencing to other records. To facilitate retrieval according to the type of item the subject statement was used. The record therefore takes the form of a minimal object record, with the addition of a full subject statement. Data would be entered directly to the computer record from the published source. Figure 43 shows the ARC radiocarbon date record arranged by NMM statements and sub-statements. Its relationship to the NMM record is formally described in Appendix C.

- Item Number
- Description
  - Physical description
    - Radiocarbon age
    - Error
    - Material of sample
    - Quality of sample
    - Sample note
- History
  - Association
    - Custodian
    - Old number
    - Laboratory identifier
    - Laboratory number
    - Quality of association
- Subject
  - Sample area
  - Sample place
  - Sample site name
  - Sample name
  - Sample context
  - Period
  - Date (not C14)
  - Type of object
  - Type of boat
  - Part of boat
  - Specific type
  - Unique name
  - Object number
  - Sample origin note
- Reference
  - Publication in Radiocarbon/Science
  - Publication
  - Museum files
  - Information files
  - Drawings
  - Conservation numbers
  - Samples
  - Objects
  - Slides
  - Contexts
  - Reference Note
- Process
  - Reproduction
    - Museum negatives
- Note
  - General note

Figure 43: ARC radiocarbon date record arranged in NMM statements and sub-statements

9.6.10 Consolidated ARC data standard

A consolidated ARC data structure, constituting the ARC subset of the NMM data standard, was produced by combining together the various different ARC records. Figure 44 shows the statements and sub-statements which were used, and Figure 45 shows the statements, sub-statements and components. Appendix B has a complete listing of the ARC data standard.

```
record
> collection code
> type (always object)
> identification statement ->
> description statement ->
> > physical description sub-statement ->
> > inscription sub-statement ->
> > condition sub-statement ->
> history statement ->
> > location sub-statement ->
> > manufacture sub-statement ->
> > finding sub-statement ->
> > acquisition sub-statement ->
> > association sub-statement ->
> > association sub-statement ->
> > original sub-statement ->
> > exhibition sub-statement ->
> > transfer sub-statement ->
> > use sub-statement ->
> process statement ->
> > reproduction sub-statement ->
> > museum process sub-statement ->
> subject statement ->
> cataloguing statement ->
> reference statement ->
> note statement ->
> detail
```

Figure 44: ARC data standard with statements and sub-statements

9.7 Transfer of ARC data to Petrel

It was decided on conclusion of processing the test batch of data described in Chapter 4, that data capture, editing and simple output would be performed locally on ARC equipment, and data would be transferred to Petrel for processing by the GOS package for the production of more complex catalogues and indexes, and to enable the ARC objects to be incorporated into the overall NMM records. The design of the forms and computer format for the input of data to the ARC system are described in Chapter 11, and the definition of the formal relationship of this record to Petrel standards which was necessary for the transfer to the GOS program is described in Section 9.6. The formats for ARC records were initially defined as part of the processing of a trial batch of data through Petrel (Chapter 4), and are described in *Manual 26* (Appendix 4). It was however necessary in certain cases to refer to the Petrel object manual (NMM 1979a), and also the Petrel computer formats manual (NMM 1979d) in instances where the ARC object manual was not sufficiently comprehensive.

Data would be transferred to the central information retrieval unit on floppy disk in the tagged form which could be processed by the GOS build facility. As computer formats for each class of data were developed the relationship between the MAXARC fields and the data expected by build was defined. It was envisaged that a program within the MAXARC suite would extract data from MAXARC files, format the data correctly for build, and then output it to a text file which could be transferred to the Petrel facility on floppy disk. Figure 46 shows the broad types of operations the software would be required to perform. For most fields it was merely necessary to precede the data with the appropriate tag. Where repeated values for the field were separated by a comma, the tag would be repeated. In some fields it was necessary to substitute certain characters - for instance in the object record the comma in the object type needed to be replaced by a # character. In addition to formatting specific fields so as to become components according to the NMM format, it was also necessary to insert the characters at the beginning and end of records, and formatting characters for statements and sub-statements. Figures 47-53 show the necessary manipulations for the various classes of record to be transferred to Petrel.

```
record
> collection code
> type (always object)

> identification statement
> > descriptor ->
> > detail ->

> description statement
> > physical description
> > > descriptor ->
> > > dimension ->
> > > detail ->

> > inscription
> > > detail

> > condition
> > > descriptor ->

> history statement
> > location
> > > place ->
> > > time ->
> > > descriptor ->
> > > cross reference ->

> > manufacture
> > > person ->
> > > place ->
> > > date ->
> > > detail

> > finding
> > > person ->
> > > place ->
> > > time ->
> > > descriptor ->
> > > dimension ->
> > > detail

> > acquisition
> > > person ->
> > > time ->
> > > descriptor ->
> > > dimension ->
> > > reference ->
> > > cross reference ->
> > > statement detail

> > association
> > > organisation ->
> > > descriptor ->
> > > person ->
> > > time ->
> > > detail

> > original
> > > detail

> > exhibition
> > > detail

> > transfer
> > > detail

> > use
> > > descriptor ->
> > > detail

> process statement
> > reproduction
> > > descriptor ->
> > > cross - reference ->
> > > detail
> > museum process
> > > person ->
> > > time ->
> > > detail
> > detail

> subject statement
> > person ->
> > place ->
> > time ->
> > descriptor ->
> > dimension ->
> > cross reference ->
> > detail

> cataloguing statement
> > time ->

> reference statement
> > reference ->
> > cross-reference ->

> note statement
> > detail
> detail
```

Figure 45: ARC data standard with statements, sub-statements and components

1	**INSERTION OF TAG** A note on the item Becomes: <d z A note on the item
2	**REPEATED FIELDS** A123, A234, A523 Becomes: <x iAT A123 <x iAT A234 <x iAT A523
3	**SUBSTITUTION** 1900 bp, +-300, HAR-346 Becomes: <m rc 1900 bp $z +-300, HAR-346 (Tag inserted, and $z substituted for the first comma in a radiocarbon date)

Figure 46: Types of operation to be performed by software restructuring data for transfer to Petrel

```
<co FLD2 FLD0

<s i      <d FLD5 # FLD6 # FLD7 # FLD8 <d $0u FLD9
          <d $0s FLD10 <d z FLD11
          (',' in FLD8 replaced by '#')

<s dc <d risk # FLD12 <m quantity # FLD13
          <d material # FLD14 # FLD15 <d c # FLD16
          <d completeness # FLD17 <d colour # FLD18
          <m l FLD19 cm <m w FLD20 cm <m h FLD21 cm
          <m weight FLD22 kg <m scale FLD23 <z FLD24

<s hf <c FLD26 # FLD25 <c site FLD27
          <c sub division FLD28 <c context FLD29
          <c $g FLD30 $b FLD31 $c FLD32 $d FLD33
          <m depth/level FLD34 <t FLD35 <p FLD36
          <d FLD37 <z FLD38
          (',' in FLD26 replaced by '#')

<s hm <p FLD39 <c FLD41 # FLD40 <t $a FLD42
          <t FLD43 <m rc FLD44 <z FLD45
          (',' in FLD41 replaced by '#')
          (The first ',' in FLD44 replaced by '$z')

<s hq <p FLD46 $z FLD47 <t FLD48 <x a FLD49
          <r $rNMM file $k FLD50 <d FLD51 $zFLD52
          <m FLD53 <z FLD54

<s hl <x l FLD55 FLD56 <c FLD57 <t FLD58
          <d FLD59 <z FLD60

<s hi <z FLD61

<s dk <z FLD62

<s ht <z FLD63

<s hu <z FLD64

<s hx <x g FLD65 <z FLD65

<s n  <r FLD66      (';' in FLD66 replaced by '<r '.)
                    (Subtags must be inserted manually.)
          <r $rNMM file $k FLD67      (',' in FLD67 replaced with '$rNMM file $k')
          <x iAI FLD68 (',' in FLD68 replaced by '<x iAI')
          <x iAD FLD69 (',' in FLD69 replaced by '<x iAD')
          <x iAC FLD70 (',' in FLD70 replaced by '<x iAC')
          <x iAS FLD71 (',' in FLD71 replaced by '<x iAS')
          <x iAO FLD72 (',' in FLD72 replaced by '<x iAO')
          <x iAT FLD73 (',' in FLD73 replaced by '<x IAT')
          <x iAL FLD74 (',' in FLD74 replaced by '<x iAL')
          <z FLD79

<s pr <x nFLD77  (',' in FLD77 replaced by '<x n')

<s hs <d custodian <o NMM $h FLD3

<s hs <d old number <x g FLD78      (',' in FLD78 replaced by '<x g')

<s c  <t FLD4 <s z <z FLD80
```

Figure 47: Transfer of object records to Petrel

```
<co FLD2 FLD0

<s i <z FLD6

<s dc <d FLD8 <d m size # FLD9cm * FLD9cm <z FLD13

<s hm <p FLD15 <t FLD16 <z FLD17

<s hq <z FLD19

<s hl <x lFLD21 FLD22/FLD23 <t FLD24 <z FLD25

<s hi <z FLD27

<s ht <z FLD29

<s hx <z FLD33

<s j <c FLD36#FLD35 <c site FLD37 <c sub division FLD38
        <c context FLD39 <p FLD42 <t $aFLD43 <t FLD44
        <m rc FLD45 <d FLD48#FLD49#FLD50#FLD51 <d $0u FLD52
        <x i FLD53 <d material#FLD56 <d process#FLD60
        <d equipment#FLD62 $zFLD63 <z FLD65
        (',' in FLD36 replaced by '#')
        (The first ',' in FLD45 replaced by '$z')

<s n <r FLD66
        (';' in FLD66 replaced by '<r '.)
        (Subtags must be inserted manually.)
        <r $rNMM file $k FLD67
        (',' in FLD67 replaced with '$rNMM file $k')
        <x iAI FLD68 (',' in FLD68 replaced by '<x iAI')
        <x iAD FLD69 (',' in FLD69 replaced by '<x iAD')
        <x iAC FLD70 (',' in FLD70 replaced by '<x iAC')
        <x iAS FLD71 (',' in FLD71 replaced by '<x iAS')
        <x iAO FLD72 (',' in FLD72 replaced by '<x iAO')
        <x iAT FLD73 (',' in FLD73 replaced by '<x IAT')
        <x iAL FLD74 (',' in FLD74 replaced by '<x iAL')
        <z FLD79
The first ',' in FLD45 is replaced by '$z'

<s pr <x nFLD77          (',' in FLD77 is replaced by '<x n')

<s hs <d custodian <o NMM $h FLD3

<s hs <d old number <x g FLD78 (',' in FLD78 should be replaced by '<x g')

<z FLD31

<s c <t FLD4 <s z

<z FLD80

*
```

Figure 48: Transfer of transparency records to Petrel

```
<co FLD2 FLD0

<s i  <z FLD6

<s dc <m quantity # FLD8 <d material # FLD9
        <d medium # FLD10 <m size # FLD11
        <m scale #FLD12 <z FLD13

<s hm <p FLD15 <t FLD16 <z FLD17

<s hq <z FLD19

<s hl <x lFLD21 FLD22 FLD23 <t FLD24 <z FLD25

<s hi <z FLD27

<s ht <z FLD29

<s hx <z FLD33

<s j  <c FLD36#FLD35 <c site FLD37 <c sub division FLD38
        <c context FLD39 <p FLD42 <t $aFLD43 <t FLD44
        <m rc FLD45 <d FLD48#FLD49#FLD50#FLD51 <d $0u FLD52
        <x i FLD53 <d material#FLD56 <d process#FLD60
        <d equipment#FLD62 $zFLD63 <z FLD65
        (',' in FLD36 replaced by '#')
        (The first ',' in FLD45 replaced by '$z')

<s n <r FLD66
        (';' in FLD66 replaced by '<r '.)
        (Subtags must be inserted manually.)
        <r $rNMM file $k FLD67
        (',' in FLD67 replaced with '$rNMM file $k')
        <x iAI FLD68 (',' in FLD68 replaced by '<x iAI')
        <x iAD FLD69 (',' in FLD69 replaced by '<x iAD')
        <x iAC FLD70 (',' in FLD70 replaced by '<x iAC')
        <x iAS FLD71 (',' in FLD71 replaced by '<x iAS')
        <x iAO FLD72 (',' in FLD72 replaced by '<x iAO')
        <x iAT FLD73 (',' in FLD73 replaced by '<x IAT')
        <x iAL FLD74 (',' in FLD74 replaced by '<x iAL')
        <z FLD79

<s pr <x nFLD77
        (',' in FLD77 replaced by '<x n')

<s hs <d custodian <o NMM $h FLD3

<s hs <d old number <x g FLD78 <z FLD31
        (',' in FLD78 replaced by '<x g')

<s c  <t FLD4

<s z  <z FLD80

*
```

Figure 49: Transfer of drawings records to Petrel

```
<co FLD2 FLD0

<s i  <d $0u FLD5 <z FLD6

<s dc <z FLD13

<s hm <z FLD17

<s hq <z FLD19

<s hl <x lFLD21 FLD22 <t FLD24 <z FLD25

<s hi <z FLD27

<s ht <z FLD29

<s hx <z FLD33

<s j <c FLD36#FLD35 <c site FLD37 <c sub division FLD38
        <c context FLD39 <p FLD42 <t $aFLD43 <t FLD44
        <m rc FLD45 <d FLD48#FLD49#FLD50#FLD51 <d $0u FLD52
        <x i FLD53 <d material#FLD56 <d process#FLD60
        <d equipment#FLD62 $zFLD63 <z FLD65
        (',' in FLD36 is replaced by '#')
        (The first ',' in FLD45 replaced by '$z')

<s n <r FLD66
        (';' in FLD66 replaced by '<r '.)
        (Subtags must be inserted manually.)
        <r $rNMM file $k FLD67
        (',' in FLD67 replaced with '$rNMM file $k')
        <x iAI FLD68 (',' in FLD68 replaced by '<x iAI')
        <x iAD FLD69 (',' in FLD69 replaced by '<x iAD')
        <x iAC FLD70 (',' in FLD70 replaced by '<x iAC')
        <x iAS FLD71 (',' in FLD71 replaced by '<x iAS')
        <x iAO FLD72 (',' in FLD72 replaced by '<x iAO')
        <x iAT FLD73 (',' in FLD73 replaced by '<x IAT')
        <x iAL FLD74 (',' in FLD74 replaced by '<x iAL')
        <z FLD79

<s pr <x nFLD77
        (',' in FLD77 is replaced by '<x n')

<s hs <d custodian <o NMM $h FLD3

<s hs <d old number <x g FLD78
        (',' in FLD78 should be replaced by '<x g')

<s hs <z FLD31

<s c <t FLD4

<s z <z FLD80

*
```

Figure 50: Transfer of information files to Petrel

<co FLD2 FLD0

<s i <d z FLD6

<s dc <d material # FLD16 # FLD17 <d c # FLD18
<m l FLD19 m <m w FLD20 m <m h FLD21 m
<d wt dry # FLD22 <d wt wet # FLD23 <z FLD24

<s hf <c FLD26 # FLD25 <c site FLD27
<c sub division FLD28 <c context FLD29
<c $g FLD30 $b FLD31 $c FLD32 $d FLD33
<m depth/level FLD34 <t FLD35 <p FLD36
<d FLD37 <z FLD38
(',' in FLD26 are replaced by '#')

<s pm <d identification <p FLD39 <t FLD40 <z 41

<s pm <d Xray <p FLD42 <t FLD43 <z FLD44

<s pm <d draw <p FLD45 <t FLD46 <z FLD47

<s pm <d photograph <p FLD48 <t FLD49 <z FLD50

<s pm <d conservation <p FLD51 <t FLD52 <z FLD53

<s pm <d C14 dating <p FLD54 <t FLD55 <m rc FLD56
(The first ',' in FLD56 replaced by $z)

<s pm <d FLD60 <p FLD61 <t FLD62 <z FLD63

<s pm <z FLD65

<s hl <x l FLD10 FLD11 <c FLD12 <t FLD13 <d FLD14 <z FLD15

<s n <r FLD66 (';' in FLD66 replaced by '<r '. Subtags must be inserted manually.)
<r $rNMM file $k FLD67 (',' in FLD67 replaced with '$rNMM file $k')
<x iAI FLD68 (',' in FLD68 replaced by '<x iAI')
<x iAD FLD69 (',' in FLD69 replaced by '<x iAD')
<x iAC FLD70 (',' in FLD70 replaced by '<x iAC')
<x iAS FLD71 (',' in FLD71 replaced by '<x iAS')
<x iAO FLD72 (',' in FLD72 replaced by '<x iAO')
<x iAT FLD73 (',' in FLD73 replaced by '<x IAT')
<x iAL FLD74 (',' in FLD74 replaced by '<x iAL')
<z FLD79

<s pr <x nFLD77 (',' in FLD77 is replaced by '<x n')

<s hs <d custodian <o NMM $h FLD3

<s hs <d initiator <p FLD8

<s hs <d date initiated <t FLD9

<s hs <d old number <x g FLD78 (',' in FLD78 replaced by '<x g')

<s c <t FLD4

<s z <z FLD80

Figure 51: Transfer of sample records to Petrel

```
<co FLD2 FLD0
<s i  <d FLD5 <z FLD6
<s dc <m l FLD11 <m w FLD12 <m h FLD13
        <d soil texture # FLD14
        <d soil organic content # FLD15
        <d soil structure # FLD16
        <d soil consistence # FLD17
        <m munsell # FLD18 $z FLD19
        <d soil moisture content # FLD20
        <d soil inclusions # FLD21
        <d structure matrix # FLD22
        <d structure constituents # FLD23
        <z FLD24
<s hf <c FLD26 # FLD25 <c site FLD27
        <c sub division FLD28
        <c $g FLD30 $b FLD31 $c FLD32 $d FLD33
        <m depth/level FLD34 <t FLD35 <p FLD36
        <d FLD37 <z FLD38
        (',' in FLD26 are replaced by '#')
<s hm <t $a FLD53 <t FLD54 $z FLD55 <m rc FLD56
        <d phase # FLD57 <z FLD58          (The first ',' in FLD56 is replaced by '$z')
<s hu <d FLD59 <z FLD60
<s n <r FLD66
        (';' in FLD66 replaced by '<r '.)
        (Subtags must be inserted manually.)
        <r $rNMM file $k FLD67
        (',' in FLD67 replaced with '$rNMM file $k')
        <x iAI FLD68 (',' in FLD68 replaced by '<x iAI')
        <x iAD FLD69 (',' in FLD69 replaced by '<x iAD')
        <x iAC FLD70 (',' in FLD70 replaced by '<x iAC')
        <x iAS FLD71 (',' in FLD71 replaced by '<x iAS')
        <x iAO FLD72 (',' in FLD72 replaced by '<x iAO')
        <x iAT FLD73 (',' in FLD73 replaced by '<x IAT')
        <x iAL FLD74 (',' in FLD74 replaced by '<x iAL')
        <z FLD79
<s pr  <x nFLD77          (',' in FLD77 is replaced by '<x n')
<s hs <d custodian <o NMM $h FLD3
<s hs <d recorder <p FLD8
<s hs <d date recorded <t FLD9
<s hs <d old number <x g FLD78      (',' in FLD78 should be replaced by '<x g')
<s hs <d part of <x iAL FLD40
<s hs <d contains <x iAL FLD41      (',' in FLD41 is replaced by '<x iAL')
<s hs <d same as <x iAL FLD42       (',' in FLD42 is replaced by '<x iAL')
<s hs <d above <x iAL FLD43         (',' in FLD43 is replaced by '<x iAL')
<s hs <d cuts <x iAL FLD44          (',' in FLD44 is replaced by '<x iAL')
<s hs <d below <x iAL FLD45         (',' in FLD45 is replaced by '<x iAL')
<s hs <d cut by <x iAL FLD46        (',' in FLD46 is replaced by '<x iAL')
<s hs <d uncertain <x iAL FLD47     (',' in FLD47 is replaced by '<x iAL')
<s hs <d butts <x iAL FLD48         (',' in FLD48 is replaced by '<x iAL')
<s hs <d butted by <x iAL FLD49     (',' in FLD49 is replaced by '<x iAL')
<s hs <d bonded to <x iAL FLD50     (',' in FLD50 is replaced by '<x iAL')
<s hs <z FLD51
<s c <t FLD4
<s z <z FLD80
```

Figure 52: Transfer of context records to Petrel

```
<co FLD2 FLD0

<s dc <m rc FLD10 $z +- FLD11, 13C FLD12
        <d material # FLD17 <d quality # FLD18
        <d quality of sample association # FLD19
        <z FLD20

<s j <c FLD36#FLD35 <c site FLD37
        <c $0u name of sample FLD38 <c context FLD39
        <t $aFLD43 <t FLD45 <d FLD48#FLD49#FLD50#FLD51
        <d $0u FLD52 <x i FLD53 <d material#FLD56
        <d process#FLD60 <d equipment#FLD62 $zFLD63
        <z FLD65
        (',' in FLD36 is replaced by '#')

<s n <r FLD66
        (';' in FLD66 replaced by '<r '.)
        (Subtags must be inserted manually.)
        <r $rNMM file $k FLD67
        (',' in FLD67 replaced with '$rNMM file $k')
        <x iAI FLD68 (',' in FLD68 replaced by '<x iAI')
        <x iAD FLD69 (',' in FLD69 replaced by '<x iAD')
        <x iAC FLD70 (',' in FLD70 replaced by '<x iAC')
        <x iAS FLD71 (',' in FLD71 replaced by '<x iAS')
        <x iAO FLD72 (',' in FLD72 replaced by '<x iAO')
        <x iAT FLD73 (',' in FLD73 replaced by '<x IAT')
        <x iAL FLD74 (',' in FLD74 replaced by '<x iAL')
        <z FLD79

<s pr <x nFLD77
        (',' in FLD77 is replaced by '<x n')

<s hs <d custodian <o NMM $h FLD3

<s hs <d old number <x g FLD78
        (',' in FLD78 should be replaced by '<x g')

<s hs <d Laboratory identifier <x g FLD13

<s hs <d Laboratory number <x g FLD14

<s c <t FLD4

<s z <z FLD80

*
```

Figure 53: Transfer of radiocarbon dates to petrel

10 TERMINOLOGY CONTROL AND NUMBERING SYSTEMS

10.1 Introduction

This chapter is concerned with describing how terminology is controlled at the lowest level within the ARC records, and with numbering systems and location recording. The NMM data standard, and its ARC subset are discussed in detail in Chapter 9, above. Because the permitted uses of statements and sub-statements were controlled through the data itself, the NMM data standard was more flexible than that of the MDA. However, to achieve consistency in the use of the NMM data standard it was necessary to ensure that the statements and components within them conform to those permitted by Petrel. At the component level the permitted contexts were defined through the ARC implementation of the data standard. For the ARC system it was planned that the statements and component roles would in most cases be automatically inserted by the software; users would only be required to enter data to the text and detail fields.

It is at this lowest level within the record, where data is entered into the text field by the user, that terminology control was required. There were three possible options for achieving this control:

1. The structure of the text is defined, but there is no control of the data itself.

2. The content is precisely defined by a permitted list of terms (word list, or thesaurus).

3. The content is not defined, but data may be unified after data entry by producing a list of all terms used, and editing accordingly.

Established practice for Petrel was to control the structure of data, but to enter the data "as found", for subsequent editing after producing sorted checking indexes. This avoided the need for terminology to be defined in advance of data input, and was also felt to be preferable as the terminology could emerge from the data itself, which had not been constrained in any way. However, this method meant that the records were not useful for retrieval until after the editing stage, and that much work had to be expended on examining checking indexes, and editing the data. This was a time consuming process, which could sometimes be neglected, even though there were various automatic editing techniques.

In order to be able to make use of the ARC computerised record for retrieval and indexing from the time when data had first been entered, it was agreed that all data in text fields (ie "an item of primary information, worthy of indexing or retrieval") should be controlled on data entry. This would not normally be necessary for the detail (note) fields (ie "an item of secondary information, not worthy of indexing or retrieval"), which would rarely be used for retrieval.

Data capture software would store data in such a way that the NMM Petrel conventions for data storage (NMM 1979c, NMM 1979d) would be wherever possible automatically applied to the data, thus ensuring that it was correctly structured. Where practicable control for data would be achieved through having a permitted list of terms, which would be checked by the computer at the time of data input, as it was felt to be generally preferable to check data at this point, so as to avoid the need for subsequent checking and editing. In the cases where this was not possible (for instance with names of people or organisations), data consistency would be achieved through the use of checking indexes.

10.2 The structure for components

10.2.1 Introduction

This section is concerned with describing how data collected by the ARC system followed the Petrel conventions, and was stored in such a way that it may readily be transferred to Petrel systems. The Petrel conventions define the formats in which data must be prepared (NMM 1979d), so that it can be "massaged" by software into the correct form for storage, as defined in *Manual 12* (NMM 1979c). In designing the ARC system it was necessary to be able to collect data in such a way that it could readily be presented to the Petrel system in the format defined in *Manual 13* (NMM 1979d). In general, users would not be required to insert subtags into the data themselves, the only exceptions being some forms of names, and bibliographic references. In practice users proved to be resistant to adding any subtags, and it was decided to manually edit in the subtags at the time of transfer to Petrel.

Each type of component has a set of rules defined within the NMM standards. For the ARC implementation, all of the NMM components except vessel were used. Firm is not explicitly utilised, but it had an identical structure to organisation. Only the detail of the inscription component was used. The subset of the NMM data standard for each component is described below, together with how it was used for ARC data.

10.2.2 Person component

In order to simplify data entry, but to keep names in a form that would facilitate simple indexing and searching, it was decided to use the simplest possible format. The surname would be entered, followed by a comma, space and initials or forenames. Titles and ranks were avoided, except where the title was Sir, or a wife took her husbands forenames:

Jones, A B

Jones, Andrew Boston

Waterhouse, Mrs Michael

Waterhouse, Sir Michael

Exceptionally (for instance when recording the royal donor of an acquisition) it was necessary to use a different title ($d) and roman numerals ($e) - the user was required to enter the sub-tags:

Michael $d Prince

Elizabeth $e II $d Queen

10.2.3 Organisation component

The preferred form in the ARC record was to just use the simple case without tags:

National Maritime Museum

Borough of Deal

However for custodian (in the association sub-statement) it was necessary for the software to add subtags when data was prepared for transfer to Petrel. The user has only to enter the name, as the remainder of the structure was provided automatically by the software:

Heal, S V E

becomes:

<s hs <d custodian <o NMM $h Heal, S V E

10.2.4 Place component

For ARC data a subset of the Petrel rules was used. Places started with the smallest, and were listed, separated by a comma and space. eg:

Banbury, Oxfordshire

In some cases it was necessary to say the type of place (eg for a river); to do this the term is put in parentheses:

Ribble (river), Lancashire

For places in Britain the country is left out, for others it is included as the last term:

Washington, Texas, U.S.A.

10.2.5 Time component

The Petrel rules for data input in *Manual 13* (NMM 1979d) outlined the formats for dates, but did not give the necessary level of detail for all forms of the dates encountered in the ARC. In particular there was a need to describe date ranges and approximations, dates BC, and dates derived by dendrochronology. (Because of the nature of dates derived by radiocarbon assay it was felt to be appropriate to use the dimension component for their storage - see 10.2.7 below). It was therefore necessary to refer to *Manual 12* (NMM 1979c) for some of the more complex formats.

Simple dates would be in the order day month year. Day, or day and month could be left out. The month was written as a three letter code, and the elements of the date were separated by spaces. The first two digits could not be left out. Doubt could be indicated by "ca" or "?":

20 Jan 1984

Jan 1984

1980

0980

ca1973

1973 ?

Detail could be added after the date. It was separated by a comma and a space:

12 Feb 1984, before

BC dates were preceded by "BC" which was entered before the "ca", if appropriate:

BC 0830

BC 2000

BC ca 1900

Dates derived from dendrochronology were indicated by using the detail:

0936, dendro

A range of dates was indicated by separating them with "-". Because of the collation sequences set up within the Petrel implementation it was not possible to give a range of dates which spanned both BC and AD. It was therefore necessary for both dates to be either AD or BC:

1300-1400

BC 2000-BC 1100

Cultural periods could also be entered, using the $a tag:

$a Bronze age, early

10.2.6 Descriptor component

The descriptor component consisted of a recursive format consisting of context, text, sub-descriptor and detail; permitting complex structures to be created. In order to avoid unnecessary complexity, ARC data was structured without the use of the sub-descriptor; only one level was used, with context and either text or detail, or occasionally both. In general, as with other components, the context was supplied by the software, with the user entering the text or detail. Where text is used, a list of permitted terms was supplied wherever possible. The selection and structuring of these lists is described in section 10.3, below.

10.2.7 Dimension component

The data entry software was used to insert the name of the measurement (eg length) and units, thus only the measurement itself needed to be entered. The user was prompted for the measurement, and the prompt displayed the units to be used. The dimension component was also used for radiocarbon dates. The date was entered followed by the statistical deviation, and the laboratory reference. (For transfer to Petrel, the statistical deviation and laboratory reference needed to be in the detail field - this was accomplished at the time of transfer by replacing the first comma with a $z):

1900 bc, +-200, QU-634

2000 bp, +-932, BM-456

874 ad, +-50, H-568

10.2.8 Reference component

For ARC data the reference component was used to refer to documents in ordered series such as NMM files, and to conventional bibliographic sources. When referring to NMM files the $r subtag for journal was used, with the number of the file following the $k subtag. These would be inserted automatically by the software, so the user only had to enter the file number.

$p - author
$t - date
$w - title of book or article
$r - journal
$e - additions to title
$k - volume number or part in series
$l - issue or part number of journals
$m - identification of issue or part
$n - detailed reference to page, plates, etc
$f - edition
$b - place of publication
$c - publishers name
$g - pagination
$i - description
$u - ISBN
$j - price
$z - note

Figure 54: Tags for bibliographic references

A full range of subtags was available for bibliographic references, so that all data elements within the bibliographic component could be correctly assigned. In practice it was found that users were resistant to using the subtags, and preferred not to see them displayed. It was therefore decided to put the components in the correct order, but not to tag them. Tagging (by manual edit) would have to occur at a later date. The subtags to be used, and the correct order for data within the bibliographic component, are shown at Figure 54.

10.2.9 Cross-references component

The cross-reference component was used to refer to items within NMM which had a formal numbering system. The development of the ARC numbering and location recording systems are described in Section 10.4, below. The cross-reference field was used extensively in the ARC system to link records. The following types were used:

a	acquisition numbers
n	negative numbers
l	location codes
g	general number

The format for the NMM acquisition number was a code for the Department (ARC), the year, a dash and the number within the year. For loans it was followed by an L:

ARC1978-19L

If it was necessary to refer to other departmental acquisition numbers the same format was used, with the appropriate departmental code. To show the type of number, an "a" was added to acquisition numbers. Negative numbers were preceded by the prefix "n" (expanded to the collection code "NG"), which was added by the software. They consisted of an upper case letter, a number consisting of up to four figures, and if necessary a slash and lower case letter to signify the frame number where several negatives were on the same piece of film:

C2341/a

At the time when the ARC system was being developed, Petrel had yet to devise museum-wide location codes, although general guidelines for constructing such codes were available. Following the Petrel recommendations, a two part system was adopted for ARC locations. The first part referred to the room or equivalent space, and was controlled by a list of permitted terms (10.3, below); the second part gave the precise location (eg Shelf 16). At the time when the ARC system was implemented there were no rules governing the detailed part of the location, and it was therefore necessary in the first instance to use checking indexes to achieve uniformity. It was planned that once a list of locations had emerged, these could form a list of permitted terms for the detailed location. Location codes were preceded by the letter "l", which was added automatically by the software.

The "general number" was a "catch all" for any type of number which did not have a clearly defined system; in the ARC it was used for gallery references, but it could also be applied to anything which has a numbering system not formally recognised by Petrel. The prefix "g" was added automatically by software at the time of transfer of data to Petrel.

10.3 Control of data content by a list of terms

Wherever possible the data to be entered to a text field was controlled by having a list of permitted terms. This aided consistency in indexing and retrieval, and obviated the need for proof reading and editing for terminology control. Data entry software permitted the terms to be selected from a list, with a single code being entered rather than the full term. These codes were expanded for display or printout. The aim was for all text fields to either have a list such as this, or where this was not possible (for instance with names of people), terminology consistency would be achieved through the use of checking indexes and editing. The development of these word lists (improperly called thesauri in ARC documentation) is described below, and there is a full listing of all the ARC word lists in Appendix D.

10.3.1 Method of acquisition

The method of acquisition word list followed terms defined for Petrel, with the addition of "excavation", as it was felt that there might be some uncertainty as to the method of acquisition for objects obtained through excavation. However, consideration of the legal status of finds recovered on land and from underwater, suggested that all finds recovered in this way would have an owner, and the usual methods of acquisition would therefore apply. Figure 55 shows the terms in the acquisition method word list.

purchase
gift
bequest
loan
period loan
deposit
transfer
exchange
excavation
made in NMM
undocumented find

Figure 55: Word list for acquisition method

10.3.2 Staff in ARC

This list was formed from the list of posts within the ARC. Because in general responsibilities are allocated to the post rather than individuals, this was felt to be a more appropriate method than referring to individuals by their name or initials. The list could be added to or amended as required. Figure 56 shows the terms in the ARC staff word list.

10.3.3 Location in NMM

The development of location recording is described in section 10.5. The word list includes all the locations where ARC items were kept or displayed in the museum. Ideally the ARC would have adopted the Petrel system for museum-wide location identification, but this was not fully developed at this stage. However, it was felt that conversion to any overall scheme would be desirable at a later date, and could be easily achieved by a simple translation program. Figure 57 shows the word list for places in the museum.

Prehistoric arch.
Medieval arch.
Medieval historian
Information arch.
Diving officer
Ethnographer
Senior scientist
Research scientist
Senior Arch cons.
Arch cons.
Secretary

Figure 56: Word list for ARC staff

FP Room 6
FP Corridor
FP Lab
FP Drawing office
FP Tank room
FP Secretaries office
FP Room 4
FP Yard
FP Other
K Spur 10A
K Spur 10B
K Spur 1
K Boat store
K other
Gallery B
Neptune Hall
Barge House
Gallery 11
FP Chief Arch. Office
Dark room
Education Dept.

Figure 57: Word list for locations in the museum

10.3.4 Boat type and components

Two word lists were used to describe traditional boats, and their constituent parts. The list for boat type, which was based on McGrail's classification (McGrail 1981) as modified by Kentley (1984), was designed to provide a comprehensive overall typology for traditionally built boats. It was slightly modified after discussion within the ARC. The list of terms for boat parts was based on the classification work by McGrail and Kentley, which was then subjected to review within the ARC. The list also aimed to group together components within a traditionally built boat - the hierarchical structure which evolved would be suited to full thesaurus treatment. Figures 58 and 59 shows the word list for boat type and boat part.

personal flotation aid
reed raft
bark raft
buoyed raft
log raft
reed boat
bark boat
logboat
extended logboat (Pirogue)
five-part canoe
planked boat
skin boat

Figure 58: Word list for boat type

keel/stem/stern
framing - transverse
framing - longitudinal
planking
decking
fitting - propulsion by man
fitting - propulsion by wind
fitting - steering
fitting - other
fastening
jointing
caulking
repair
dunnage
cargo
equipment

Figure 59: Word list for boat part

10.3.5 Type of object

This word list was based on the top level of Chenhall's functional classification for objects

(Chenhall 1978). It aimed to provide an aid to the retrieval of artifacts which were not boats or components of boats. Figure 60 shows the object type word list.

unclassifiable artifact
structure
building furnishing
personal artifact
tools and equipment
communication artifact
boat
art object
recreational artifact
societal artifact
packages and containers
floral/faunal remains
display item
records

Figure 60: Word list for type of object

10.3.6 Graphic items

Graphic material in the ARC mainly consisted of drawings (on a wide range of media), but for convenience of storage this class of item also included photographic prints and other two dimensional records. Three word lists were used to record the location, material, and type of such items. As graphic material was only kept at a few discrete locations the location list is a subset of the overall location list (see Section 10.4.3), with added detail. The graphic materials word list consisted of a list of the physical material of the items. The type list describes the broad class of item, for instance whether it was a field drawing, publication artwork, or a photograph. All three lists were developed for the circumstances at the time, and could be added to as required. Figures 61-63 show the word lists for graphic items.

FP Corridor - vertifile
FP - Info file
FP Secretaries office - Plans chest
K Spur 10B - Plans chest

Figure 61: Word list for location of graphic items

Paper
Linen
Card
Permatrace
Tracing paper
Dyeline
Photographic paper
Photographic film
Glass negative
Xerox
Plastic

Figure 62: Word list for material of graphic items

Field drawing
Reference drawing
Publication drawing
Mounted publication artwork
Photograph
Chart
Map
Display artwork
Papers
Newspaper

Figure 63: Word list for type of graphic items

air-abrasive
compressor
pumps
tanks
microscopes
freeze-dryer
cleaning tools
microtome
X-ray cabinet
heating and drying equipment
electrolytic equipment
weighing
coring
pilodyn
cranes
misc laboratory equipment

Figure 64: Word list for equipment

10.3.7 Equipment, materials and processes

These word lists were used to control terminology for the activities which were carried out by the ARC both during fieldwork and in the laboratory. They were designed to describe the full range of activities undertaken at the time when the lists were developed, but could be extended as required. The equipment list included types of equipment in use in the ARC conservation and scientific work. It incorporated a broad classification which aimed to cover the main groups of equipment. The materials list contained the broad groups of materials used in processes. The process list included all processes which could occur to an item during its life in the ARC. Figures 64-66 show the word lists for processes, equipment and materials.

PEG
resins
waxes
adhesives
acetone
IMS
ether
water
alcohols
acids
benzotriazol
biocides
polyurathane foam
plastics
sugars

Figure 65: Word list for materials

10.3.8 Object material

This list of object materials was developed within ARC in a fairly *ad hoc* fashion, and consequently suffers from being unstructured and from not having a classification scheme or groupings of materials. However in practice it proved to be reasonably comprehensive, and an effective means of ensuring consistency. It was felt that structure could be added at a later time if necessary. Figure 67 shows the word list for object material.

documentary evidence
aerial survey
geophysical survey
metal detector survey
sonar survey
probing
augering
fieldwalking
surveying
land excavation
underwater excavation
recording
drawing
planning
photography
sampling
environmental evidence
sieving
photogrammetry
machinery
safety
dating
identification
post excavation study
display
documentation
archive
publication
microscopy
freeze-drying
pre-treatment
dehydration
impregnation
electrolysis
cleaning
desalination
X-ray
examination
on-site conservation
moulding
loading
storage
post-conservation

Figure 66: Word list for processes

10.3.9 Period

The word list for period was developed through consultation with the individual period specialists within the ARC. It was designed to give a broad temporal classification, which could be further qualified. Figure 68 shows the word list for period.

copper	antler
copper alloy	bone
gold	horn
iron	ivory
lead	shell
zinc	hardwood
pewter	softwood
silver	leaves
steel	roots
tin	branches
brick	bark
fired clay	moss
glass	reed
pottery	grass
tile	rope
daub	lichen
mortar	charcoal
plaster	stone
leather	coral
animal textile	amber
vegetable textile	jet
hair	shale
skin	flint
leather	

Figure 67: Word list for object material

Cromerian
Anglian
Hoxnian
Wolstonian
Ipswichian
Devensian
Mesolithic
Earlier Neolithic
Later Neolithic
Beaker
Earlier Bronze Age
Later Bronze Age
Earlier Iron Age
Later Iron Age
Romano British
Saxon
Viking
Medieval
Post Medieval
Modern

Figure 68: Word list for period

10.3.10 Geographic locations

The word list for place was developed in the ARC, and was designed to give a comprehensive top level classification for all areas of the world. Particular attention was given to the various island groups, which could be significant for ethnographic craft. These locations were further qualified with the precise country and location. Figure 69 shows the word list for place.

Britain and Ireland
Scandinavia
Northern Europe
Southern Europe
Eastern Europe
Eskimo Arctic
North America
Central and South America
Atlantic Islands
North Africa
West Africa
East Africa
Central Africa
Southern Africa
Middle East
Asiatic Russia
Indian Ocean
Indian Sub-Continent
Indo-China
Malaysia
Indonesia
Philippines
Chinese Sub-Continent
Japan
Micronesia
Melanesia
Polynesia
Australia

Figure 69: Word list for geographic locations

Firm
Soft
Hard
Friable

Figure 70: Word list for soil consistence

Dry
Moist
Wet

Figure 71: Word list for soil moisture content

Peat
Sandy peat
loamy peat
Humose
Non humose

Figure 72: Word list for soil organic content

Crumb
Granular
Blocky
Prismatic
Columnar
Platy

Figure 73: Word list for soil structure

Sand
Loamy sand
Sandy loam
Sandy silt loam
Silt loam
Sandy clay loam
Clay loam
Silty clay loam
Sandy clay
Silty clay
Clay

Figure 74: Word list for soil texture

10.3.11 Soils

In common with the practice of the Central Excavation Unit (Jefferies 1977), and the Museum of London (Schofield 1980), word lists taken from the Soil Survey Field Handbook (Hodgson 1976) were used to control the description of soils. These are consistence, moisture content, organic content, structure, and texture. Figures 70-74 show the word lists for soils.

10.3.12 Manufacturing process

Although it was intended that there should be a word list for the process by which an object had been manufactured, such a list was not developed.

10.4 Numbering and location recording

This section defines the numbering systems which were used for items, and the system which was used for location recording. Two types of number could be applied to an object; an acquisition number referring to the formal process of acquisition, and an item number which uniquely identified the item. For both types of number, conventions employed Museum wide were adopted for the ARC system.

10.4.1 Acquisition number

Acquisition numbers were usually only given to conventional objects (item class "object") in ARC, although other types of material (for instance drawings) were exceptionally acquired or loaned to the Museum. For convenience, all acquired and loaned material was treated as an "object", so that for the management of acquisitions and loans, only the object records needed to be accessed. Where appropriate, it would also be documented in the appropriate record. Thus an original site drawing from an important excavation would occur in the object records (type "object") but would also be catalogued as a drawing.

The acquisition number was used to refer to the transaction by which the item came into the Museums keeping; it could refer to a single item, or a collection of items from one donor, or the material from a single excavation. The acquisition number consisted of the year of acquisition, the departmental code, and the number of the acquisition in that year. It was followed by "L" if it was a loan. The acquisition would receive the next number in the year. There was a "-" between the year and the number, and the "L" was in upper case:

ARC1980-5L

ARC1979-3

In order to avoid the duplication of acquisition numbers a log of numbers used was kept.

10.4.2 Item number

The item number consisted of three components; the MDA identifying code for the Museum, the department and collection, and the number for the individual item, which consisted of a letter and four digit number. Thus an item in the National Maritime Museum's collections, which is in the Archaeological Research Centre's object collection, which is numbered A1 would be fully numbered thus:

NMM AO A1

Numbering proceeded from A1 to A9999, and then from B1 to B9999 and so on. Most classes of item in the ARC were sufficiently small in quantity to only have need of the "A" series of numbers. For certain classes of item (for instance information files) different series letters were used to break up the numbering into its natural groupings. When letters other than "A" were required, the potentially misleading letters, I (confused with 1), and O (confused with 0) were avoided. Wherever possible the collection code was an easily remembered mnemonic. The collection codes used by the ARC are as follows:

Objects	O	(NMM AO A1-)
Slides	T	(NMM AT A1-)
Drawings	D	(NMM AD A1-)
Information Files	I	(NMM AI A1-)
Samples	S	(NMM AS A1-)
Conservation Records	C	(NMM AC A1-)
Contexts	L	(NMM AL A1-)
Radiocarbon dates	R	(NMM AR A1-)

(Photographic negatives, and bibliographic records had numbers assigned by their relevant departments).

For internal use the departmental code, and collection code were mandatory; externally the NMM prefix was also necessary. A log of numbers used was kept to avoid duplication. Figure 75 contains a full description of the numbering system for the classes of item with more than one series letter.

10.4.3 Location recording within NMM

Ideally the Petrel conventions for location recording within NMM would have been used, but at the time of establishing the ARC system, the need for a Museum-wide numbering scheme had been noted, but conventions had not been agreed. The system to be used for the ARC was required to locate items to a space within the Museum, and secondly to locate them within this space. ARC stores and displays items in a relatively few areas of the Museum, so it was possible to list these, and use the list thus derived as a means of terminology control. The simple list, with locations in the Feathers Place Annexe, Kidbrooke stores, and elsewhere in the Museum, is shown at Figure 57. The second portion of the location was designed to give the precise location, such as drawer 2, tank 3, plan chest drawer 2, and so forth. Initially there was no attempt at standardisation of this, but it was hoped that consistency could be achieved later by using checking indexes to extract the natural vocabulary.

INFORMATION FILES

NMM AI A1-	Logboats
NMM AI B1-	Sites and vessels
NMM AI C1-	Technical
NMM AI D1-	Seafaring
NMM AI F1-	Underwater sites and vessels
NMM AI P1-	Ethnographic places
NMM AI Q1-	Ethnographic vessels and types
NMM AI R1-	Objects
NMM AI S1-	Ethnographic glossary
NMM AI T1-	Ethnographic technical
NMM AI U1-	Conservation

SAMPLES

NMM AS A1 - 999	Not used
NMM AS A1000 - 1999	Brigg
NMM AS A2000 - 2999	Logboats
NMM AS A3000 - 3999	Ferriby
NMM AS A4000 - 4999	Graveney
NMM AS A5000 - 5999	Not used
NMM AS A6000 - 6999	Wood Quay
NMM AS A7000 -	Miscellaneous

CONSERVATION RECORDS

NMM AC A1 - 1999	Not used
NMM AC A2000 - 2999	Graveney
NMM AC A3000 - 3999	Brigg
NMM AC A4000 - 4999	Not used
NMM AC A5000 -	Miscellaneous

Figure 75: Item numbers where there is more than one series letter

11 DATA CAPTURE BY FORM AND DIRECT COMPUTER INPUT

11.1 Introduction

The record system developed for the ARC would need to have both a "user friendly" computerised data capture system to facilitate direct input, and paper recording media. The paper record was necessary when data from a number of sources needed to be combined before input, or when the computer was unavailable, or when records were to be compiled at a remote location such as the stores or an excavation. The paper record was also needed to record the certified sightings of an object during annual stocktaking, and as a medium on which to affix the record photograph of the object. Initial recording on paper was also preferred by some staff. A particular need was for data capture in the field - whilst experiments in the use of portable personal computers for direct input were undertaken, such facilities were seen to be unlikely to be generally available for some time.

The development of software for data input is described in Chapter 12, below. It was necessary to define the data categories which would be recorded, and the prompts to aid the user to input the data in the correct format. The formats devised for computerised data capture via the MAXARC software consist of a subset of the data categories from the ARC Data Standard (Chapter 9), as the MAXARC software had limitations in record size, and in the maximum number of data categories which could be recorded, and it was therefore not possible to accommodate all of the (several hundred) possible fields of data in the ARC data standard. Chapter 11 is concerned with how data to be stored in this format would be collected, both by direct input to the computer, and by proforma. Included at section 11.12 is a brief description of methods used for recording in the field. The forms in use are listed in Figure 76.

OBJECTS	
A4 Acquisition Card Item Master Record Form Excavated object form Item Label	Acquisition Slip (Form NMM35) Item Photo, Muster and Valuation Form Finds form
SLIDES Slide Mount	
DRAWINGS Drawing index Card	
INFORMATION FILES Information file form	
SAMPLES Original Sample form Sample form Sample circulation slip	
CONSERVATION RECORDS Conservation form	
CONTEXTS Context form	
PHOTOGRAPHIC NEGATIVES Photographic negative index card	
RADIOCARBON DATES Radiocarbon date index card	

Figure 76: Forms in use in the ARC

11.2 Data capture for objects

11.2.1 Overview

The record structure for objects (section 9.6.2) was designed to provide for the storage of all of the information concerning an object. In practice there were however certain categories of data for which it was felt that the computerised record would not be the primary record. Included in this class was information that was subject to relatively frequent changes (such as locations and loan valuations), and data in forms which presented technical problems for computer storage, such as photographs, and lengthy passages of text. In addition it was felt to be necessary to have a signed record when objects were sighted during annual stocktaking, and this needed to be in conventional paper media. Two forms were therefore devised, an item photo, muster and valuation form, to provide a permanent record for data which was not in the first instance going to be computerised, and the item master record form, which would serve as a data capture and input form for the computerised record. A label to be attached to objects was also required.

11.2.2 Existing media

The existing media for objects consisted of an A4 acquisition card which served as a master record for the object (Figures 77 and 78), and Form NMM35 - the acquisition slip (Figure 21). The A4 card recorded information on the acquisition, description, and provenance of the object, together with location history, and cross references to other records. There was space on the acquisition card for affixing a photograph.

ACQUISITION NUMBER

Previous Acquisition number

Source of Acquisition

Name address donor

Description of object

Dated

Photograph of object
Ref. No.

Manner of Acquisition	Cost	Date Acquired	Accepting Officer

Figure 77: A4 acquisition card (obverse)

Excavated Object | Site Reference No.

Map Reference | Grid Reference

Studio Negative Numbers

Slide Reference Numbers

Drawing Reference Numbers

Conserved	Yes	No
Carbon Date	Yes	No

Dated

Sample Numbers

Other Sample Numbers

Related Files

Storage and Display

Publications

RLn 60112/1/125375 500 5/79 TP

Figure 78: A4 acquisition card (reverse)

N.M.M. A. R. C.
ITEM MASTER RECORD FORM

ITEM NO.
ACQS. NO.

ACQS Donor (Name,Title, Address)

Date Acquired | Cost/Value | Manner of Acqs.

Museum file | Date of Return | Accepting Officer

Curator responsible for object

ID Type of Object

Name of Object | Status (if model or replica)

DESC Description of Object

Wt. | Length | Breadth | Ht.

FIND Where found | Date

Finder | How found

PROD Where made | Date

Maker

TRANS Date | Mus.file | Person/body involved

ORIG Identification | Item no.

Name | Dating

Place of manufacture | Maker

ASSN Old numbers, Assoc. people

REPRO NMM negative nos.

REF Related items (cons, sample, drawings, negs, prints, slides, objects, research file)

Bibliographic refs.

---

see over for notes/continuation

Figure 79: Item master record form

11.2.3 Item master record form

This form is reproduced at Figure 79. It was designed to facilitate the recording of all the information which would be needed for the completion of the computerised record. Although not intended to have any permanence, in practice it was usually retained. The information is similar to that contained on the original A4 acquisition card, but location, valuation, and the photograph are recorded on the item photo, muster and valuation form (section 11.2.4). Information on acquisition, identification, description, finding, production, transfer, and the original (if the item is a copy or model) could be included in detail, together with cross references to other types of information.

11.2.4 Item photo, muster and valuation form

This form is reproduced at Figure 80. The form was designed as a formal repository for the object's record photograph, and as it was not felt practical or desirable to frequently modify the computer record, location and valuation information were recorded on it also. In addition it provided a place where the signature of the curator conducting the annual stocktaking (muster) could record the sighting of the object. To aid the identification of the item the description and dimensions were reproduced on this form.

11.2.5 Excavated object form

The excavated object form (Figure 81), which was printed on waterproof paper, was designed for the recording of objects which had been recovered via fieldwork, and incorporated into the ARC systems. The form was used to record the provenance and description of the object, its location, acquisition history, and references to other sources of information. When the record (and object) had returned from the field the form was be complimented by the Item muster, valuation and photo form (see above). If necessary the item master record form which has additional space for detailed description and interpretation could be used as well.

NATIONAL MARITIME MUSEUM ARCHAEOLOGICAL RESEARCH CENTRE *ITEM PHOTO, MUSTER & VALUATION FORM* (March 1982)	ITEM NUMBER ACQUISITION NUMBER

DESCRIPTION OF OBJECT

DIMENSIONS

Weight Length Breadth Height

PHOTO NEG.No.

MUSTER

DATE	PLACE	PURPOSE	INITIALS

VALUE (LOANS)

Date	Value	Initials	Date	Value	Initials

Figure 80: Item photo, muster and valuation form

EXCAVATED OBJECT FORM (V.82.12)	ARCHAEOLGOCIAL RESEARCH CENTRE NATIONAL MARITIME MUSEUM (01-858 4422)		OBJECT NO. AO
DESC	SINGLE/GROUP FIND: QUANTITY (IF GROUP)		ACQUISITION NO. ARC
	SIMPLE NAME OF OBJECT(S)		SITE
			SUB. DIV.
	MATERIAL OF OBJECT(S)		CONTEXT
			GRID
	DIMENSIONS		LEVEL/DEPTH
			METHOD OF EXCAVATION
	DESCRIPTION		
	DATING		
LOC.	STORAGE LOCATION		
REF.	INFO. FILE	CONS.	SAMPLE
	DRAWING	PHOTO	SLIDE
	OBJECTS ETC.		
ACQ.	DONOR (NAME, TITLE, ADDRESS)		
	DATE ACQUIRED	COST/VALUE	MANNER OF AQS.
	MUSEUM FILE	DATE OF RETURN	ACCEPTING OFFICER
	CURATOR RESPONSIBLE FOR OBJECT(S)		
	RECORDED BY:		DATE

Figure 81: Excavated object form

FINDS FORM (V.82.3)

ARCHAEOLOGICAL RESEARCH CENTRE
NATIONAL MARITIME MUSEUM
((01-858 4422)

SITE

SUB DIV

DATE DUG   RECORDED BY   PAGE   OF

CONTEXT

FINDS PLAN. ADD 2 GRID POINTS & LABELLED SECTIONS

FIND NO.	EAST	NORTH	DEPTH	TYPE	METHOD	STORAGE	NOTE

PTO FOR NOTES

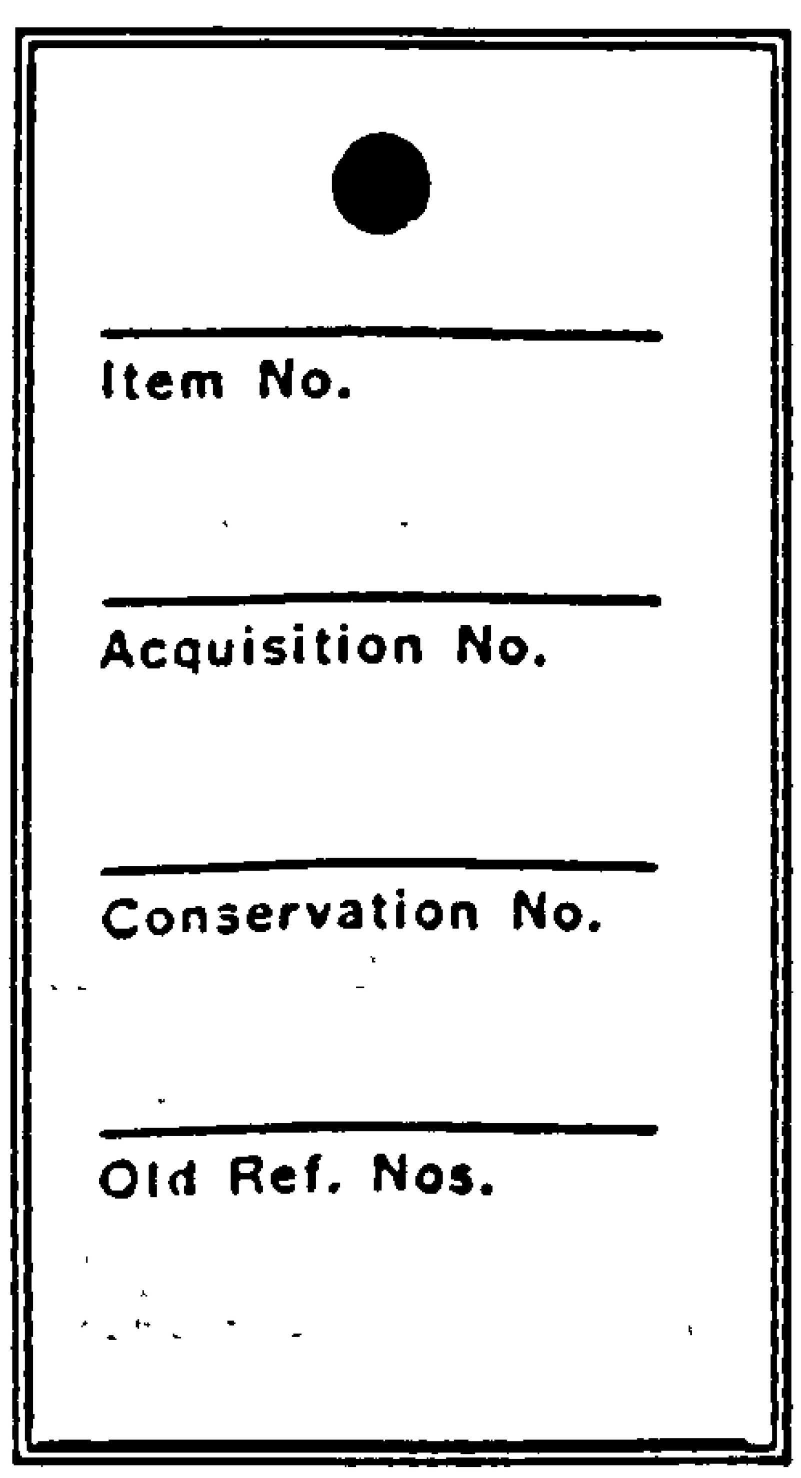
Figure 82: Finds form

11.2.6 Finds form

The finds form was designed for the detailed plotting of artifact locations in relation to other artifacts and stratigraphy. It compliments more "formal" drawings and plans, and was designed to be used in conjunction with the excavated object form, or where a detailed object form would not be made out in the field. In the field it was envisaged that all finds would be recorded on the finds form, whilst the excavated object form might only be used for special finds. The finds form (Figure 82) was printed on waterproof paper. The form was based on a design used by the Fenland Archaeological Trust (Booth 1985a).

11.2.7 Item label

The label (printed on waterproof paper) was designed to facilitate the rapid identification of any item, and was intended for use on both acquisitions and loans. It is reproduced at Figure 83. In addition to the item number there was space for the acquisition and conservation numbers, and for any previous reference numbers.


Item No.

Acquisition No.

Conservation No.

Old Ref. Nos.

Figure 83: Item label

Object number
File (NMMAO)
Series (A)
Custodian
Date entered (eg 15 Sep 1983)

Object type
Boat type
Boat part
Specific type
Unique name (eg Brigg raft)
Status (eg replica, model)
Identity note

Risk item (Y for yes, RETURN for no)
Quantity
Object material
Material note
Condition
Completeness
Colour
Length (cm)
Width (cm)
Height (cm)
Weight (cm)
Scale (eg 1:10)
Description note

Find area
Find place (see format for place)
Site name
Sub Division (eg Trench 3)
Context
Grid type (NG or site)
Grid square (for NG)
Easting
Northing
Depth/level (m)
Date found (eg 13 Jun 1888)
Finder (eg Heal, S V E)
Excavation/find method (eg shovel, gravel extraction)
Find note

Maker (eg Wright, E V, Iceni)
Area of manufacture
Place made (see format for place)
Period of manufacture
Date made (see format for date)
Radiocarbon date (see format for RC date)
Manufacture note

Acquired from (eg Jones, J or Science Museum)
Address of donor
Date acquired (eg 14 Jan 1957)
Acquisition number (eg ARC1983-4L)
Acquisition file (eg Y82/23)
Acquisition method
Return/review date for loan (eg Jul 1984)
Value/cost
Acquisition note

Location
Specific location (eg Box 14)
Location outside NMM (see format for place)
Date at location (eg 14 Jan 1983)
Reason (eg storage, display, conservation)
Location note

Original note (if object is model, replica etc)

Inscription note

Transfer note

Use note

Exhibition note (use also for gallery refs eg NH.33.2)

Publication (see format for references)
Museum files (eg A1/13/1, G34/1(ii)/1)
Information files (eg A12, B44)
Drawings (eg A234, A4545)
Conservation numbers (eg A2345, A2346)
Samples (eg A6767, A9812)
Objects (eg A123, A125)
Slides (eg A3435, A3436)
Contexts (eg A345, A234)
Museum negatives (eg C3457/a, A4012/3)
Old numbers (eg RM56, NC12)
Reference note

General note

Figure 84: Prompts for data input for objects

11.2.8 Computerised data capture for objects

The prompts for user input followed the structure of the item master record form (above). There were data fields for recording identification, description, finding, manufacture, acquisition, location, and cross references to other sources of information in full. For original, inscription, transfer, use, exhibition, and publication a note only could be recorded, as the software limitation on the number of fields did not permit space for detailed recording in these less used data categories. Figure 84 lists the prompts for data input for the object computerised record.

11.3 Data capture for slides

11.3.1 Data recorded on the mount

The main means of retrieval for slides was by browsing, as they were stored in racks of 100, which permitted their viewing against an illuminated screen. No forms were used for the recording of transparency information, but the mount was marked with the subject of the slide, storage location, negative number, and a spot on the bottom left hand corner to aid orientation for projection. With the introduction of the new ARC record system, the slide item number was added to the information recorded on the mount (Figure 85). Additional information was supplied by curators from their own knowledge, either for recording on the slide mount, or for input to the computer record.

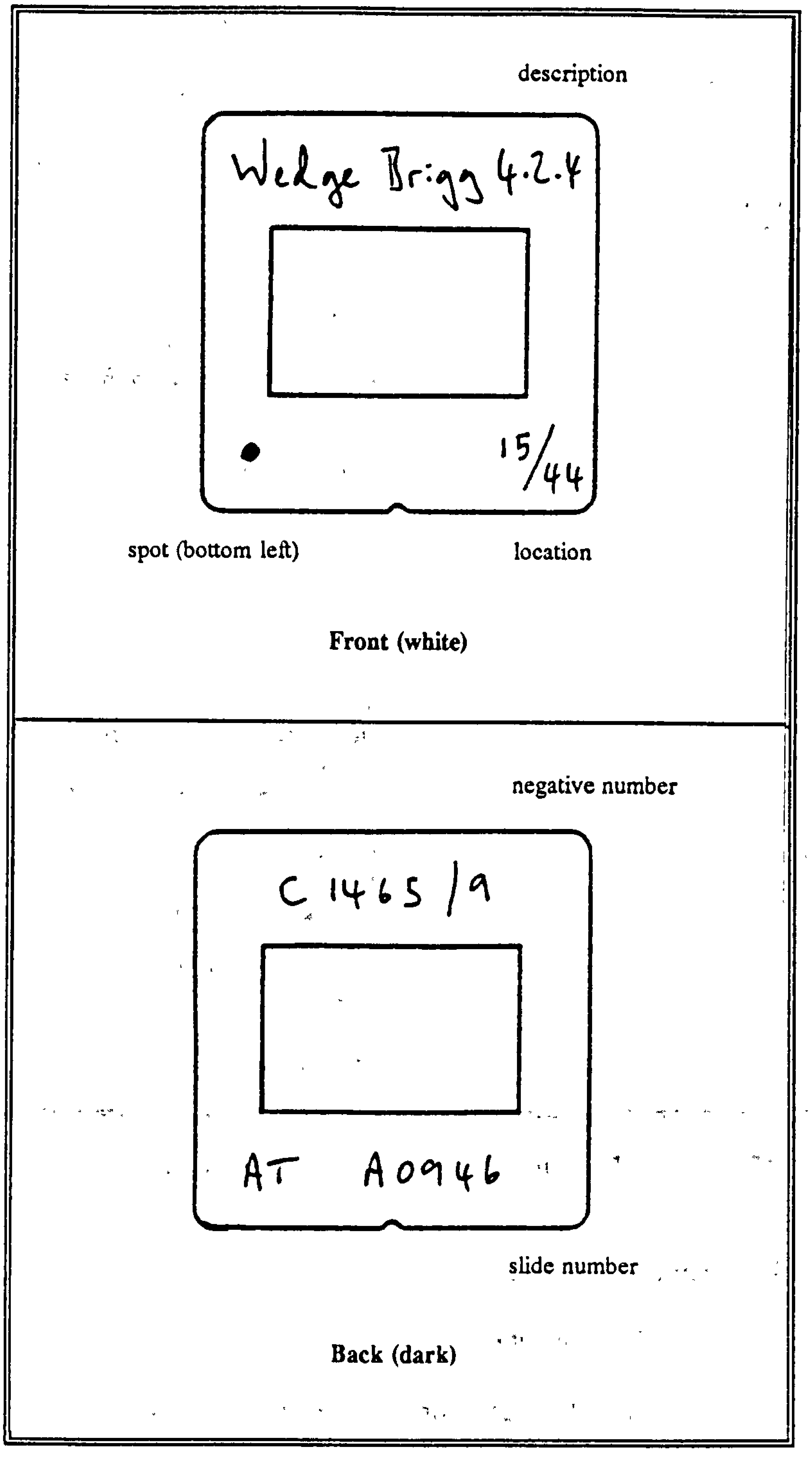


Figure 85: Slide mount

Slide number (eg 634)
File (NMMAT)
Series (A)
Custodian
Date entered (eg 3 Oct 1983)

Identity note

Colour/monochrome (C/M)
Size square in cm (only use if not 5cm)
Description note

Maker (eg Wright, E V or British Museum)
Date made (see format for date)
Manufacture note

Acquisition note

Location
Rack number (eg 14)
Place on rack (eg 99)
Date at location (eg 3 Oct 1983)
Location note

Original note

Transfer note

Association note

Exhibition note

Subject - area
Subject - place
Subject - site name
Subject - sub division (eg Trench 3)
Subject - context
Subject - person (eg Wright, E V)
Subject - period
Subject - date (see format for date)
Subject - radiocarbon date (see format for rc dates)
Subject - type of object
Subject - type of boat
Subject - part of boat
Subject - specific type
Subject - unique name (eg Brigg raft)
Subject - object number (eg A123)
Subject - object material
Subject - manufacture note
Subject - process
Subject - material
Subject - equipment
Subject - process/material/equipment note
Subject - note

Publication (see format for references)
Museum files (eg A1/13/1, G34/1(ii)/2)
Information files (eg A12, B44)
Drawings (eg A234, A4545)
Conservation numbers (eg A2345, A2346)
Samples (eg A6767, A9812)
Objects (eg A123, A125)
Slides (eg A3435, A3436)
Contexts (eg A345, A234)
Museum negatives (eg C3437/a, B4012/3)
Old numbers (eg RM56, NC12)
Reference note

General note

Figure 86: Prompts for data input for transparencies

11.3.2 Slide computer record

The main purpose of the slide computer record was to serve as a cross-reference to other sources of information, and to link other records to the slides. The computer record was not generally used as an aid to the retrieval of slides, as this was usually achieved by browsing. However, should they be required, a full range of data categories was available to describe the subject of the slide. The computer record had facilities for recording the description, manufacture, location, subject, and cross references. For identification, acquisition, original, transfer, association and exhibition a note only could be recorded. Figure 86 shows the prompts for data input for the slide computer record.

11.4 Data capture for drawings

11.4.1 Card index

The existing records for drawings consisted of a card index arranged by subject category, such as "Brigg", "Ferriby", or "Sewn Boats". On the card was a brief note describing the drawing, and a record of the storage location of the drawing. It was decided to add the item number of the drawing to this card, rather than create any new paper documentation - the computer record would become the main record, with this card record serving as an index, and as an input document for the curator, who could if necessary add to the record at the time of input. Drawings could also include other graphic materials, including dyelines, and photographic prints. Figure 87 shows an example of a drawing index card.

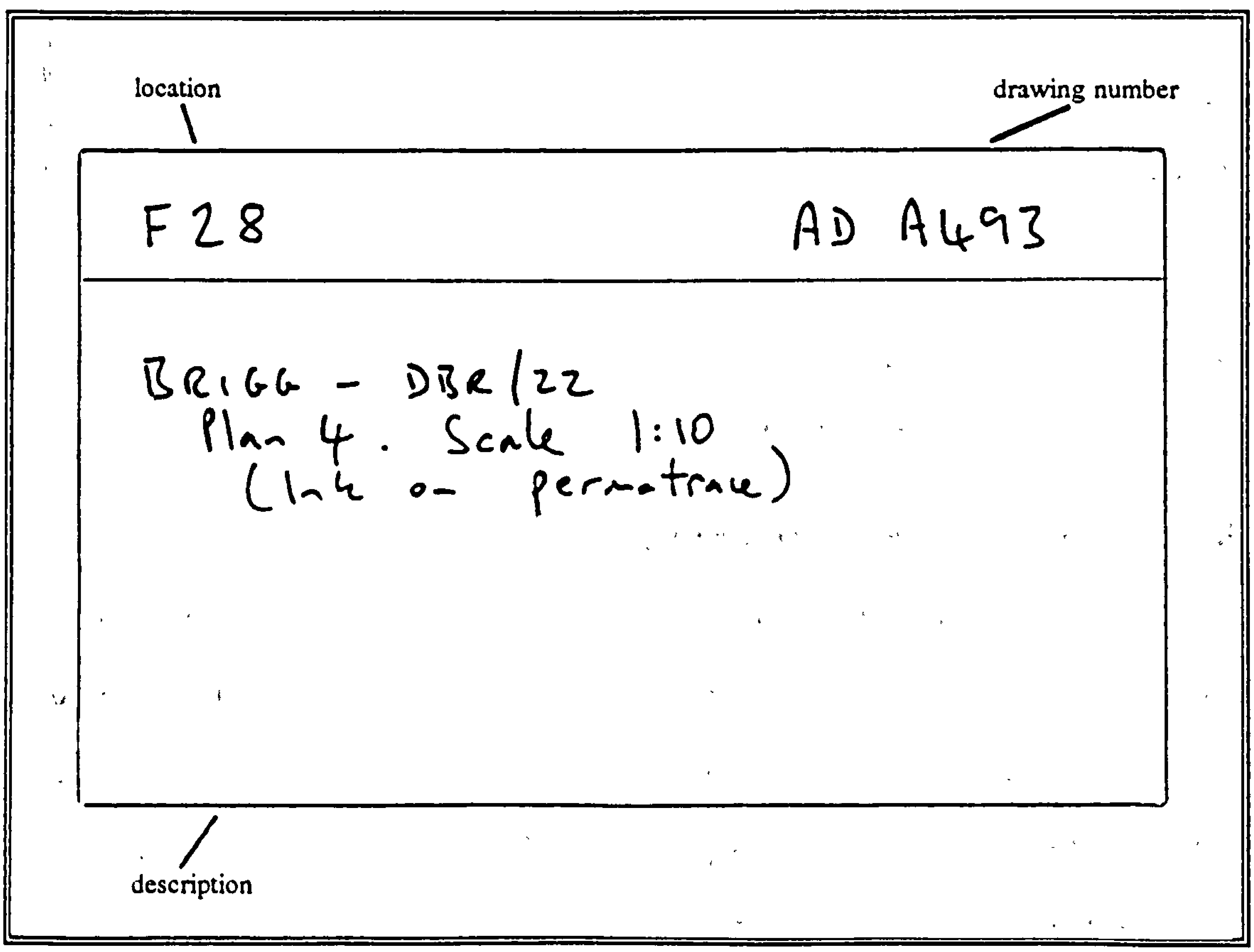


Figure 87: Drawing index card

Drawing number (eg 634)
File (NMMAD)
Series (A)
Custodian
Date entered (eg 3 Oct 1983)

Type of material
Identity note

Quantity
Material
Medium (eg pencil, ink)
Size (eg AO, A4 etc)
Scale (eg 1:10)
Description note

Maker (eg Wright, E V or British Museum)
Date made (see format for date)
Manufacture note

Acquisition note

Location
Type of storage
Specific location (eg vertifile, info file, plans chest number)
Date at location (eg 3 Oct 1983)
Location note

Original note

Transfer note

Association note

Exhibition note

Subject - area
Subject - place
Subject - site name
Subject - sub division (eg Trench 3)
Subject - context
Subject - person (eg Wright, E V)
Subject - period
Subject - date (see format for date)
Subject - radiocarbon date (see format for rc dates)
Subject - type of object
Subject - type of boat
Subject - part of boat
Subject - specific type
Subject - unique name (eg Brigg raft)
Subject - object number (eg A123)
Subject - object material
Subject - manufacture note
Subject - process
Subject - material
Subject - equipment
Subject - process/material/equipment note
Subject - note

Publication (see format for references)
Museum files (eg A1/13/1, G34/1(ii)/2)
Information files (eg A12, B44)
Drawings (eg A234, A4545)
Conservation numbers (eg A2345, A2346)
Samples (eg A6767, A9812)
Objects (eg A123, A125)
Slides (eg A3435, A3436)
Contexts (eg A345, A234)
Museum negatives (eg C3437/a, B4012/3)
Old numbers (eg RM56, NC12)
Reference note

General note

Figure 88: Prompts for data input for drawings

11.4.2 Computer record for drawings

The computer record was intended to serve as an aid to drawing retrieval, as a cross-reference to other sources of information, and as a means of linking other records to drawings. A full section for describing the subject of the drawing was therefore available. The computer record had facilities for recording the description, manufacture, location, subject, and cross references. For identification, acquisition, original, transfer, association and exhibition a note only could be recorded. Figure 88 shows the prompts for data input for the drawing computer record.

11.5 Data capture for information files

11.5.1 Information file form

The existing records for information files consisted of a list of files, with no additional information regarding the subject of the files, or the items physically contained within them. The information file form (Figure 89) was designed as a means of collecting data for subsequent computer input, but being kept in the file, served also as a record of the items physically stored there. It recorded the name and number of the file, the responsible curator, and had space for a detailed description of the subject of the file, and for listing bibliographic items, drawings, photographs, and other items either contained in the file or related to it. The items likely to be kept in the file were be offprints or xerox, and small (less than A4) drawings, and photographs.

11.5.2 Information file computer record

The computer record was intended to serve as an aid to information file retrieval, and as a cross reference to other sources of information, and as a cross reference from other records to the information file. A full section for describing the subject of the file was therefore available. The computer record had facilities for recording the identification, location, subject, and cross references. For description, manufacture, acquisition, original, transfer, association and exhibition a note only could be recorded. Figure 90 shows the prompts for data input for the information file computer record.

ARC Information File Form	Name of File:
	Number of File: AI
	Custodian of File:

Subject of File: (Only complete categories relevent to file).

Excavation name:

Place:

Person:

Period/date:

Object number of subject:

Type of object/boat:

Part of object/boat:

Material of object/boat:

Process:

Material:

Equipment:

Note:

Content of File.

Bibliographic references: (both in file, and referred to by the file)

Drawings: (give drawing numbers of drawings and other graphic material in file)

Photographs: (give negative numbers of photographs contained in the file)

Other items contained in, or referred to by the file:

Continue overleaf, or on a separate sheet as necessary.

Figure 89: Information file form

Info file number (eg 634)
File (NMMAI)
Series (A)
Custodian
Date entered (eg 3 Oct 1983)

Name of file (eg South Edinburgh Channel)
Identification note

Description note

Manufacture note

Acquisition note

Location
Specific location (eg filing cabinet drawer 14)
Date at location (eg 3 Oct 1983)
Location note

Original note

Transfer note

Association note

Exhibition note

Subject - area
Subject - place
Subject - site name
Subject - sub division (eg Trench 3)
Subject - context
Subject - person (eg Wright, E V)
Subject - period
Subject - date (see format for date)
Subject - radiocarbon date (see format for rc dates)
Subject - type of object
Subject - type of boat
Subject - part of boat
Subject - specific type
Subject - unique name (eg Brigg raft)
Subject - object number (eg A123)
Subject - object material
Subject - manufacture note
Subject - process
Subject - material
Subject - equipment
Subject - process/material/equipment note
Subject - note

Publication (see format for references)
Museum files (eg A1/13/1, G34/1(ii)/2)
Information files (eg A12, B44)
Drawings (eg A234, A4545)
Conservation numbers (eg A2345, A2346)
Samples (eg A6767, A9812)
Objects (eg A123, A125)
Slides (eg A3435, A3436)
Contexts (eg A345, A234)
Museum negatives (eg C3437/a, B4012/3)
Old numbers (eg RM56, NC12)
Reference note

General note

Figure 90: Prompts for data input for information files

11.6 Data capture for samples

11.6.1 Existing records

A sample form had been in use for some time as the primary record for samples (Figure 92).

A log of sample numbers was also kept.

11.6.2 Sample form

It was decided to develop a new form primarily as part of the system for the field collection of data, although there could also be some circumstances where it would also be used in the museum (Figures 92 and 93). The obverse of the sample form was designed to record the source of the sample (including detailed stratigraphic location if relevant), the item the sample is taken from, its physical description, and cross-references to other sources of information. On the reverse was the purpose for which the sample was taken, a checklist of processes it could be subjected to, the results of any tests, notes or drawings, and the storage location of the sample. The storage location box could also be used to indicate if the sample had been destroyed. The sample form was printed on waterproof paper.

After initial trials it was found that some means of controlling the circulation of the form was needed, and a sample form circulation slip was therefore designed, to be attached to the form. This was to ensure that the form was returned to the person initiating the work, and that the computer record was being kept up to date (Figure 95).

11.6.3 Sample computer record

The computer record for samples was designed to serve as a detailed summary of the information about the sample. It had facilities for recording in detail information about the location, description, provenance, processes to which it has been subjected, and cross references to other sources of information. A note may be recorded about the samples identification, and association. Figure 94 shows the prompts for data input for the sample computer record.

Ref. to full report and publications

Contact Print

Drawing YES/NO

Sample no.

Name, site no. or other identification marks

Description of sample

Length	
Breadth	
Width	
Weight wet	
dry	

Origin

Acquisition no.

Precise location of where sample taken

Conservation no.

Photo. neg. no.

Instructions

SIGNATURE ....

Sample taken by

Date

Brief results and conclusions (sign and date)

Location/Sent to

Date	Name/Place

cont'd. over leaf

Figure 91: Original sample form

SAMPLE FORM (V.82.3)

ARCHAEOLOGICAL RESEARCH CENTRE
NATIONAL MARITIME MUSEUM
(01-858 4422)

SAMPLE NO

LOCATION	SOURCE OF SAMPLE	SITE
		SUB DIV
		CONTEXT
		GRID
		LEVEL

IDENT	Is the sample part of something else? Describe the whole, and part if applicable.
DESC	Material
	Condition
	Dims. Lth. / Bdth. / Dpth. / WT.(w) / Wt(d)

XREF	Cons. No.	Xray
	Acq. No.	C14
	File No.	Store
	Drawing No.	Sub Samples
	Photo	
	Collected	Date

Figure 92: Sample form (obverse)

Precise question(s) to be answered:	BACK INSTRUCTIONS
Xray · Draw · Photo · Conserve · C14	(Tick)
Retain after exam. · Signatures. · Date	
Signature: · Date	Results & conclusions
	Notes, Drawings, etc.

DATE	PLACE	INIT	DATE	PLACE	INIT	LOCATION
DATE	PLACE	INIT	DATE	PLACE	INIT	
DATE	PLACE	INIT	DATE	PLACE	INIT	
DATE	PLACE	INIT	DATE	PLACE	INIT	

Figure 93: Sample form (reverse)

Sample number (eg 634)
File (NMMAS)
Series (A)
Custodian
Date entered (eg 29 Feb 1984)

Identification note

Initiator (eg Heal, S V E)
Date initiated (eg 13 Jan 1984)

Location
Specific location (eg Box 13)
Location outside NMM (see format for place)
Date at location (eg 17 Oct 1982)
Reason (eg ID, photo etc.)
Location note

Sample material
Material note
Condition
Length (cm)
Width (cm)
Height (cm)
Weight wet (kg)
Weight dry (kg)
Description note

Find area
Find place (see format for place)
Site name
Sub Division (eg Trench 3)
Context
Grid type (NG or site)
Grid square (for NG)
Easting
Northing
Depth/level (m)
Date excavated (eg 14 May 1982)
Finder (eg Squirrell, J P)
Excavation/find method (eg shovel, toothpick etc.)
Find note

ID person
ID date
ID result
Xray person (eg Gregson, C)
Xray date (eg 13 Jan 1984)
Xray result
Draw person (eg Hunn, J)
Draw date (eg 15 Mar 1984)
Draw note
Photo person (eg Hutchinson, G)
Photo date (eg 19 Jun 1982)
Photo note
Cons person (eg Stevens, D)
Cons date (eg 25 Apr 1983)
Cons note
C14 Person (eg Switzur, R)
C14 date (eg 3 Mar 1977)
C14 result
Other analysis type
Other analysis person (eg Booth, B K W)
Other analysis date (eg 1 Apr 1984)
Other analysis note
Process note

Publication (see format for references)
Museum files (eg A1/13/1, G34/1(ii)/2)
Information files (eg A12, B44)
Drawings (eg A234, A4545)
Conservation numbers (eg A2345, A2346)
Samples (eg A6767, A9812)
Objects (eg A123, A125)
Slides (eg A3435, A3436)
Contexts (eg A345, A234)
Museum negatives (eg C3437/a, B4012/3)
Old numbers (eg RM56, NC12)
Reference note

General note

Figure 94: Prompts for data input for samples

SAMPLE FORM CIRCULATION SLIP	
INITIATOR	
ACO LOG COMPUTER	
ANALYST	
INITIATOR	
ACO LOG COMPUTER	
INITIATOR	

Figure 95: Circulation slip for samples

11.7 Data capture for conservation records

11.7.1 Existing records

It was decided (pending the testing of the sample form described at 11.6.2 above) to retain the conservation form which had been in use for some time (Figure 96 and 97). It records on the obverse the provenance and description of the item being conserved, and there is a space for a photograph of the object. On the reverse the conservation processes, sample numbers, and storage locations are recorded. In conjunction with the conservation daybook this serves as the primary record for conservation work, with the possibility at a later date of a portion of the record (for indexing and retrieval purposes) being stored on the computer.

CONSERVATION NUMBER

Other identification marks	Site number	
Source of object	Date received	
	Date returned	
Returned to		
Description	Length	
	Breadth	
	Width	
	Weight	

Photograph of object
Ref. No.

Laboratory workbook Number	Conservator	Continuation Sheet No.	
	Initials		

Figure 96: Conservation form (obverse)

Conservation details

Storage special requirements

Display special requirements

Related files

Sample numbers	Storage/display area

Figure 97: Conservation form (reverse)

11.8 Data capture for contexts

11.8.1 Existing records

Previously the recording of stratigraphy in the field had been carried out using a notebook, although some trials were conducted using the draft versions of the MDA field recording forms. (MDA 1980c). The MDA forms were found to support a comprehensive set of data categories, but to lack the design features aimed at making them easy to use in the field, such as those adopted by the Central Excavation Unit (Jefferies 1977) and others.

11.8.2 The context form

The Context form (Figures 98 and 99) was developed to provide a means of recording stratigraphy in the field. The context form broadly followed that developed by Jefferies (1977), but used some of the multiple choice aids to rapid form filling which had been developed by the Fenland Archaeological Trust (Booth 1985a). On the obverse of the form were items to be completed in the field, consisting of the location of the context, the description of its form, the description of the soil following Soil Survey Handbook guidelines (Hodgson 1976), relationships following Jefferies (1977), and cross references to other records. The Munsell system was used for recording soil colours (Booth 1983b). As well as aiming to make the filling in of the form as easy as possible, an objective was to reduce to the minimum the amount of unstructured notes. If notes were required the form was designed so that they may be written on the reverse without unclipping the form from a clip board. On the reverse were (in addition to the notes) interpretive comments, references, and a summary of the finds recovered from the context. The form was printed on waterproof paper.

CONTEXT FORM (V.82.3)

ARCHAEOLOGICAL RESEARCH CENTRE
NATIONAL MARITIME MUSEUM
(01-858 4422)

CONTEXT NO

TYPE

LNGTH: BDTH: WDTH

METHOD OF EXC.

NOTE. (Shape, slope, etc.)

SITE

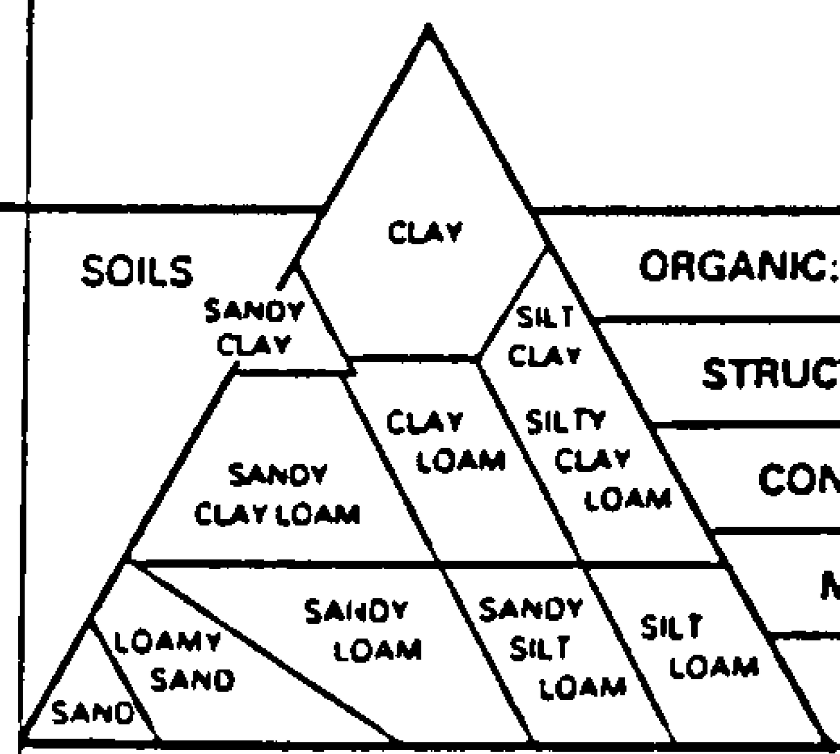
SUB. DIV

GRID

LEVEL

DESC

SOILS



ORGANIC: PEAT/SANDY PEAT/LOAMY PEAT/HUMOSE/NON HUMOSE

STRUCTURE: CRUM/GRANULAR/BLOCKY/PRISMATIC/COLUMNAR/PLATY

CONSISTENCE: (WET) FIRM/SOFT (DRY) HARD/FRIABLE

MUNSELL: NOTE

MOISTURE: DRY/MOIST/WET

INCLUSION %	INCLUSION %
INCLUSION %	INCLUSION %

MATRIX (STRUCTURES)

CONSTITMENTS (STRUCTURES)

NOTE

RELATIONSHIPS

PART OF

CONTAINS

SAME AS

ABOVE

CUTS

BELOW

CUT BY

UNCERTAIN

BUTTS

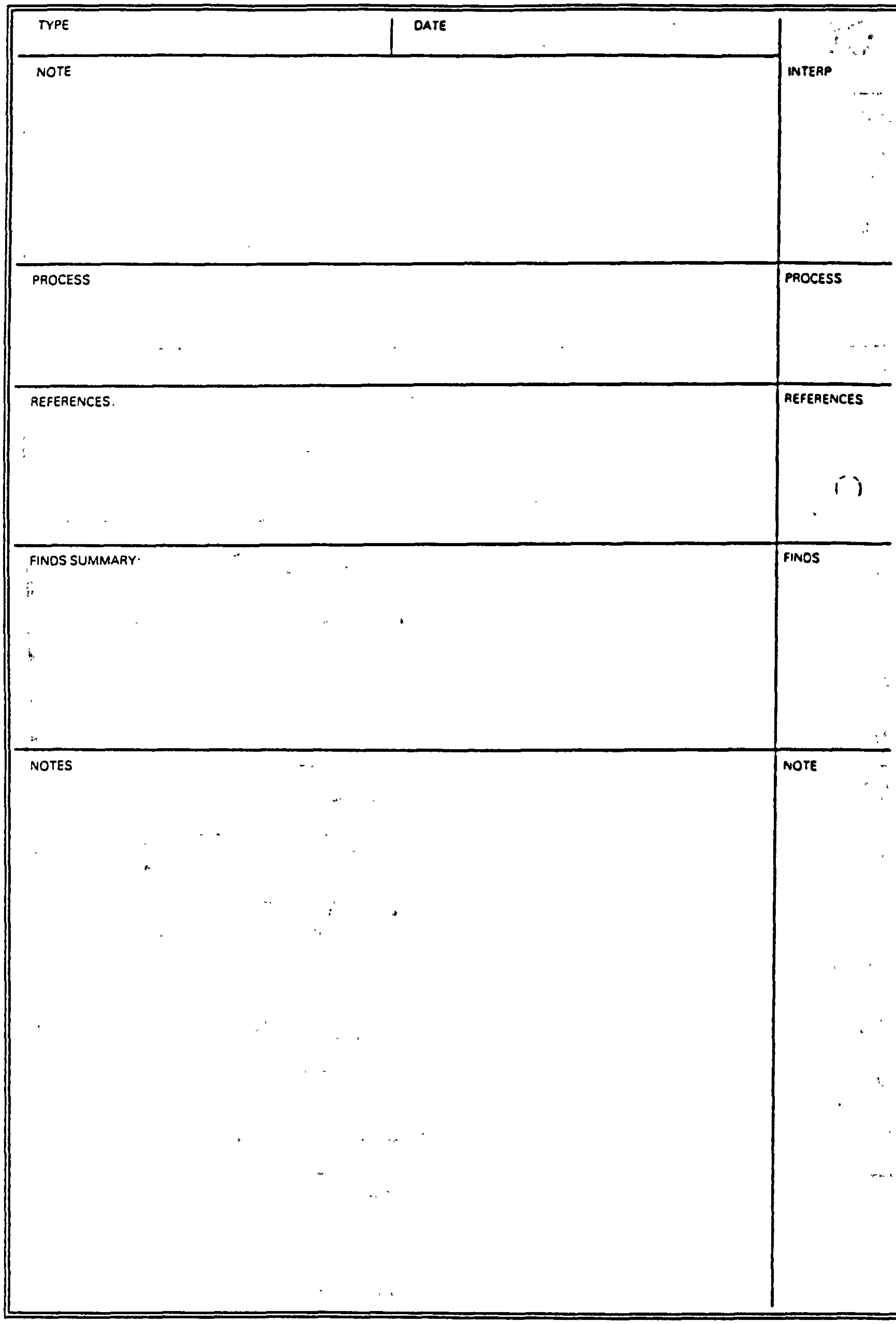
BUTTED BY

BONDED TO

XREF

PLANS	SECTIONS
PHOTO	SAMPLES
Exc DATE PERSON	RECORDED DATE PERSON

Figure 98: Context form (obverse)



TYPE
DATE
NOTE
INTERP
PROCESS
PROCESS
REFERENCES.
REFERENCES
FINDS SUMMARY
FINDS
NOTES
NOTE

Figure 99: Context form (reverse)

Context number (eg 634)
File (NMMAL)
Series (A)
Custodian
Date entered (eg 12 Mar 1984)

Type (eg layer, cut, structure)
Type note

Recorder (eg Heal, S V E)
Date recorded (eg 13 Jan 1984)

Length (cm)
Width (cm)
Height (cm)
Soil texture
Soil organic content
Soil structure
Soil consistence
Munsell (eg 10YR 5/2)
Soil moisture content
Soil inclusions
Structure - matrix
Structure - constituents
Description note

Find area
Find place (see format for place)
Site name
Sub Division (eg Trench 3)
Context
Grid type (NG or site)
Grid square (for NG)
Easting
Northing
Depth/level (m)
Date found (eg 13 Jun 1888)
Finder (eg Heal, S V E)
Excavation/find method (eg shovel, gravel extraction)
Find note

Part of (eg 15)
Contains (eg 176, 412)
Same as (eg 120, 614)
Above (eg 12, 14)
Cuts (eg 451, 901)
Below (eg 213, 902)
Cut by (eg 547, 906)
Uncertain (eg 231, 432)
Butts (eg 512, 871)
Butted by (eg 231, 187)
Bonded to (eg 54, 2)
Relationship note

Date (see format for dates)
Method of dating (eg pottery, dendro)
Radiocarbon date (see format for RC dates)
Phase
Dating note

Function (eg ditch, pit etc.)
Interpretation note

Process note

Finds summary

Publication (see format for references)
Museum files (eg A1/13/1, G34/1(ii)/2)
Information files (eg A12, B44)
Drawings (eg A234, A4545)
Conservation numbers (eg A2345, A2346)
Samples (eg A6767, A9812)
Objects (eg A123, A125)
Slides (eg A3435, A3436)
Contexts (eg A345, A234)
Museum negatives (eg C3437/a, B4012/3)
Old numbers (eg RM56, NC12)
Reference note

General note

Figure 100: Prompts for data input for contexts

11.8.3 Context computer record

The computer record for contexts was designed to be a full record of the context. It provided facilities for identifying the type of context, its location on an excavation, relationships to associated contexts, the interpretation of the context, a summary of finds recovered from it, and related records. There was a note field for any processes affecting the context, and a general note. The prompts for inputting the context computer record are listed at Figure 100.

11.9 Data capture for photographic negative records

A card index (arranged by both negative number and subject) was in use to record the subject of photographs. It was decided to continue to maintain this system, pending the development of a museum wide index of photographic negatives. Figure 101 shows an example of a photographic negative index card.

11.10 Data capture for bibliographic records

A card index of bibliographic holdings was in existence, arranged by author. It contained the author, title, and publication or journal details. An example of an index card is at Figure 102. There was also a subject index, but it was felt to be inconsistent. Agreement could not be reached on how to maintain it, and its use was therefore discontinued. It was decided to use the author card index as a finding aid within the ARC (UDC not being used for shelving), with the full bibliographic source being contained in the Petrel system, as the majority of bibliographic items had been catalogued by the NMM Library.

negative number

B4446/17

Graveney Boat

Complete boat as excavated
(Print attached to acquisition card).

description

Figure 101: Photographic negative index card

author

Fenwick, V. H.

"The Graveney Boat, a Pre-conquest
discovery in Kent".

IJNA 1 (1972), p 119-29.

title and reference

Figure 102: Bibliographic item index card

11.11 Data capture for radiocarbon dates

11.11.1 Existing records

A card index arranged by site and date, with the bibliographic citation for the date, was already in existence, together with a file containing a xerox copy of all references to C14 dates. The card index (example at Figure 103) was maintained, with a more detailed record being input to the computer.

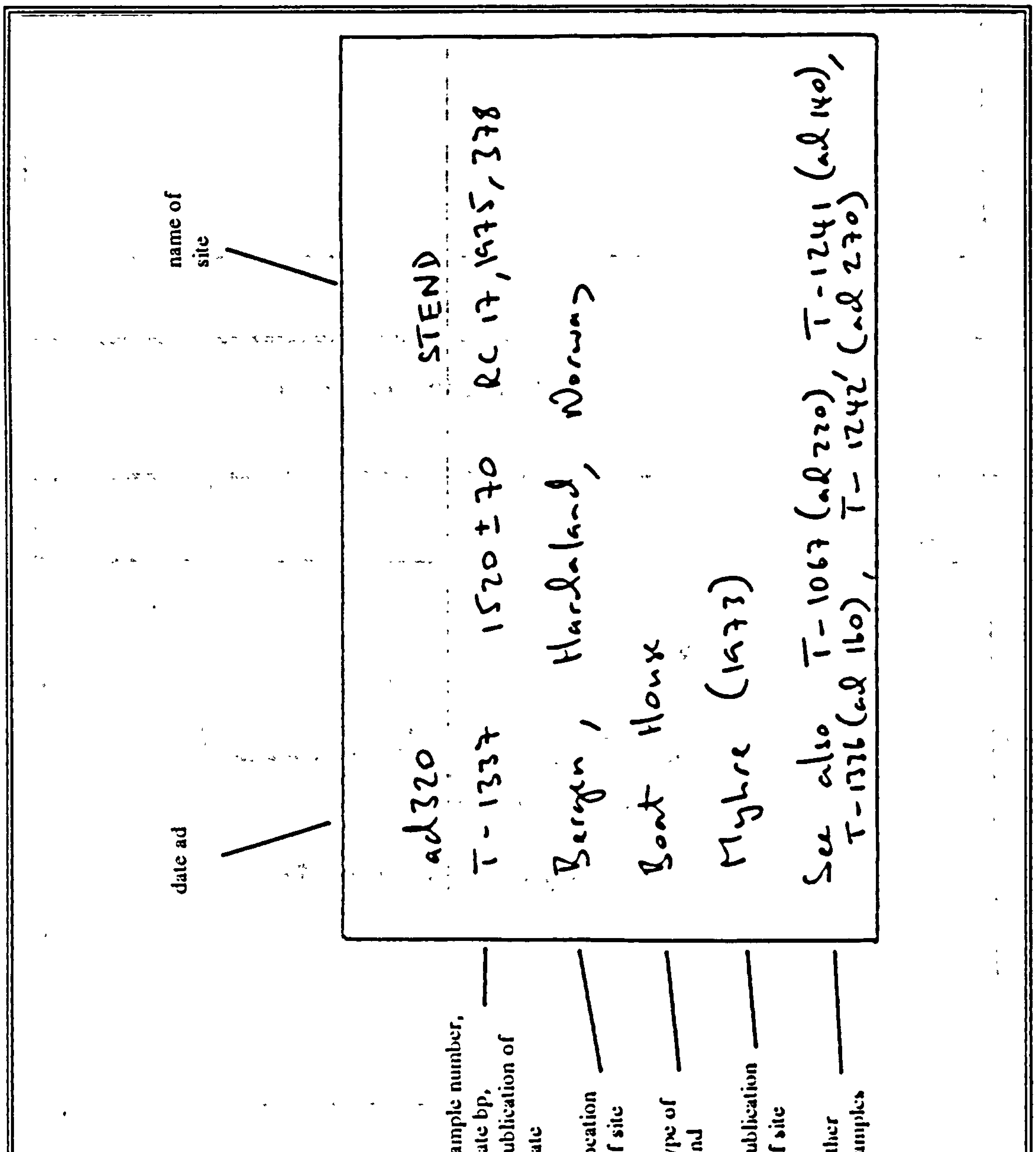


Figure 103: Radiocarbon date index card

11.11.2 Radiocarbon date computer record

The radiocarbon date record was designed to provide full retrieval and indexing on the date, and on the find from which the sample to be dated was derived. It was also integrated with other records via cross-referencing to the information file for the site or find. There were some facilities for describing the find itself, but these were fairly rudimentary, and were designed mainly to give the amount of information required for the publication derived from the computer record. The computer record had facilities to record information about the date, a full record of the sample from which it was derived (as outlined by Moffett and Webb 1983), the provenance of the item from which the sample was taken, dating other than by radiocarbon, a description of the item from which the sample was taken, and cross-referencing to other sources of information. Prompts for data input to the computer record are shown in Figure 104. Whilst this record was integrated with the other ARC records its main use was to produce text for the publication of a "Handlist of Maritime Radiocarbon Dates" (Booth 1984b).

11.12 Recording in the field

Recording on site could be achieved either by traditional paper methods, or using portable, weatherproof computers, equipped with suitable software. The development and trails of such computer systems are described in Chapter 12, below. Field recording forms were required for classes of item which would only be recorded in the field (contexts and most samples), and a special form was required for objects recovered in this way. It was also decided, following the system derived by the Fenland Archaeological Trust (Booth 1985a), to have an A4 sized finds plan, for the recording of relationships between artifacts. These forms would be complimented by drawings and photographs, together with a site note book (if applicable). The forms are described in the relevant sections above.

C14 Number (eg 56)
File (ARC14)
Series (A)
Custodian
Date entered (eg 3 Oct 1983)

Laboratory identifier
Laboratory number
Material of sample
Quality of sample
Quality of association
Sample description note

Sample - area
Sample - place (town, region, country)
Sample - site or vessel name
Sample - name
Sample - context
Sample - period
Sample - date not from C14
Sample - type of object
Sample - type of boat
Sample - part of boat
Sample - specific type
Sample - unique name (eg Brigg raft)
Sample - Object number (eg A123)
Sample origin note

Publication in Radiocarbon/Science
Publication (see format for references)
Museum files (eg A1/13/1, G34/1(ii)/2)
Information files (eg A12, B44)
Drawings (eg A234, A4545)
Conservation numbers (eg A2345, A2346)
Samples (eg A6767, A9812)
Objects (eg A123, A125)
Slides (eg A3435, A3436)
Contexts (eg A345, A234)
Museum negatives (eg C3437/a, B4012/3)
Old numbers (eg RM56, NC12)
Reference note

General note

Figure 104: Prompts for data input for radiocarbon dates

12 THE COMPUTER SYSTEM

12.1 Introduction

This chapter is concerned with the development of the software for the ARC record system, and with the selection of the computing environment to support the software. A short section outlines the requirements for field recording, and some experiments in the development of computer facilities for this purpose.

Chapter 6 reviewed the status of microcomputer based systems at the time when the computing environment was being selected. The conclusion was that a computer using the Z80 chip, based on the S100 bus, and using the CP/M operating system would provide the best platform for whatever software was selected. It would be necessary to have the maximum available random access memory (64K), a "winchester" hard disk, and a floppy disk drive. This conclusion was in line with the then recently published recommendations for archaeological computing (Stewart 1980b); which proposed Z80 S100 bus systems, with 64K memory, CP/M operating system, and an 8 inch floppy disk drive. If this type of machine was selected for the ARC, a wide range of software would be available, and the ARC computer system would conform to the "Industry standard". However, such a system would not be as inherently easy to use as the proprietary Apple or Commodore PET computers.

Having reviewed the ARC requirements, and guidelines for archaeological computing, compatibility with Petrel systems was considered. This would be necessary in order for data to be readily transferred for processing by the GOS program package. The Information Retrieval Section at NMM had at that time a Cromemco 8 bit microcomputer, running a variant of the CP/M operating system (CDOS). The advice from the Information Retrieval Section was that similar hardware should be acquired for the ARC.

Accordingly a Cromemco CS-1H was selected as it was compatible with the NMM system, and satisfied both the ARC requirements and the MDA recommendation. It had an S100 bus, a Z80 processor, 64K RAM, a 5MB winchester disk, and a 5.25 inch double sided, double density disk drive. The 8 inch disk drive recommendation was not followed, as this would prevent the straightforward transfer of data to the NMM Information Retrieval Section. In any case the 5.25 inch disk drive appeared to be becoming more widely used than the 8 inch variant, although most manufacturers 5.25" formats remained incompatible. The CS-1H had capacity to upgrade to a 68000 processor if this was required, and had the Cromemco reputation for reliability. It was supplied with a Lear-Siegler VDU and Centronics Printer, at a combined cost of £4,000.

Two types of software were required. The first was to allow the entry, editing and output of data, so as to be able to produce a catalogue and indexes of the various types of record held in the ARC. The second was to facilitate complex enquiries to be made of the data. This complex analysis would necessitate searches or recovery across more than one class of item - for instance to retrieve all the records for a particular boat find (including objects, samples etc.), and all records of similar finds. This second type of search would require all the records to be linked in some way, rather than remaining in discrete files.

The experience gained in processing the trial batch of data (Chapter 4, above) had shown that the facilities provided Petrel were unsatisfactory for data capture and editing, but via the GOS program package, were likely to be adequate for generating sophisticated catalogues and indexes, and could also be the means of accomplishing the more complex analyses outlined above. Alternative software for data capture would therefore have to be found, or written in-house. The following sections describe the specification and acquisition of software for data capture and editing, and the definition of requirements for more complex analysis.

12.2 Specification of data capture software

The first task was to examine the types of records which needed to be kept. The NMM data standard is extremely lengthy when used to the full, even though it is compactly defined (Chapter 9, above). However the subset employed by the ARC is smaller, and it was felt that a maximum of only about 130 fields of data would be required in total, and the different types of item would each require a subset of these fields. The most complex of these, the object record, would require a little under 80 data categories. The inclusion of long passages of text was not a requirement, as these would remain in the paper records, and a notional 256 bytes (characters) for any individual field was therefore felt to be adequate. The largest size of any individual record was estimated at 1,000 bytes (for the context record), with the remainder (such as objects) all at about 600 bytes. The survey described in Chapter 3 had shown the maximum number of records anticipated in any class was 4000, for slides. It was anticipated that the following types of data would need to be stored; free text, integer, real, and coded text (where a number is entered, which is automatically converted to its decoded value by the software). Some data categories would need to be repeated within a record, although it was felt that indexing on the repeated fields could be left until the data had passed to GOS. Figure 105 summarises the requirements for the record which was to be supported.

The software was required to allow the entry, editing and viewing of data on screen, and its output in ordered catalogue or summary index form to a printer. It was also necessary to have facilities to direct output to a file for subsequent word-processing, rather than immediately printing it. At the data entry stage it was a requirement that it should be impossible to input a record which was syntactically incorrect, and it was also necessary to be able to perform checks on the content of the data. Facilities for repeating data from one record to the next were required, so that where some of the information for several records is the same, the data only has to be input once.

MAXIMUM FILE SIZE	4000 records
MAXIMUM RECORD SIZE	1000 bytes
MAXIMUM NO. OF FIELDS PER RECORD	80
MAXIMUM FIELD SIZE	256 bytes
DATA TYPES	Free text Integer Real Coded text

Figure 105: Summary of software requirements

Retrieval according to certain parameters on a combination of fields was required. Because of the potential complexity of the records it was desirable that there should not be artificial limits on the number of fields a file may be indexed or retrieved on. Simple numeration was required; for instance to count the number of records matching certain criteria, or to add the contents of a certain field (for instance when finding the total value of all items on loan to the Museum).

Utilities were required to enable editing of a selected portion of the file automatically, according to predefined parameters. It was also a requirement for the structure of records to be modified. Facilities for output to other packages, and import from other packages were necessary. Utilities for backup and archiving were needed; a log of activity detailing the operation performed, the records accessed, and the user had to be kept. Records were required to be date stamped when altered, and the user altering had to be recorded; it should not be possible to alter records "owned" by another user. No password protection was specified, but users would have to identify themselves; one user would be designated "file manager"; only that user could perform the potentially more dangerous activities such as global erasure of records. A separate set of programs would be required for the setting up and maintenance of the databases. The majority of operations had to be interactively operated, via a simple to understand menu system; thorough documentation at users and technical level was required.

12.3 Selection of data capture software

The review of software carried out in Chapter 6 examined database management packages which could be suitable for archaeological records. In particular dBase II and Superfile were assessed in detail. The survey showed that none of the packages which were then available had the necessary facilities in terms of record length or number of fields, and many also had maximum limits on file sizes which would make them unsuitable for the classes of ARC items with large numbers of records.

Having discounted these commercially produced packages, software designed specifically for archaeological data was examined. Three systems were reviewed; the Central Excavation Unit package developed by Jefferies (Jefferies 1977, and Hinchliffe and Jefferies 1985); the software developed by Graham and Moffett for Mucking (Catton *et al* 1982), and the system being used by the Welland Valley Project at Maxey (Booth *et al* 1984).

The Central Excavation Unit's software was developed on Research Machines hardware, using the CP/M operating system, and was written in Microsoft Basic. It was able to support the required record structure, and, being integrated with a set of recording forms and procedures, was potentially able to provide the nucleus of a complete record system. It had the further advantage that it had been adopted by several archaeological units as well as the

Central Excavation Unit, and showed signs of becoming a standard for excavation records. However, it had a major disadvantage in that (like Petrel) data capture was via a text file of tagged data prepared using a standard word processor. Data entered in this way was prone to errors in both structure and content, which would require considerable resources to proof read and correct. Being a batch system the central Excavation Unit suite of programs lacked the interactive facilities which were required for interrogation. For these reasons it was decided not to use the Central Excavation Unit system.

The Mucking post-excavation system, which was also in use for the Museum of London's excavations at Billingsgate, was developed on Midas hardware, using the CP/M operating system, and was written in Z80 assembly language. It was able to support the required data structure, and through the use of a "question-sourcefile" it had interactive data input. Work was also in progress to develop facilities for analysis, but at this stage was not yet complete.

The third system to be reviewed was that developed for the Welland Valley Project. It was able to support the required data structure, and had facilities for simple retrieval. It was developed on an Apple microcomputer in Applesoft Basic, and as such did not conform to the preferred computing environment for the ARC system.

The need to prepare data in text form, and the lack of interactive facilities, made the Central Excavation Unit system unattractive. These deficiencies seemed likely to cause operational difficulties, and made the system appear dated, even by 1982 standards. Both the Mucking and Welland Valley programs seemed to broadly provide what was required, although neither offered full retrieval and analysis facilities, and the Welland Valley software had been written for the proprietary Apple environment. Because of first hand familiarity with the Welland Valley product, it was decided to investigate whether it would be possible to rewrite the

Welland Valley project software to run under CP/M, so as to provide the required facilities.

12.4 Prototype software

The software developed at the Welland Valley project had already passed through two stages. Initially separate programs were required for data entry, editing and output, and the data structure was contained within the program. To alter the record structure required an alteration to the program code, and to set up a new file required a new set of programs. These programs were used successfully for feature, artifact and animal bone records (Booth *et al* 1984 and Booth 1985a). A development from this was to produce one program which would accomplish all the required operations (Booth 1980). Alterations to the data structure, or the setting up of new files still required the intervention of a programmer, but the software was structured in such a way that these amendments could be done relatively easily. In practice it was found that Welland Valley Project staff with little technical knowledge could achieve this. This program was successfully used for small finds (Crowther and Booth 1982) and for a Sites and Monuments Records for the Fens (Coles and Hall 1983). The programs were written in Applesoft basic, and ran on an Apple II with 48K of memory.

These programs were adequate for data input, editing and output, although the large number of floppy disks which were required for some files was inconvenient, and the programs lacked a facility to producing sorted output. The Apple and its software were relatively easy to program, but the size and complexity of the records was probably at the limit of what could be achieved with such a system. The need to alter the program code when amending or setting up a new database was also a significant disadvantage. Nevertheless the programs were satisfactorily used for a variety of applications, including the very large numbers of finds recovered from Maxey (Pryor and French 1985).

12.5 Selection of programming language

As the environment selected for the development of the ARC software was a Z80 based 64K microcomputer, running a variant of the CP/M operating system, there were several programming languages which could be used (Practical Computing 1983). In particular, BASIC (in several dialects) was widely available, as were Pascal and Fortran. A BCPL compiler for CP/M was being sought so that GOS could be ported to this environment. Fortran was rejected as it did not adequately handle the text component of the records. Pascal had a following in archaeological circles, and provided the structured programming which was lacking for most variants of BASIC. BASIC had the advantage that it was a relatively easy language in which to program. It was the language in which the original suite of programs for the Welland Valley project had been written, and there was a wide community of users with some knowledge of it. BASIC, therefore, appeared to be an attractive choice, although Pascal would perhaps have better on purely technical grounds.

The various easily available dialects of BASIC were reviewed, in order to select a version that would handle the text arrays which would hold the data. A BASIC language which could be compiled was desirable, because of the resulting compactness and speed. Only two BASIC compilers were in general use for the CP/M operating system; MBasic from Microsoft, and CBasic from Digital Research (Lewis 1984a). MBasic was widely used, and was becoming the *de-facto* standard (Bidmead 1982a, 1982b, 1982c); however it did not offer the character handling of CBasic, and was rejected for this reason. Consideration was given to Cromemco's own version of BASIC, but like many of the BASIC interpreters supplied by manufacturers with their computers, it was non-standard, lacked a compiler, and appeared in general to have very limited functionality. CBasic from Digital research was selected, as in addition to having almost all of the facilities of MBasic, it had particularly memory efficient handling of character arrays; and its intermediate compiled code was compact and fast in execution.

12.6 Program development

The broad requirements for the software are set out in Section 12.2, above. Experience with the Welland Valley Project prototypes had shown that a single program, able to perform all the desired functions, was more convenient than having several programs, which the user would have to load and run separately. The data structures for files to be accessed by the program was to be contained in separate configuration files, as was any word lists used for controlling vocabulary, which would thus be accessible to all the files which needed to draw upon them. A separate program was required to maintain the file definitions and word-list files. The name of MAXARC (with apologies to Ian Johnson and MINARK - Johnson 1979) was coined, being a combination of Maxey, the Welland Valley project's principal excavation at that time, and ARC, the Archaeological Research Centre.

The central feature of the program was a text array which was able to hold a complete record, and any parameters affecting fields within that record. MAXARC Version 1 attempted to contain all the required facilities within one program. The program code soon became too bulky, and MAXARC Version 2 was split into several overlays which were chained to from the main program. Similarly three overlaid programs for maintaining file definitions, word lists, and the log of activity were produced. The package is fully documented in Appendix E, with software listings in Appendix F.

It was anticipated that in the longer term further facilities would be required, including a cut-down version for systems with only floppy disk drives; the addition of a facility to produce sorted output, and improvements to the user interface. A 16 Bit version was also likely to become desirable.

12.7 Description of MAXARC

This section gives an overview of the MAXARC package; a full functional and technical description is given in Appendix E. Files for MAXARC contained records of a fixed length, with a fixed number of fields. In order to facilitate the copying of data to floppy disk, or to use a system with only floppy disks, files were split into convenient portions called volumes. There was therefore no limit to the number of records in a file. The number of records per volume was defined when the file is first set up; usually this feature was used to produce volumes which would comfortably occupy a floppy disk.

Record sizes were also defined when a file was first set up; there was a facility for altering the record length if it proved to be inadequate. Records could be accessed randomly or sequentially. Similarly the number of fields in a record was also established when the file is first defined. As MAXARC was initially configured, it allowed 10, 20, 40 or 80 fields. A field could be of any length up to 255 characters, providing that the cumulative total of all the fields in a record did not exceed the maximum characters permitted for the record. Permitted field types are free text, numeric or coded text. In addition there was a facility to produce compact sequential files (mainly used for backup and archiving), and to convert this form back to MAXARC random access files.

Certain fields could be defined as "coded text". These were input and edited through the user being presented with a table of numbered options; the number corresponding to the chosen term was entered. The number was stored by the computer, but for editing and output the user would always see the decoded term. Lists of terms like this could be shared by several files.

All users could enter new data, and read or output all data, but only the user who had entered a record could edit or overwrite it with a new record. The date when a record was last altered, and the identity of the user who first entered it, were recorded in each record. At the time when a file was first set up, a user was designated the file manager; this user could alter, overwrite or delete any records, and was also able to perform a number of other operations which could be hazardous to data (eg reformatting files, mass deletions, global edits, etc.). Users were asked to identify themselves when they first log in to MAXARC, but there was no password protection.

A log was kept by the software of all operations performed on files by MAXARC, except for setting up and amending of file definitions, which were not recorded. This log recorded the date and time logged in and out, the users identity, the file accessed, operations performed, and the records operated on.

Routine backup was performed by writing data to compact sequential files on floppy disk. Data could be read back from this form into MAXARC random access files. By using a system facility (Xfer, the Cromemco CDOS equivalent of PIP in CP/M) volumes of data could be transferred to floppy disk in expanded form; this was faster than the method described above, but the resulting files occupied much more space.

1	Setup, edit and print out a file definition
2	Setup, edit and print out a list of terms
3	Print out the log

Figure 106: Facilities available from SETUP

MAXARC consisted of two groups of programs. The SETUP program was used to define files and word lists, and to print the log. Figure 106 shows the facilities of SETUP. The MAXARC program was used to perform operations on files thus defined.

1	Input of new data
2	Simple editing of data
3	Print all or selected fields of records
4	Retrieve records conforming to certain characteristics, and print all or part of records thus retrieved.
5	Retrieve records conforming to certain characteristics, and count the numbers of records retrieved.
	Additionally this option will add the contents of specific fields.
6	Print the numbers of void records

Figure 107: MAXARC facilities available to all users

7	Retrieve records conforming to certain characteristics, and perform predetermined edits on them.
8	retrieve records conforming to certain characteristics, and individually edit new values to these records.
9	Set up a new volume of a file.
10	Bulk erasure of records, and bulk cancellation of erasure.
11	Output data to a sequential file, and read data from a sequential file.
12	Reformat records.

Figure 108: MAXARC facilities available to the user designated file manager

Options available to MAXARC were divided into operations which were available to all users, and operations which were only available to the user designated the file manager. Figure 107 shows the MAXARC options which were available to all users. Figure 108 shows the MAXARC options which were available only to the file manager.

12.8 Software for complex analyses

It was anticipated that complex indexing (on repeating fields within records), and the production of sophisticated catalogue formats would be carried out by the Information Retrieval Section using the GOS program.

Other comprehensive operations were also be needed; a major requirement was the ability to retrieve all items (whatever class they belonged to) which related to each other. Routinely it would be necessary to list all the items relating to a single find (linked by the research file), or relating to a certain object (linked via the object record). At a more complex level it was necessary to extract records relating to more abstract entities; perhaps a certain boat type, geographical area, or manufacture technique. A further level of metrical analysis was anticipated, but it was felt that this might constitute a separate study, requiring its own "bespoke" systems.

In processing the test batch of 500 records (see 4.4, above), and in observing other projects (particularly the NMM library) the powerful GOS facilities for cataloguing and indexing had been observed; it was therefore expected that final catalogue generation would be achieved through the use of GOS.

It was anticipated that for more complex retrieval (for instance extracting all records relating to a particular information file) GOS, via the use of its editor which can accept input from several input files, would be a suitable tool. Another approach would be to put all of the ARC records together in one file. This was possible as they were all of type "object" and could therefore be readily combined. A further possibility was to use one of the new relational database packages, which could process data simultaneously from a number of tables (Date 1981).

Research at Bradford University was investigating the applicability of the relational model (Grimley and Haigh 1982, Grimley 1983), but this had not yet resulted in a fully useable system. GOS was a facility which was already available in the museum, but its use in this way appeared to be cumbersome, and was largely untried. The relational database products were only just becoming available on microcomputers. As there was no obvious satisfactory means of performing this more complex analysis, it was decided to delay a decision in this area until MAXARC had been developed, and a sufficient volume of data had been entered. By such time GOS was planned to be running on a microcomputer in the Museum, and some of the relational databases would be commonly available on microcomputers. It was also possible that the ARC 8 bit microcomputer could be upgraded to a 16 bit model, thus providing a more powerful processor, and facilities to simultaneously address more than the 64K random access memory which could be used by the Z80 chip. Such an upgrade would facilitate the use of more powerful software.

12.9 The Systems for fieldwork

12.9.1 Introduction

For archaeological work away from the ARC (whether survey or excavation) two facilities were required. Firstly, it was necessary to be able to carry out normal catalogue and index generation, and simple analyses. These were activities which could take place at the fieldwork base, or in accommodation adjacent to the site, but would normally be carried out indoors, where there would be access to mains power. The second type of activity was for recording on-site; this could be achieved either by traditional paper methods (described in Chapter 11, above), or using portable, weatherproof computers, equipped with suitable software.

12.9.2 Computing away from ARC

In carrying out fieldwork the requirement was for systems which could perform routine catalogue and index generation, and simple analyses, at a location away from the ARC. Such activities would normally take place either in the accommodation used by the field team, or in the hut or caravan adjacent to the site. It was assumed that at both locations there would be a reliable power supply, and that a dry and clean office environment would be available. Should electrical power not be able to be supplied to the site, a portable generator could be used, or the computing could be carried out at another location. Software requirements were the same as those for data capture and simple analysis (12.2 above).

These aims could be achieved either through a telephone link from a terminal, via a modem to the ARC, or by transporting a microcomputer to the field. With the development of a microcomputer based system for the ARC it became a relatively simple operation to transport this facility (or a similar one), to the field, bringing with it a fully operational system. No further thought was given to telecommunications. The chosen approach was therefore to take the ARC system as defined above, or preferably a duplicate one, to the field. For operation adjacent to the site, precautions would need to be taken against dust, and against fluctuations in the power supply. As hard disk systems at this time were not well protected against vibration and knocks, it was necessary to take precautions when transporting the computer. The office where the machine was kept would need to be well secured, and a backup of all data taken away at night. Whilst it would be possible to comply with these conditions in providing computing facilities adjacent to the site, there was some debate as to whether the benefits made it worthwhile, and it was decide that a better approach would be to have the computer in a secure environment nearby.

12.9.3 Recording in the field

The need for making records in the field could be answered by the use of a notebook or pre-printed forms. To this end the forms described above (Chapter 11) were developed, and printed on waterproof paper for outdoor use. An alternative approach was to use a portable microcomputer. The potential benefits of cutting out the paper record by direct computer input appeared attractive, as transcription errors would be avoided, and it was felt that with properly designed software this method could be a better means of recording than traditional "pencil and paper" methods. However, in attempting this the ARC would be "first in the field", and might have to expend considerable resources to be successful. It was therefore decided to initially approach the project in a fairly tentative way, by defining the requirement, and carrying out some tests.

The requirement was for a portable, battery powered facility which would allow the entry of the portion of the full record which would expect to be compiled in the field. It would be necessary to be able to review the data, edit it, back it up to a non-volatile medium, and to produce hard copy. A half or full day of recording would have to be undertaken in this way, without the need to unload data, or to recharge batteries, although a change of batteries at tea breaks and lunchtime might be acceptable. Particularly because of the ARC requirement to work in wet and muddy conditions, the facility would have to be thoroughly waterproof. In the first instance it was decided not to specify the need to operate underwater !

1	Input of new data
2	Simple editing of data
3	Print selected records
4	Transfer of data to main computer

Figure 109: Subset of MAXARC facilities for use on portable PC for field recording

The range of software available for portable microcomputers was at this time very limited, and it became apparent that programs would have to be written in-house. Similarly there was also a limited range of languages available for such machines (usually only non-standard basic), so it would be necessary to write in whatever dialect of BASIC was available on the chosen portable microcomputer. Software would be implemented using a subset of MAXARC (see 12.7, above), so as to provide facilities for data entry, editing, and output (Figure 109).

Of the microcomputers in this class only the Husky appeared to be sufficiently weatherproof, although at around £4,000 it was beyond our means - other methods of weatherproofing had to be sought. Eventually the Epson HX-20 was selected. It came from a reputable manufacturer, had the facilities which were required, and at under £1,000 was affordable. This battery powered microcomputer had in addition to its main memory a RAM disk for additional data storage, a micro-cassette drive, and a small thermal printer. Following the dictum that "No problem is insoluble given a big enough plastic bag" (Stoppard 1972) weatherproofing was achieved by placing the computer in a large transparent plastic bag, which was then sealed. Tests showed that the computer could be operated satisfactorily through the bag, and remain dry, even under the extremely muddy conditions on the River Hamble (Clarke *et al* 1993).

13 SYSTEM OPERATION

13.1 Introduction

Earlier chapters have described the overall structure of the ARC, the definition of the system requirement, and the design of the system. This chapter describes how the various parts of the system were operated. The following chapter draws conclusions from the experience of using the system, and put it into the context of other related work.

The aim at the design stage was, as far as possible, to form a comprehensive system, which would be operational for, and link, all types of information within the ARC. Once the system moved from the design to the operational phase a number of pragmatic considerations came into play. These included priorities (as defined in 3.9 above), and the availability of staff and other resources. As well as local considerations there was also a new museum wide initiative for information processing (the Information Project Group - Booth 1985b), and there was also a fundamental re-appraisal of the role of the ARC. Operational decisions on the implementation of the system were taken in order to make the best use of available resources. Consequently, the actual operation of the system only made use of those facilities which were of immediate use, others remaining dormant, to be used if required in the future. A major limitation was that as a result of the reorganisation of the ARC it was not possible to test the operation of the system as an interlinked whole; an examination of the potential for this described in Chapter 14. Chapter 13 describes the system operation for each class of information, then describes computer operations, and the field system.

13.2 System operation for each information type

13.2.1 Introduction

This section describes how the system was operated for each type of information. In contrast to the design for the complete system (Chapter 7) it only describes those features of the whole which were actually implemented. Computer operations are treated separately in section 13.3, and the (limited) use of the field system is described in section 13.4.

13.2.2 Objects

Procedures for newly acquired objects are documented in the Objects Manual (Appendix C); additionally it was necessary to document the objects already in the collection using the new procedures. The first priority was identified to be the input to the new system of items which were already in the ARC, and which for the most part had some form of records. The manual record (original documentation) for objects consisted of an A4 form (printed in green), and duplicate copies of the Acquisition slip, form NMM35. These are described in Chapter 11. The first stage of this retrospective documentation was to reconcile the original documentation with the objects in the collection. An annual stocktake (referred to as "muster") of objects had been held, and it was therefore possible to show a recently verified one-to-one relationship between the documentation and the items in the collection. One item, a piece of fibre rope did however prove difficult to locate, but it was found that two similar lengths of rope had been treated as one object for conservation purposes. Having established through the stocktaking records that all the documented objects should be in the collection, a sample were rechecked to test the validity of the muster, and no objects were found to be missing. As a reverse check a thorough survey of object storage locations was made, relating each object to its record. Two undocumented objects were found, these were treated as new acquisitions.

Having accomplished these checks, item numbers were assigned to the original documentation, and each object was labelled with its item number (following the guidelines for labelling set out in the Objects Manual - Appendix C). At the same time the location record on the A4 Acquisition form was checked, and any other necessary amendments were made to the form. This form was then used as the input document for computerisation.

Backlog object records were all input by the author, and were then output for checking by individual custodians.

Initially, two routine outputs were required; a catalogue arranged by individual custodians (in item number order) for proof reading, and a catalogue arranged by custodian according to location, for stocktaking. Other outputs were produced to order; for instance all items on loan, or all items loaned or donated by a particular individual.

At this stage the system provided a useful means of assisting in collections management, particularly for the stocktaking of objects, and for producing output in response to *ad-hoc* enquiries. Sorted output via MAXARC was not available at this stage, and data was not yet transferred to Petrel, so output was limited to retrieval (on any field or fields) ordered by item number, the item number being the primary key.

1. Complete Acquisition or Loan-in procedures as appropriate.
2. Obtain item number and acquisition number from log.
3. If in the field, complete excavated object record form.
4. Label object.
5. Arrange for object to be photographed.
6. Complete object photo, muster and valuation form.
7. Open information file for object.
8. Complete computer record for object.

Figure 110: Procedure followed for object documentation

New objects entering the system followed the procedures laid down in the Objects Manual, with the input and documentation being done by the custodian with responsibility for the object. These procedures are summarised in Figure 110.

13.2.3 Slides

At the outset there was no system of documentation for slides, except that they (usually) had the negative number, subject, and spot (to provide the correct orientation for projection) inscribed on the mount. A computer record and guidelines for documentation were developed, these are described in Chapter 11. Preliminary documentation involved arranging the slides on storage racks according to subject, ensuring they were marked with the negative number, description and spot, and adding a cross reference to the relevant information file. As most slides either related to a particular site or find, or to a particular type of craft, the assignment of the slide to a subject area and information file was usually uncontroversial. Having completed the physical arrangement of the slides, input to the computer was achieved directly from the slide, initially with only the basic information marked on the mount being input. When the data had been input a catalogue of slides was produced.

1	Mount slides
2	Discuss storage location with information archaeologist.
3	Obtain item number and storage location from log.
4	Mark Slide.
5	Complete computer record for slide.
6	Put slide away.

Figure 111: Procedure followed for transparency documentation

Newly acquired slides were processed according to the Slide Manual (Appendix C), by the custodian responsible for the slide. At the first level the computer record provided a catalogue of slides, and a means of linking the slides to other records. Because the slides are stored in racks where each slide may be viewed against an illuminated screen, the best means of selecting a slide was to browse through the racks. Except for stocktaking and management, the computer record was rarely used. The considerable work necessary to enhance the record was not, therefore, considered to be a high priority. The procedures followed for slide documentation are summarised in Figure 111.

13.2.4 Drawings

The manual record for drawings consisted of a card index arranged by "subject", and location. Each location had a letter, and within that location drawings and other graphic material were numbered sequentially, with a separate sequence for each location. At the start of the operation most drawings were kept flat in drawers in plans chests, where it was often not easy to find a particular drawing. The aim of physical re-organisation was to place all items of A4 size or less in the appropriate Information file, with larger drawings being suspended on vertical hangers in a "vertifile"; drawings not suited for either of these treatments would be stored as before in plans chests. It was estimated that few drawings would need to remain in the plans chests, so the number of plans chests could be reduced, and there would be fewer drawings per drawer, aiding retrieval.

During physical reorganisation each item was marked with its item number (allocated sequentially) and location, and the item number was recorded, together with the new location, on the index card. The system of location numbering (a letter and number) was continued for both vertical hangers and plans chests, as this aided recovery when using old documentation. Thus a drawing which was previously located at L16 (a plans chest drawer) would be located at "Vertifile L16".

The card index was used as the input document for the computerised record, and was maintained in parallel to it. Newly arrived drawings would be documented according to the Drawings Manual (Appendix C), by being included in the card index and input to the computer record. As MAXARC did not at this time have an indexing module, and the record had not been transferred to Petrel for indexing by GOS, it was necessary to maintain the card index in order to provide a subject index to the drawings. *Ad-hoc* retrieval from the computerised record held in MAXARC was of course possible. Initially catalogues arranged by custodian were produced to facilitate proof reading. The procedure followed in documenting drawings is summarised in Figure 112.

1	Discuss the storage location of the drawings with the information archaeologist.
2	Obtain drawing numbers from log.
3	If appropriate, attach hanging strip to drawing.
4	Mark drawing with drawing number and location.
5	Complete computer record.
6	Make entry in card index.
7	Put drawing away.

Figure 112: Procedure followed for drawing documentation

13.2.5 Information files

Certain classes of information file, such as logboats which had a system derived from McGrail (1978), had a formal numbering system. Lists of these numbers, and the information file names were already maintained in the ARC (11.5, above). For others the only documentation consisted of the name of the file inscribed on the folder. The first stage in integrating these files into the ARC system was to apply the item number and name to the folder, or the equivalent of the folder, where for instance an excavation archive occupied a much larger storage space.

The information files were seen, together with the object records, as the core of the ARC system, providing the main explicit links between various types of records. It was therefore essential to have at least a skeleton computer record for each information file. The first phase was therefore to ensure that each information file had a computer record. The next stage would be to complete the subject categories for the computer record so as to facilitate indexing and retrieval by subject. In order to facilitate the preparation of the basic data needed for subject indexing, an Information File form was placed in each file, so that the compilation of this record could take place as custodians used the files. The form also proved to be a useful check list of the contents of the file, and related records. The systematic collection of subject indexing data for the information files, and its input, was not attempted, as it was not felt to be a priority at this stage. The procedure followed to document information files is summarised in Figure 113.

1	Discuss with the Information Archaeologist which series the file should be in.
2	Obtain information file numbers from log.
3	Discuss with Information Archaeologist an appropriate name for the file.
4	Mark file with name and number.
5	Fill out Information file form.
6	Complete (skeleton) computer record.
7	Put information file away.

Figure 113: Procedure followed for information file documentation

13.2.6 Samples

The existing system for samples, consisting of a record card and log of item numbers, is described in 11.6 above. No further action was required with these pre-existing manual records, which could be directly input to the computer. Initially, the computer record was used to produce lists by storage location, to facilitate stocktaking. *Ad-hoc* retrievals were also possible for specific enquiries.

The new sample form was developed to aid the capture of data in the field, and to provide a form that better matched the requirements of work in the Museum. At the same time it was also structured to better facilitate input to the computer record. Once this form had been produced it superseded the original form, for both excavation recording and for use in the Museum.

1	Archaeological Conservator issues numbered circulating copy of form, plus circulation slip to initiator.
2	Initiator records essential details and required action on circulating form, and if required makes a copy of the form for the Information File.
3	Circulating form is returned to Archaeological Conservator who creates master sample form, and inputs initial data to the computer record.
4	Sample sent to analyst.
5	For internal analysis the analyst records results on the sample form, and the form is returned to the initiator.
6	For external analysis the analyst records the results, and returns the results and sample to the initiator, who updates the form with the results.
7	Information file copy of form may be updated by initiator at this stage.
8	Initiator updates the form with any further analysis required, and sends form to Archaeological Conservator.
9	Archaeological Conservator updates master sample form, and computer record. If further analysis is required a new circulation slip is attached, and action continues at stage 4, above.
10	If no further action is required the circulating sample form is sent to the initiator, who stores circulating form, and may update information file copy of form.

Figure 114: Procedure followed for sample documentation

Processing of samples involves the circulation of the sample and its accompanying form from the person initiating the work to the analyst who carries out the work. Between each stage it passes via the Archaeological Conservator who is responsible for keeping the main records up-to-date, and monitoring the processing of the sample. An important innovation was the sample circulation slip, which was designed to ensure that no steps of the circulating sample forms itinerary were omitted. This was necessary to ensure that the relevant records are kept up to date. It was found to be necessary to have as many as three copies of the Sample form. A central copy which formed the primary record, a circulating copy which was used to record required actions and results, and (if necessary) an additional copy kept on the appropriate information file. The procedure followed for sample documentation is summarised in Figure 114.

13.2.7 Conservation records

Similar circumstances prevailed for Conservation records as for Sample records (13.2.6 above). The existing system for conservation records, consisting of a record card and log of item numbers, is described in 11.7 above. Pending the trials of the system for samples no further work was done on developing replacement systems for conservation records.

13.2.8 Contexts

Although some trial use of the MDA field recording forms had been attempted, there was no existing record system (except for the use of a notebook) for context recording in the ARC. The development of the context recording form, and of the computer record are described in 11.8, above. Because of the nature of the majority of the finds investigated by the ARC, there were generally few contexts to record from each fieldwork project.

There was some field testing of the forms, but because of the limited number of records it was not felt to be worthwhile to use the computerised record, which was never tested. Initially it was proposed that a single series of numbers would be used, as for most other types of item. However, discussion with users suggested that a separate number series for each excavation, following the Central Excavation Unit model (Jefferies 1977) would be more appropriate.

13.2.9 Photographic negatives

Pending the outcome of the Petrel project to computerise the NMM central negative index the existing card indexes in the ARC (arranged by negative number and subject) were maintained - there was no attempt to computerise these indexes. The card index provided a working tool for photographic retrieval, but apart from the cross-reference by negative number, there was no integration with the overall ARC system.

13.2.10 Bibliographic records

Books, periodicals and miscellaneous papers were already being catalogued via Petrel. The author and UDC indexes which were thus produced, were available on microfiche, providing a means of accessing the book stocks, and recording those items stored in the ARC. However, more detailed indexing was required, and as UDC was not felt to be the best arrangement in ARC a further finding aid was required. For this purpose the existing author card index was maintained, so that books and other bibliographic material could be readily retrieved according to agreed ARC criteria. There was also interest in formalising and continuing the existing subject card index, but agreement could not be reached on the terminology to use, so it was abandoned.

13.2.11 Radiocarbon dates

Manual documentation for this class of information consisted of card indexes arranged by date and subject (usually site name), and a folder containing xerox copies of the references to the dates. As there were fewer than 500 such dates the manual system was effective. However, it was decided to publish a list of dates (Booth 1984b), and it was felt that a computerised record would help this.

Accordingly the computer record was compiled, and this was then output in the required order to a text file, which could be edited, and have the introduction and references added. This was used as the manuscript for the paper (in printout form); it would have been possible to transfer the data directly on floppy disk to the printers had they been able to accept text in this form. Further records were added to the computer record and card index, which was maintained pending the availability of computerised indexing.

13.3 Software

13.3.1 Introduction

This section describes how the MAXARC programme package was used to carry out the documentation activities described in the earlier parts of this chapter. These include input, output for proof reading, editing, outputs for use, and necessary system maintenance. Each of these aspects is summarised below. A full description of the facilities of the MAXARC package is given in Appendix E.

13.3.2 Input

To input data the execution of the MAXARC program was initiated, after which the computer prompted the user for his or her identity, and for the name of the file to use. Each class of information had a separate file, the file name being the first 5 letters of the full item number (eg NMMAO for objects, NMMAD for drawings and so on). Once the name of the file had been input the series letter part of the number (usually A) was then entered, followed by the range of numbers to input (single items may also be input).

The first record was then entered, reviewed, and sent to disk. Once the first record had been entered the user was asked to specify for the next record what "level" it is at. This was so that common data could be carried over between records. For instance data on objects concerning acquisition, finding and so forth was repeated in this way, with specific data concerning the individual object being added by the user. Subsequent records were then input, reviewed by the user, and stored on disk.

Once the specified series of records had been input, the user had the option of entering more of the same type (eg objects), or choosing another process to perform on the same file (such as edit or print) or leaving MAXARC. To enter records for a different type (for instance to change from entering slides to samples) it was necessary to leave MAXARC, and restart the program.

13.3.3 Output

After initial data input, the next stage was usually to produce printed output for proof reading, to be followed by editing. Output for proof reading consisted of a simple catalogue of items arranged by item number. A separate catalogue was produced for each custodian, using the retrieval option. It was sometimes necessary to extract specific blocks of record numbers.

To produce this output the user selected the retrieve option, and specified a particular custodian and range of item numbers. It would be usual to output all fields from the record. The resulting printout was then passed to the appropriate custodian for proof reading, at which time errors and omissions would be noted on the printout.

13.3.4 Editing

Having proof read the initial output the next stage was to edit the records. Usually specific alterations needed to be made to individual records, in which case the simple edit option was used. Having started the MAXARC program, the user was asked to specify the file, series letter, and range of item numbers to edit. The records of these items were then displayed on the screen, and could be altered as required.

Where the contents of a particular field or fields needed to be altered for a range of records (for instance where a consistent error has been made for several records), the automatic editor was utilised. The user was asked to input retrieval characteristics, and the alterations to be made to records so retrieved - MAXARC then made these alterations automatically. Because this option had the powerful facility to make substantial alterations to a large number of records, its use required great care. For this reason it was restricted to the user who was designated the file manager.

13.3.5 Outputs after editing

Once the editing cycle (usually two printouts and edits) was complete, the records would usually been sufficiently accurate to be output for use. Using the print records option a complete catalogue, or a catalogue for a range of item numbers, could be produced, arranged in item number order. Using the retrieval option a catalogue for each custodian would be printed out. Both of these types of catalogue usually contained all fields.

Ad-hoc enquiries were usually answered by either visual inspection of one of the above catalogues, or by a specially produced printout using the retrieve option. In order to produce the data for the radiocarbon dates publication (Booth 1984b) a special printout was required, ordered by geographic zone and country, and with only certain fields output. To do this a module of the retrieve option which is able to print an arbitrary sequence of records was used. The facility reads a list of item numbers which has been prepared using a text editor, and outputs records in this order to a file. This means of retrieving and outputting records according to a predetermined list of item numbers was a useful facility in the absence of the yet to be developed MAXARC sort module.

13.3.6 System maintenance

Routine maintenance included the setting up and editing of files and word lists, creation of a new volume of a file, backup of data to floppy disk, transfer of data to floppy disk to make additional disk space, and maintenance of the log.

The SETUP programme was used to input the definitions of new files, and to edit file definitions. It was also used to create and edit word list files. Once defined and tested file definitions tended not to need much revision, but word lists were often found to need alteration.

Setting up a new volume of a file was achieved through MAXARC. This procedure resulted in a file of empty records being created ready for input. If the order of fields within a file required alteration, this was also achieved through MAXARC, by using the facilities for file reorganisation. A matching alteration had to be made to the file definition, through the use of SETUP.

Routine backup of data to floppy disk was undertaken to guard against hard disk failure and user error. Three sets of backups were kept, backup was usually carried out once a month. Sets of backup disks were rotated, with the most recent set being kept off-site, in order to guard against fire and similar disasters. There were also three sets of the file definition and thesaurus files, similarly backed up and curated. Backup was performed using the "write to sequential file" option of MAXARC; this was a little slower than using the CDOS system utility XFER (PIP in CP/M), but the resultant compressed files took up significantly less space on floppy disk, with several files being accommodated on a single disk.

Because of the small hard disk size (5Mb - the largest available at the time) it was not possible to keep all types of data on-line at once. Those used frequently (such as objects), and those being currently worked on, would remain on disk, whilst the others were backed up to floppy disk, to be restored when required.

The MAXARC log provided a history of actions taken, and the records accessed, for each file; if the system was being extensively used then the log file could grow quite large. To guard against this, the log was periodically copied to floppy disk and deleted from the hard disk. A new log file was then opened on the hard disk. Often a print of the log was produced in the same operation as copying it to floppy disk. No facilities for the analysis of the log were provided, and it was rarely consulted.

13.4 The field system

Due to the relatively small scale of fieldwork, the entire system was never required to be operated in the field. However the context, sample and excavated object form were tested on small scale projects. There was also a limited test of a portable computer in adverse conditions. Forms were completed (as far as possible) in the field, and then returned to base for input/analysis, as appropriate.

An Epson portable computer, running an abbreviated form of MAXARC for data capture and editing only, (see 12.9.3, above) was used on the River hamble (Clarke *et al* 1993). The test showed that when encased in a plastic bag the keyboard could be operated satisfactorily, so as to record stratigraphic, sample and finds data. No transfer to the main systems was attempted.

14 ANALYSIS OF COMPLETED ARC SYSTEM

14.1 Introduction

This chapter describes the completed ARC system, and examines how well it achieves the objectives set for it. The first section describes the elements of the structure which were in place at the completion of the development phase of the project in March 1984, and the completeness of the integration of the ARC records into the system. This is followed by a review of the users' observations of the overall system, and an examination of the effectiveness of the software. Aspects of the system which were not eventually implemented are modelled, to see whether they would have been able to perform as projected. In conclusion the overall effectiveness is assessed. These conclusions are further examined in Chapter 15, which provides an overall assessment of the ARC case study, and outlines proposals for areas requiring further investigation.

14.2 Description of the completed system

Development work on the system finished in March 1984, although there were some later enhancements to the software, and the conservation computerised record was a later development by ARC conservation staff. The situation in March 1984, together with some recommendations, was outlined in a report which was prepared at the end of this development phase (Appendix 5). Figure 115 summarises the progress with the development of the system and its usage at this time. The report showed that by early in 1984 the storage and labelling of items was complete, and that where manual records were appropriate, card indexes and lists of these records were also complete. The only manual records which had been checked by their custodians were those for objects, samples and conservation records.

Formats for the entry of data to the computer had been devised for all types of record, except for photographic negatives and bibliographic records, which were awaiting museum wide initiatives, and conservation records, where the development of the format for the computer record was pending the trial of the sample format. Data entry was complete for objects and drawings, a minimal record had been entered for all information files, and data had been entered for some slides. Object records had been checked and corrected by the custodians responsible for them, but none of the other computerised records had been corrected. It had not been felt worthwhile to store on computer the small number of context records.

	Qty.	% of total items	Storage & labels	Manual records	Manual indexes	Computer record setup	Computer record input	Computer record checked
Objects	1,000	5%	100%	100%	N/A	YES	100%	100%
Transparencies	4,000	21%	100%	N/A	N/A	YES	30%	0%
Drawings	1,500	8%	100%	100%	100%	YES	100%	0%
Information files	1,500	8%	100%	100%	100%	YES	0%	0%
Samples	2,000	11%	100%	100%	N/A	YES	100%	0%
Conservation	3,000	16%	100%	100%	N/A	NO	N/A	N/A
Contexts	100	1%	N/A	100%	N/A	YES	0%	0%
Photographic negatives	3,000	16%	N/A	100%	100%	NO	N/A	N/A
Bibliographic items	2,000	11%	100%	100%	100%	NO	N/A	N/A
Radiocarbon dates	500	3%	N/A	100%	100%	YES	100%	100%

Figure 115: State of ARC records in March 1984

The recommendations in the report (Appendix 5) are summarised in Figure 116. For labelling and storage the only recommendations were that in a few cases where small amounts of work needed to be done. No enhancement of the object computer record was required (except for necessary updating, for instance to record a changed location), and it was recommended that the computer record for drawings should be checked. Details of some slides had already been entered onto the computer, and it was recommended that the remainder should be entered and checked. For other classes of item where a computer format had been set up in the ARC, but data had not been entered, it was recommended that data should be input and checked. As they perform a central role in the overall ARC system, it was also recommended that, in particular, the information file series of records should be developed from the already existing skeleton record.

OBJECTS	A small number of objects required photography and labelling. The main recommendation was that Information files should be created for those objects (or groups of objects) without them. The majority of objects did not have information files
TRANSPARENCIES	The location and item numbers of all slides needed to be checked and recorded. For the 70% of slides which did not have a computer record minimum information should be entered, including location, information file number, and if possible a note on the subject of the slide
DRAWINGS	The few outstanding drawings should be marked and properly stored. The computer record should be checked by custodians
INFORMATION FILES	The 'R' series should be extended to cover all objects The 'Sites and Vessels' and 'Underwater' series should be developed to become a 'Sites and Monuments Record' for maritime archaeology Essential information (in addition to name and title) should be recorded on the computer Major excavation archives should be sorted and indexed to Frere Level III standard
SAMPLES	All records should be transferred to computer, and checked
CONSERVATION	The design and implementation of the computer record should be completed, once the sample record had been thoroughly tested. Conservation records should then be input to the computer
CONTEXTS	To continue with the manual system, unless the size of an excavation suggested that computer storage of contexts would be advantageous
PHOTOGRAPHIC	To continue using the card index until the computer project is effective
BIBLIOGRAPHIC	Any uncatalogued items should be catalogued by the museum. Books should be stored in UDC number order, so as to not need to keep separate finding aids

Figure 116: Recommended future work

Radioacrbon dates are omitted from the recommendations, and it can therefore be inferred that only the manual record would remain in use, as the computer record had been developed in order to provide the text for a publication (Booth 1984b). The computerised record could however be revitalised, if a revision or supplement to the "Handlist of Maritime Radiocarbon Dates" was required.

The stage which the development of each part of the MAXARC computer program had reached is summarised in Figure 117. The facilities which are described as operational had been thoroughly tested, and were found to be generally effective. It was anticipated that Petrel would provide the indexing which was absent from the MAXARC suite. The portable computer system for data capture in the field had been little used, and it was recommended that the further development of computer data entry for fieldwork was not likely to be necessary, unless a major programme of fieldwork was anticipated.

MAIN MAXARC PROGRAMMES	
Define file	Operational
Write	Operational
Edit	Operational
Print	Operational
Setup new volume	Operational
Erase	Operational
Cancel erasure	Operational
Detect null records	Operational
Retrieve	Operational
Produce GOS output	Prototype
Sort	Design
PORTABLE COMPUTER	
Define file	Prototype
Write	Prototype
Edit	Prototype
Print	Prototype
Transfer to large computer	Design

Figure 117: Status of computer programs in March 1984

Overall recommendations were concerned with the management of records (for instance the desirability of keeping records in one place for ease of use), producing a microfiche security copy (possibly via the Royal Commission on the Historical Monuments of England), and a recommendation that whilst word processing would be a useful facility its careful management would be necessary if it was not to monopolise the ARC's single computer.

14.3 Review of the ARC record system in use

14.3.1 Introduction

A survey of user's views was carried out through the medium of a questionnaire, which was distributed to those using the system in May 1989. There is a copy of the survey form at Appendix 6, and the survey results are listed in Appendix 7. The results are summarised in Figures 118-121.

At the time of the survey the ARC had been restructured, and was considerably smaller - the original twelve staff having shrunk to two archaeological and two scientific posts. It was split between two sites, with the computer, sample manual records and conservation manual records at one location, and the remainder of the records at another. The reduced staffing seems likely to have lead to an overall reduction in demands on the system, and the remoteness of the computer would mean that it would be unlikely to be used for on-line access except for sample and conservation records. It seems likely that in addition to effecting the volume of demand, these structural changes would also have altered the overall requirements for the ARC records. The operation of the system at the time of the survey in May 1989 is discussed below.

	Procedures	Numbering	Location recording	Labelling	Storage
Objects	B	B (1)	B	A	A (2)
Transparencies	B	B (3)	B (4)	B	B (5)
Drawings	B	B	B	B	C (6)
Information files	B	B	B	B	B
Samples	B	B	B (7)	B	N/A
Conservation	B	B	B (8)	B	N/A
Contexts	B	B	N/A	N/A	N/A
Photographic negatives	B	B	B (9)	B	B (10)
Bibliographic items	N/U	N/U	N/U	N/U	N/U
Radiocarbon dates	N/U	N/U	N/U	N/U	N/U
Key:	A - good	B - adequate	C - poor	N/A - Not applicable	N/U - Not used

Notes:

1. Several objects can be grouped together under one acquisition number
2. Sub-divisions of locations would be useful
3. Item numbers not felt to be necessary
4. Systems dependent on rack based storage
5. Some stored in boxes due to move
6. Glue on vertical hangers failed after 7 years
7. Room numbers would be desirable for whole museum
8. Room numbers would be desirable for whole museum
9. Not used much
10. Master set of contact prints not maintained

Figure 118: User survey - procedures

	Data content	Structure	Media	Storage	Remarks
Objects	B	B	A	B	Waterproof paper excellent. Thick card unnecessary.
Transparencies	N/A	N/A	N/A	N/A	No paper records.
Drawings	N/A	N/A	N/A	N/A	Card index remains in use.
Information files	B	N/U	B	B	Paper record used as cross-reference.
Samples	B	B	B	B	Waterproof paper useful on site.
Conservation	B	B	B	B	Waterproof paper useful on site.
Contexts	A	B	B	B	Waterproof paper useful on site.
Photographic negatives	N/A	N/A	N/A	N/A	Card index remains in use.
Bibliographic items	N/A	N/A	N/A	N/A	Card index remains in use.
Radiocarbon dates	N/A	N/A	N/A	N/A	Card index remains in use.
Key:	A - good	B - adequate	C - poor	N/A - Not applicable	N/U - Not used

Figure 119: User survey - paper records

	Content	Termin-ology	Size of record	Struc-ture	Output	Queries of output	Storage
Objects	B(1)	B(2)	B(3)	B	B(4)	N/U	B
Samples	B	B	B(5)	B	B	N/U	B
Conservation	B	B	B(6)	B	B	N/U	B

Key:	A - good	B - adequate	C - Poor	N/U - not used	N/A - not applicable

Notes:

1. Some fields not used
2. Uncertain
3. Used as summary
4. Usually use paper records for queries
5. Would like to have all sample records on-line at once, together with related records of other types (eg objects and conservation).
6. Would like to have all conservation records on-line at once, together with related records of other types (eg objects and samples).

NB: Transparency, drawing, information file, context, photographic negative, bibliographic and radiocarbon date computer records not used at this time.

Figure 120: User survey - computer record

Objects	-
Transparencies	Browsing is the main means of access. The computer and manual records are rarely used.
Drawings	As drawings are either kept in the appropriate information file, or on vertical hangers, the computer record is not used for retrieval.
Information files	Record is used to cross-reference to related records, but the summary describing the subject of the file is rarely used.
Samples	-
Conservation	-
Contexts	Not numerous enough to make use of the computer record worthwhile.
Photographic negatives	Prints and contact prints (when available) are kept in the appropriate information file. The original card index is still maintained.
Bibliographic items	Items are either shelved, or kept in the appropriate information file. The original card index is still maintained.
Radiocarbon dates	The original card index system is still used.

Figure 121: User survey - general remarks

14.3.2 Objects

Both manual and computer systems were in use for object records. Users were generally content with systems for numbering, location recording, labelling and storage, and found the combination of acquisition number and item number particularly helpful. A suggested improvement for location recording was the subdivision of large storage areas. When the users had become familiar with them, the paper records were found to be well structured; the waterproof paper was much praised, but the stiff card was felt to be unnecessary. The computer record was used as a summary of the other records, and was felt to be adequate for that purpose. Outputs were generally produced in response to specific requirements, and were found to be adequate, although with a complex record numbered fields were felt to be a useful guide to the structure of the record. In general the paper record was used as the initial way of dealing with enquiries, except for object location, size, and the expiry date of loans. At the time of the survey the computer was not easily accessible, and printout was therefore usually the means of answering enquiries.

14.3.3 Slides

Because slides are stored on racks which facilitate browsing, neither the computer record or additional manual records were required. It was felt that whilst numbering the slides with their location and negative number was helpful, the addition of an item number (linking the slide to paper and computer records) was superfluous, as the computer record of slides was not used, and it was felt that the link to related computerised records was not necessary.

14.3.4 Drawings

Drawings were kept either in the appropriate information file, or suspended in vertical filing racks, except for a small number which were stored flat in plan chests. The major problem was that the glue attaching drawings to the plastic or card hangers was failing after 7 years, causing the drawings to fall to the bottom of the cabinet, and to become detached from the number and location code which were recorded on the hanger. Procedures, numbering, location recording, labelling and storage were found to be satisfactory (with the exception above). In general (like transparencies) selection of drawings was by browsing, rather than by using paper or computer records.

14.3.5 Information files

Procedures, numbering, location recording, labelling and storage were found to be adequate. It was felt that a major function of the paper record was to provide a cross-reference to related drawings, photographs and other records. The descriptive data categories on both the paper and computer record were infrequently used.

14.3.6 Samples

The numbering, location recording, labelling and storage procedures for samples were found to be adequate. However without an institution-wide numbering system for rooms the location of items in the museum could not be consistently recorded. Both paper and computerised records were found to be useful, but it was felt that it would be desirable to have a larger hard disk, enabling all types of computerised records to be kept available at once. A second suggestion was to have all computer files combined in a single database, thus enabling related objects, samples, and conservation records to be accessed concurrently. The computer was generally used to produce regular printouts, rather than for *ad-hoc* searches.

14.3.7 Conservation

In addition to the long-established manual records for conservation, a computerised record had latterly been developed by ARC conservation staff. The record, which provided for the computer storage of data contained in the conservation form, is not described here as it is felt to be outside the scope of the present study. However, the users survey found the manual records and procedures to be effective, and the computerised record to be used similarly to the sample record (above).

14.3.8 Contexts

The forms were felt to be well structured, and the waterproof paper was found to be an effective practical measure. Because the excavations undertaken by the ARC had not produced a large enough number of contexts to warrant computerisation, the computerised record had not been used.

14.3.9 Photographic negatives

Photographic negatives were stored centrally by the museum. The ARC kept a card index, and copies of contact prints, which were usually stored in the appropriate information file. The card index was found to be useful, but was rarely updated. Pending the development of a museum-wide computer system for photographic negatives, a computerised system had not been established in the ARC. An attempt to keep a reference set of photographs in negative number order had been abandoned, as it was not felt to be sufficiently useful.

14.3.10 Bibliographic records

Bibliographic items could be easily retrieved, as they were either shelved in subject groupings, or kept in the appropriate information file. The card index, and centrally supplied printouts were not therefore generally used.

14.3.11 Radiocarbon dates

The card index and photocopies of the original reference to the date were found to be sufficient for the retrieval and consultation of radiocarbon dates. The computerised system (which had originally been set up to support the publication of the dates) was not used.

14.3.12 Conclusions from the ARC user survey

The survey showed that both paper and computer records were used for objects, samples and conservation records. Procedures, numbering, location recording, labelling and storage were felt to be generally satisfactory for all classes of item. The computer record for objects was particularly used for location recording, object size and loan expiry dates. For slides, drawings, bibliographic items, and photographic negatives, neither paper or computer systems were used, as items could be readily retrieved, either because they were physically stored in the appropriate Information file, or because their storage method enabled easy browsing. The card index and xerox copies of radiocarbon dates were used rather than the computer record, which had in any case been established mainly to facilitate a publication. The information file paper record was used as a cross-reference to other records. The forms used for context recording in the field were praised.

At the completion of the design phase in 1984 the ARC staff had been presented with the structure of a comprehensive record system. However, this coincided with a period of declining resources, during which the posts of several staff who had moved on to other jobs remained unfilled. In particular, the post of Information Archaeologist remained vacant, and the management, use and development of the system was therefore entirely in the hands of its users. In analysing the subsequent usage of the system it seems fair to assume that the overall climate of stringency would mean that only those aspects of the system which provided visible benefits would be utilised.

The evidence suggests that in broad terms for items such as objects where there is a substantial administrative requirement, and where the records contain large quantities of data, the use of both manual and computer records is necessary. For items which may be kept by "subject" in a form that facilitates browsing, (such as slides, drawings, negatives, and bibliographic items) no computerised or manual records are needed to support the day-to-day use of the material. The items must however be clearly marked with their location (and other appropriate identifying information), so that they can be returned to the correct place. Items which can be kept in their appropriate information file (drawings, photographs and smaller bibliographic material such as photocopies/offprints) did not require additional finding aids. For items which document processes or discoveries (samples and conservation records) full manual and computerised records are desirable. If excavation on any scale was anticipated, it is likely that computerised storage of stratigraphic information would be needed.

The observed pattern indicates that for a small number of items, linked logically to a site archive or particular item, sophisticated systems are not required. For small quantities of records a card index would be quite adequate. In the ARC, the relatively small numbers of items, combined with a high level of curatorial expertise, would make it less necessary to have finding aids. A further disincentive to using the automated system was that for records other than samples and conservation, access to the computer was inconvenient. Should any of the staff leave, however, there is the risk that the expertise would be lost, causing there to be difficulties in locating material.

14.4 Review of the software in use

In addition to the general use of the ARC system it would have been desirable to ask the ARC staff to comment specifically on the MAXARC software package. However, due to the inconvenience of access to the computer (discussed in 14.3.12 above), little use was being made of the computerised record, except for sample and conservation records. It was therefore decided to survey an alternative group of users. The Fenland Archaeological Trust had been using MAXARC (and its predecessor) for excavation records, and it was felt that this usage was sufficiently similar to the ARC system for valid comparisons to be made. Five of the staff of the Fenland Archaeological Trust completed a questionnaire covering their use of MAXARC. The questionnaire asked about the frequency of use of the various parts of the package, and for comments on the facilities which it provided. This survey form is reproduced at Appendix 8, and the complete results are at Appendix 9. The frequency of use of the different parts of the package is summarised at Figure 122, and users comments are at Figure 123.

As one would expect the facilities most often used were for input (on average a little under daily use), simple editing (weekly) and simple printing (weekly). These reflect the primary tasks of data capture, routine output and editing. Less commonly used were the facilities for automatic editing, and the various more complex types of output which were available from the print, retrieve, and sort options. Output to a "mailmerge" file was used relative frequently, because of the need to produce output in a form for processing by commercially produced packages (particularly Statgraphics). Less frequently used were the facilities for routine housekeeping, including backup to a sequential file, and setting up new volumes of records. Erase, cancel erasure, read from sequential file, and file restructuring were reported to be rarely used. The setup program was found to be inconvenient, as the user was required to go through the definitions for all fields, rather than just those fields which needed to be edited.

The record structure permitted by MAXARC was found to be satisfactory, although the computerised records kept by the Fenland Archaeological Trust were generally used only as a summary of the information about an item, rather than for a complete description of items. The range of field types was adequate, although it was reported that a longer text field would be desirable. However, as a text field of up to 32K bytes is permitted, the perceived limitation on text probably reflects the maximum record size which had been selected. For data input it was felt to be desirable to have a facility similar to that developed by Moffett (Catton *et al* 1982), which would allow the prompts for fields not relevant to a particular type of item to be omitted. The use of such a "Question Source File" would mean that for different types of item (for instance bone and pottery) a different series of data items would be requested. Editing was felt to be cumbersome. Output facilities were generally felt to be adequate, but users may not have been familiar with the more obscure features. Additional facilities were required for graphics and statistics, and it was necessary to be able to input data from, and output data to other packages, including spreadsheet.

Action User:	1	2	3	4	5	Av.	Interpretation
Write to file	200	200	200	200	200	200	Daily
Edit (standard)	200	12	50	200	100	112	Weekly - daily
Edit (automatic of selected fields).	1	1	1	50	0	11	Less than monthly
Edit (manual of selected fields)	1	0	1	50	0	10	Less than monthly
Print (standard to printer)	12	50	50	50	25	37	Less than weekly
Print (programmable to printer)	0	0	0	50	0	10	Less than monthly
Print (standard to file on disk)	0	0	0	50	0	10	Less than monthly
Setup new volume	1	1	12	1	1	3	Rarely
Erase records	1	0	0	1	0	1	Rarely
Cancel erasure	1	0	0	1	0	1	Rarely
Print numbers of void records	12	1	1	0	1	3	Rarely
Retrieve	12	12	200	0	12	47	Weekly
Count and enumerate	12	1	1	0	12	5	Rarely
Write to sequential file	1	1	0	1	12	3	Rarely
Read from sequential file	1	1	0	1	0	1	Rarely
Write to mailmerge file	100	0	12	0	12	25	Every two weeks
Restructure file	0	0	0	0	0	0	Never
Sort	1	12	1	0	12	5	Rarely
Scoring: 0 - never	1 - once a year		12 - monthly		50 - weekly		200 - daily

Figure 122: Usage of MAXARC software

1 Data structure and Setup facilities

1.1 Setup

Useful and flexible. Would be helpful to be able to alter selected fields rather than all of them.

1.2 Record structure

Size of record is adequate. More space for text would be desirable. Output to sequential files to save space.

1.3 Fields

Repeated field within the same record not usually required, but present means of achieving this is cumbersome. Present range of field types is adequate, but would like to add graphics. Space is adequate, but not too liberal.

2 Input

Import of files in other formats (eg Lotus 1-2-3, dBase) desirable. Desirable to be able to skip fields not relevant, for instance to a particular artifact type. (eg if sherd is decorated user will be prompted for questions on decoration.)

3 Editing

Slow, cumbersome, and can lead to errors - the weakest part of MAXARC. View without altering facility would be useful.

4 Outputs

Feature to allow selected fields of selected records would be useful. Sorting, retrieval, count and mailmerge output are useful.

5 General remarks on present facilities

Recycling of programme between operations irritating. Log file slows down startup and is not used.

6 Additional facilities

Statistical facilities such as those provided by statgraphics would be useful, as would easier interfacing to other packages. Graphics would be useful.

Figure 123: MAXARC software - users comments

The overall conclusions to be drawn concerning the software are that it supported the required records, but some improvements in the convenience of input and editing, and in the editing of file definitions would be desirable. Links to other packages were becoming increasingly important, as MAXARC could not provide all that was required without significant enhancements.

14.5 Facilities within the ARC system which were not implemented

The sections above have described how appropriate physical storage was achieved for all items, and how means of retrieving individual items had been provided, through manual or computerised indexing, or by browsing. The original requirements, which are outlined in Chapter 3, also specified additional facilities, including a means of retrieving all of the items relating to a specific site or object, and means of answering "research oriented" questions. The present section examines how the proposed system would have satisfied these requirements, what would be necessary to enable them to be met, and how the system as it stands can be used to provide these facilities.

14.5.1 Retrieval of all items relating to a single excavation or find

This requirement was specified so that it would be possible to retrieve all of the items from a particular excavation or find. Typically this would include photographs, slides, drawings, samples, and bibliographic references. The ARC system has been designed to facilitate the retrieval of all items relating to an excavation or find, as each excavation or find will be represented in the system by an information file, and each record relating to the excavation or find should be cross-referenced to the information file. The information file record in either its manual or computerised form can contain references to all related items, thus providing a simple means of ascertaining which other classes of item refer to the find. However, for a complex find or excavation this would be unwieldy, as it would be necessary to record many individual items in the information file record. The alternative approach is to search each class of item for those containing the information file number of the excavation or find. As each item should have in its record the information file number, such a search would reveal all related items.

1	Each item to have a computer record, containing the minimum of information file number, and location.
2	Information file number to be entered in each record.
3	Secondary index on the information file number to be established for each class of item.
4	Sufficient disk storage to be available for all records in ARC system to be on disk at once.
5	Software facility so that once an Information File has been retrieved all related records may also be retrieved.

Figure 124: Requirements for retrieval of items relating to a single find or site

The software facilities necessary to automate such searches are set out in Figure 124. The enhancements would not be difficult to implement, and would be effective provided that the computer used had a hard disk of sufficient size to mount all of the ARC records, and that a minimal record (containing the information file number) has been entered for each item. Experience with the ARC system suggests that there could be some user resistance to creating computer records for all of the items in the system, as in the case of items such as slides, there was no user requirement for computerised retrieval. However, the entry of a skeleton record containing only the information file number and location, would be a straightforward clerical task. If such facilities were available a user wishing to find all records relating to the Hasholme logboat would either search for "Hasholme", or would directly key in the information file number A200. The software would then use the secondary indexes to search each class of item for those with the information file number of A200, and prepare an appropriate report.

At present a user wishing to retrieve all records relating to a single find or excavation would first go to the information file, where drawings of up to A4 size, copies of bibliographic items, and contact prints of negatives would be found. Other forms of record would be found by browsing or using manual or computerised indexes, but it would be necessary to search each type of record individually.

14.5.2 Retrieval of items relating to a single object

The requirement to retrieve all items relating to a particular object is similar to the need to retrieve all items relating to a find or excavation (14.5.1 above). To facilitate the retrieval of all of the items relating to an object, it would be necessary to either record all references to related items within the object record, or alternatively for the records for each item to contain a cross-reference to the object record. Alternatively an information file could be established for each object, or group of objects, and each item could be cross-referenced to the information file. The user wishing to retrieve all records relating to a particular object would therefore navigate from the object record to the information file record, and from there to related records.

With the ARC system as presently configured, a user would first ascertain whether there is an information file for the object. If there is an information file then a similar method to that described in 14.5.1 would be used. If there is no information file, the user will start with the object record, where it is likely that a number of related items will be explicitly recorded. Other records would then be searched using manual or computerised indexes, or by browsing.

14.5.3 Research oriented enquiries

In the first instance the thrust of development was towards the provision of facilities which would aid in the orderly management of the items in the care of the ARC, and their related records. However, a further requirement was to facilitate enquiries from researchers, which by their nature would range across the whole of the ARC's collections, and would be concerned to identify all of a particular phenomenon, or to establish relationships between different finds. A typical query might be aimed at retrieving all sewn boats in North West Europe, or all medieval finds from the Mediterranean. Arguably such enquiries would be answered through curatorial knowledge, but a more automated approach could become appropriate if there were staff changes or reductions, or an increase in the quantity of enquiries, or a substantial increase in the number of records.

- Subject
  - Broad area
  - Specific place
  - Site name
  - Sub-division
  - Context
  - Person
  - Period
  - Date
  - Radiocarbon date
  - Type of object
  - Type of boat
  - Part of boat
  - Specific type
  - Unique name
  - Object number
  - Object material
  - Manufacture note
  - Process
  - Material
  - Equipment
  - Process/material/equipment note
  - Subject note

Figure 125: Fields in information file providing subject access

Answering research queries was considered to be important when the system was being designed, but as it was a low priority for the first phase, little development was undertaken.

However, because the information file records contain facilities for a wide range of subject indexing, they can be used as a means of access to the whole system. In the absence of information file records for all objects, the object record itself would also have to be searched. In the long term it would be desirable for all objects to have an information file, with as full as possible computer record. Figure 125 shows the fields in the information file record which would be used to provide subject access, and Figure 126 shows the relevant fields in the object record which would be used to satisfy research oriented queries. Some other classes of record would also provide access points specific to the type of record - users wishing to research conservation methods would need to have access via the conservation records, which provide certain specific indexing. Extensive subject indexing was provided for record classes such as transparencies, but as these fields are rarely used it is unlikely that they would prove to be effective in practice. The facilities to allow searching across the whole range of record types would be useful for research enquiries.

Identification	History	History
Object type	Finding	Manufacture
Boat type	Find Area	Maker
Boat part	Find Place	Area of manufacture
Specific type	Site name	Place made
Unique name	Grid type	Period of manufacture
	Grid square	Date made
	Easting	Radiocarbon date
	Northing	manufacture note
	Depth/level	

Figure 126: Fields in object record to satisfy research oriented enquiries

14.6 Transfer of data to Petrel

At the time when the record format for each class of item was being devised, the subsequent transfer of the data to Petrel was also considered. Section 9.7 describes this process, documents the relationship of each class of item to the Petrel standard, and describes the manipulations which would be required to transfer data to Petrel. The design of the computer formats for data capture is described in Chapter 11. Although no data was transferred to Petrel during the life of the project, in designing the record structure care was taken to ensure that any manipulations required for data to be transferred to Petrel could be performed automatically by a relatively simple piece of software. The present review of these requirements supports this, and it is argued that all the manipulations and substitutions described above could be carried out by a computer program which could insert tags and other controlling data, and make substitutions according to a simple set of rules. However for the bibliographic reference field, which requires a complex set of subtags to be inserted, automatic tag insertion would not be possible. There was resistance to inserting these tags at the time of data input, because of complexity for the users, and the unsightliness of tagged data occurring in simple printouts. The subtags therefore had to be omitted. For the transfer to Petrel these tags would have to be inserted manually. With hindsight it is possible to suggest that the tags should have been entered when the data was originally input, and a modification made to the output program so that they did not appear in printed or screen output. The conclusion is therefore that for all data except bibliographic references the transfer to Petrel could be readily achieved; for bibliographic references manual editing would be required to supply the necessary tags. Whilst this section has specifically considered the transfer of data to Petrel, similar manipulations would be required for transfers to other software, including post-Petrel developments at NMM.

14.7 Overall assessment of the ARC system

The objectives in developing a record system for the ARC (Chapter 7) are summarised as:

- to be able to easily locate objects and records
- to produce a catalogue and indexes
- to enable related items to be readily retrieved

The overall system architecture specified a complete range of facilities including procedures, data structures, terminology control, numbering and location recording, recording media, and computer hardware and software for each class of record within the ARC. These were to be linked together by a logical structure derived from the NMM implementation of the MDA data standard. An extension of the system for field recording was also required.

The review of the use of the ARC system described in section 14.3 showed that in general those parts of the ARC system which had been implemented were operating to the satisfaction of its users, and section 14.5 concluded that those parts which were not implemented would work effectively if they were required.

A significant conclusion to emerge from the use of the system was that the underlying data structure provided an effective framework for the data concerning individual classes of record, and provided an homogeneity of structure across the whole system. Although computerised links between different classes of record were not implemented, the underlying data structure has been shown to be capable of facilitating this. Similarly, although data was not transferred to the NMM Museum-wide Petrel system, it was concluded that (with the exception of bibliographic reference fields) this could be achieved automatically. On this evidence it is argued that the underlying data structure is a necessary foundation for a comprehensive record system such as that required by the ARC. The ARC data standard which is a subset of the NMM data standard (itself a subset of the MDA data standard), was appropriate and effective.

The second means whereby consistency within a class of record, and links across classes of record were maintained, was through terminology control. The controlled lists of permitted terms were found in practice to be generally effective, although the "object material" and the "process" lists lack structure, and a "production process" list was not developed. Such terminology control was necessary within each class of record, and is an essential prerequisite if research oriented enquiries need to be made across several classes of record. The absence of a museum-wide means of identifying locations was noted as hampering location recording, but this has now been remedied (Gillian Hutchinson, pers. comm.). The numbering systems for both item numbers and acquisition numbers were found to be satisfactory where they were applied.

In contrast to the comprehensive nature of the data structures underlying the ARC records, only components of the system which were demonstrably of immediate benefit to its users were actually used. In particular the records for objects, samples and conservation which had a management imperative were used in full, providing a primary source of data for some fields, and an overall summary and index to the complete records, whereas for records such as drawings and slides which could be retrieved by browsing, basic housekeeping was all that was needed. The effort involved in completing full manual records, or in the input and checking of computerised records is quite considerable. Limited resources meant that this would only be undertaken where necessary. Whilst at the time when the system was being designed it was imagined that all parts would be used in full, it is suggested that in the absence of an enthusiastic records manager, only those parts of the system which were essential would be implemented. It is unfortunate that the division of what had been the ARC between two sites, meant that only half the potential users had ready access to the computer.

As was indicated in the specification for the ARC system, a computer system was developed to facilitate data input and simple outputs, with the capability to transfer data to the NMM central information retrieval facility. It was shown to be able to accommodate the required data, and to provide the basic facilities which were needed. There was however some criticism of the cumbersome nature of editing, and in the use of the setup program to alter file definitions. In using the MAXARC software package the design parameters for the package were shown to be valid, although there were some reservations about the operation of the program itself. Through the life of the system links to other software such as graphical, statistical and spreadsheet packages were becoming an increasingly important requirement.

As has been discussed in section 6.3, by the time the ARC system was in use the newly available dBase III database management software appeared likely to be able to provide all of the facilities of MAXARC, as well as satisfying the criticisms of MAXARC concerning ease of use and links to other packages. A possible shortcoming with dBase III was that whilst MAXARC has flexible length data fields within a fixed length record, dBase III requires all fields (except text) to be of a predefined length, with a consequent effect on the amount of disk space required.

Overall the ARC system proved in practice to be able to satisfy the immediate requirements for records and object management, and to have the potential to support research based data manipulation. The underlying data structure was shown to be sound and sufficiently flexible to accommodate the full range of records and to facilitate present and anticipated manipulations. The software specification also proved to be a good match to its users requirements, although by the time the system was in use, it was possible to purchase off-the-shelf commercially produced software, which appeared to be able to provide the same facilities without many of the criticisms levelled at MAXARC. These conclusions are further discussed in Chapter 15.

15 Review of the ARC case study

15.1 Results

The ARC case study was designed to answer several specific questions about the design and operation of archaeological information systems (section 2.1 above), and to provide some insights into archaeological information handling through the experience gained in developing the system. The case study showed that a single system, based on the MDA and NMM data standards, was capable of:

- accommodating all types of archaeological and museum data

- supporting an archaeological record from the field through to analysis, archive, publication and transfer to a museum collection

The case study defined the components of such a record system and examined in detail the data structures which were necessary to support the record types and activities. Whilst all the record types which were thought to be necessary were modelled, not all of them were tested with "live" data. The case study also touched on the requirements for field recording, looked in detail at collections management needs and examined the transfer of data from a field situation to the museum. The computer system which was developed to support these data structures and manipulations proved to be a valid means of testing what facilities were required, but was rapidly overtaken by what was available commercially. These findings are described in detail in Chapter 14, above.

The ARC system was developed against a backdrop of very rapid development in computer science, information science, and in the uses that these disciplines were put to by libraries, museums and archaeology. The following sections outline the main themes in these advances and put the ARC case study into context. (A fuller account of development in these areas, together with a comprehensive bibliography, is given in Booth 1995c). In conclusion an assessment is made of the value of the ARC study and areas for future work are identified.

15.2 Developments in information technology

During the life of the ARC system there have been a succession of major developments in computer hardware and software, with perhaps the most significant advance being the overall increase in computing power. From the early 1980's when the maximum generally available configuration consisted of an S100 bus based machine with a Z80 chip, 64K RAM, a 5Mb hard disk and a 100K floppy disk drive, using the CP/M operating system, the typical system is now an intel pentium processor, 16Mb RAM, a 1Gb hard disk, a 600Mb CD-ROM and a 1.4Mb floppy disk drive (although these change by the month). In parallel with developments in the Intel arena, Apple computer have provided similar developments based on the Motorola 68000 series of processors.

MS-DOS and latterly Windows have remained the *de-facto* standard for single user PCs, despite the promise of OS/2 (Sheldon 1992). Multi-user access to microcomputer facilities was provided in the early 1980's through the use of the MP/M operating system running on one of the Z80 family of microcomputers, and latterly with the introduction of 16-Bit processors running Concurrent CP/M-86. For computers in the mini-computer class there were a range of proprietary operating systems, with Unix beginning to be quite widely used on machines of this scale. In the mid-1990s Unix remains the standard for multi user platforms at the PC and mini-computer scale (Yager and Smith 1992).

Up until the late 1980's there were a range of proprietary network systems, offering facilities from simple file and message transfer to access to central servers. For smaller networks servers employing the Novell Netware operating system have become the norm, although Windows NT is developing a significant following. For larger networks, particularly those spread across wide-area communications, Unix servers are more often used, with TCP/IP as the network protocol. Currently the most widely used network protocol is TCP/IP. Cabling technology has evolved from thick and thin "Ethernet", to a structured approach, typically consisting of a mixture of unshielded twisted pair (UTP), and fibre-optic.

Over this period there have been considerable advances in wide area networks, both in terms of what is provided by utilities such as BT and Mercury for public use, and what is available via the academic networks. In the early 1980's a range of leased lines were available from British Telecom but were expensive in terms of the capacity provided. An alternative was the use of dial-up lines (mostly analogue links throughout) with a modem, but these were not very reliable. EPSS (the Experimental Packet Switching Service which eventually evolved into PSS) allowed modem access to a high capacity link. Today leased lines are available at various speeds and there remains the dial-up PSS service. ISDN2 (the Integrated Services Digital Network Version 2) service from BT provides dial-up access to lines of almost limitless capacity, thus enabling the bandwidth (and cost) of the link to rise in order adapt to the volume of data being carried. In addition to the uncertainty of the cost of the call, ISDN also has a high connection and rental cost, although these are much lower in other parts of Europe (Andrews 1994). Except for the final link from the network to the subscriber for low speed links, connections are now entirely provided through digital networks with a high degree of reliability.

JANET (the Joint Academic NETwork) together with the high capacity SuperJANET, provides a comprehensive link to academic institutions in the United Kingdom, and to the Internet. Although first limited only to higher education, JANET and SuperJANET are now available to a much wider field of research and educational establishments. In the past these have been very much facilities for experts and enthusiasts, but with the World Wide Web has made access to data and images over the Internet accessible to anyone who has the necessary PC or Apple Mac, browser software and network connection.

Technological improvements in processor speed, and in memory, storage and network capacities, have facilitated the widespread use of image based and graphical facilities which had previously been prohibitively expensive. In this area Kodak's Photo-CD technology is becoming a standard for image storage (Chen 1993). The ease of manipulation of images has facilitated graphical user interfaces (GUI), and even more sophisticated ways of representing data including three dimensions and virtual reality (Peltu 1994).

There has been a substantial growth in the availability of packaged software for both personal computers (IBM compatible and MAC), and larger systems (Picher *et al* 1987). Such products range from commonly used applications such as word processors, databases and spreadsheets, to a whole gamut of programs for particular industries and application areas. Although in many ways an extension of word processing, desktop publishing was hailed as a new and powerful technology (Seybold 1987), and has provided an effective means of producing copy, either for direct printing from a laser printer, or for reproduction by more conventional technology.

Database technology underlies a broad range of packaged software, and forms the basis for much bespoke development. Mainstream developments have seen evolution through hierarchical, network and relational models (Hales and Guilfoyle 1989). Other approaches such as Pick, and text oriented products such as ADABAS have had their following, but much of the supposedly superior functionality which had been provided by the non-relational approaches is now incorporated within the mainstream relational products such as Oracle and Informix. Databases now employ a high level of sophistication in their functionality, user interfaces and facilities to guard against data corruption. The "object oriented" approach provides a further level of abstraction and simplifies programming, and helps to support different data types such as still and moving images and sound, which are increasingly required.

With the Apple Mac and Windows environments the predominantly textual menu-driven interface which characterised interactive software in the 1980s has been replaced by a graphical interface where much of the interaction is achieved through the use of a mouse to "click" on selected options. A facility which fits well with the graphical user interface is "Hypertext", which enables links between related items of information to be programmed in to facilitate browsing (Merrill Tazelar 1988). For instance in a museum context the text about a particular item will describe it have been made in Bristol. The user can "click" on Bristol, and information about the city will be displayed, together with links to other information, and so on. A graphical interface together with hypertext linked data, enables users to readily browse through related data, without having to follow a single linear route, and without having to master a keyboard driven interface.

An important development is the convergence of telecommunications and computing, with almost all the telecommunications in the developed world now use digital technology for data transmission. Following on from the convergence of computing and telecommunications, there is now a convergence of telecommunications and entertainment technologies. In competition with terrestrial television, and the later satellite services, high speed digital networks are being installed to enable entertainment to be broadcast to domestic customers.

Standards have become important in facilitating the interconnection of equipment and applications and in allowing users to select hardware and software from a range of suppliers. Throughout much of the 1980s there was little commonality between different suppliers, and sometimes even within the offerings of a single supplier. The OSI (Open Systems Interconnection) standard, which specifies seven levels of standard for data communication is in practice not often implemented in full, but it has nevertheless had a big effect on the development of a suite of *de facto* standards, including Ethernet networking, and hardware and software using the Unix operating system. Pragmatically MS-DOS, Windows and Novell tend to be included within the "open systems" environment.

A further range of standards have emerged for the specification, implementation and maintenance of computer systems, including a range of methodologies such as SSADM (Structured Systems Analysis and Design Methodology), PRINCE (Projects IN Controlled Environment), GOSIP (Government Open Systems Interconnection Profile), CRAMM (Computer Risk Analysis and Management Methodology), to name some more prominent examples (CCTA 1989a, 1990a, 1990b, 1991a, 1991b). With these standards aimed at providing better designed and managed IT projects has come the appreciation of the need to provide customer-focused IT services, subject to rigorous cost management (CCTA 1989b, Johnson *et al* 1994, Johnson 1991).

15.3 Developments in libraries

The last few years have been a period of intense technological development in the library field. Initially technology was used to support what was essentially a traditional library operation - a printed or microform computer generated catalogue, and latterly an online public access catalogue (OPAC), provided access to predominantly paper resources. In contrast the emerging scenario is one where the library is no longer primarily a keeper of paper resources, but a facilitator of access to knowledge available online from around the world. Furthermore access may be available from within the library, or remotely from the users home or workplace (Machovec 1992, Gelfand & Booth 1993).

Computers are also used for a range of management purposes in libraries, and in particularly for stock control and circulation management. A range of facilities for searching both locally held and remote data, and for electronic document delivery, are now routinely expected by users. This growth in the facilities provided by libraries has been matched by the production of electronic information sources available on CD-ROM and via networks.

15.4 Developments in museums

Perhaps because of an inherent conservatism, or because of the dichotomy between their roles as "cabinets of curiosities" and "centres of information" (Stewart 1984), museums have in general lagged behind libraries in the application of new technology.

The initial focus of automation projects was on the production of a printed catalogue (IRGMA 1969, 1977) and the data standards to support these initiatives (Light and Roberts 1981). Whilst this emphasis on cataloguing continued into the 1980's, collections management, and in particular accountability, have taken on a greater importance (Booth 1985b, Roberts 1988). This change in focus towards collections management seems likely to have been due to an overall increased emphasis on management and accountability in the public sector (for instance the UK Government Financial Management Initiative of the early 1980s), and to critical reports by the National Audit Office (NAO) and others (UK 1988, 1989).

Latterly there has been a further change in emphasis from collections management to public access and to encouraging the public to enjoy museums (Department of National Heritage

1996). This shift in focus was marked by the 1989 MDA conference on "Sharing the Information Resources of Museums", and by the 1993 MDA conference, which specifically addressed museums use of interactive multimedia (Roberts 1992a, Lees 1993). The LASSI (Larger Scale Systems Initiative) project, a collaborative venture aimed at specifying and procuring a software package for museums, is illustrative of this trend. It sits astride the change in priorities, having been conceived as an aid to collections management, but with an increasingly important public access component (Warren 1996).

Following McFarland and McKenny's model (1983) museums have in general yet to see information delivery as "strategic" in terms of their overall objectives. Nevertheless several large museums have carried out a strategic review of their information systems needs (Smithsonian Institution 1992, Booth 1995a, Lees and Booth 1993). These studies have tended to stress the potential of networking for both internal and external communication, and the role to be played by such new technologies as multimedia.

The public now expect to see images as well as text. A text only application such as that at the Department of American Art at the Metropolitan Museum of Art, New York (Hoover Voorsanger 1992), would not now be acceptable. Museums which have developed systems to display text and images include the National Museum of Denmark (Wanning 1993), the Design Museum in London (Rubinstein 1992), and the National Railway Museum, York (Heap and Booth 1993). At the National Gallery in London the Micro Gallery has digital images for almost all of the entire collection of over 2,000 paintings (Ellis 1991).

One difficulty in providing access to museum information is that the majority of computerised information is stored in structured databases which lack interfaces suitable for direct public access. In order to address this problem the Hypermuse project at Loughborough University examined how structured databases could be linked to an interactive hypermedia interface which would be suitable for public access (Poulter *et al* 1994). A further issue to be resolved is whether much of a museum's main data holdings, which are typically oriented towards collections management, are of interest to the public.

There have been some successful implementations of centralised databanks (for instance the Canadian Heritage Information Network - CHIN (McGee 1992), and the FENSCORE natural science collaborative database (Pettit 1992). However it seems likely that in the future databases will be maintained in individual institutions, but networked access will provide users with the impression of a single centrally held database, thus providing the characteristics of the union databases which have been sought for so long. Users will thus be able to access a much larger collection of information than is actually present at a single location.

CD-ROM is being explored by museums as an alternative means of distributing information. Chadwyck-Healey Ltd have been particularly prominent in this area (Chadwyck-Healey 1992). CD-Rom provides a very significant advance on microfiche, and is likely to become a successful means of distributing museum's data to a wide public.

Several museums are now implementing networking strategies to facilitate access to centrally maintained applications, and to foster synergy through internal communication. External communications are also becoming increasingly important as they provide access to information sources in other museums and in libraries, and for external electronic mail. External links can also facilitate remote use of the museum's resources.

External links may be achieved via the Internet (using JANET the UK academic network or one of the many commercial providers), or via a direct link from a telecommunications provider into public or leased lines. Examples of the museum use of external networks include the Science Museum in London (Booth 1995b), and the museums and libraries of the Smithsonian Institution in Washington DC (Smithsonian Institution 1992) and many others (Wallace and Jones-Garmil 1994, Gaffin 1994).

There are a number of standards initiatives which have a bearing on the use museums make of information technology. Overall procedures for collections management are set out in the guidelines for the Museums and Galleries Commission registration scheme (Museums and Galleries Commission *no date*) and in guidelines for the care of particular collections (Museums and Galleries Commission 1992a, 1992b, and others in preparation). In parallel to these initiatives the MDA has continued to develop its recording media and documentation standards (Holm 1991), and has published a revised version of the Data Standard (MDA 1991), which takes account of contemporary data modelling techniques. Initiatives in both procedures and documentation have been brought together with the publication of "Spectrum", a comprehensive guide to museum documentation standards (Grant 1994). In the United States the CIMI (Computer Interchange of Museum Information) initiative has also been investigating the requirements for museum data (Bearman 1990, Bearman and Perkins 1993).

15.5 Developments in archaeology

The arrival of microcomputers in the late 1970s put computer technology within reach of most archaeological organisations. After initial *ad-hoc* development the discipline began to consider the optimum way to use this technology, and in the early 1980's a number of papers were published on this subject. Varied aspects of archaeological work were covered, including museum based fieldwork (Flude 1983a), sites and monuments records (Copeland 1983a, 1983b), field units (Whinney 1984), and excavations (McVicar 1985, McVicar and Stoddart 1986). Richards (1985) examined what was needed to train the profession to use computers, and Cooper (1985) examined the need for a national strategy. A formal approach to acquiring computer systems is discussed by Clubb (1989 and 1991). The majority of the above themes were further developed at the Computer Applications in Archaeology conferences in 1993 and 1994 (Wilcock and Lockyear 1995, Huggett and Ryan 1995).

Much of the work in archaeological information systems has been directed towards the design of systems for excavation records. There are case studies for the Central Excavation Unit of the Department of the Environment (Hinchliffe and Jefferies 1985, English Heritage 1985), the Department of Urban Archaeology of the Museum of London (Williams 1991), and Heslerton (Powlesland 1991). The volume by Ross, Moffett and Henderson (1991) provides an overview, post-excavation practice is surveyed by Richards (1991), and archive requirements are described by Schofield and Tyers (1985). Many authors have proposed database designs for field records, including Andresen and Madsen (1992), Cheetham and Haigh (1992), Cogbill (1985), Huggett (1989), Huggett and Cooper (1990), Ryan (1992) and Stead (1988). Stratigraphic analysis has been a perennial issue, with contributions from Alvey and Moffett (1986), Boast and Chapman (1990), Ryan (1988), Haigh (1983) and Herzog and Scollar (1990).

Apart from the papers by Chapman (1984) there has been little discussion of the process of systems analysis and design, although this is remedied to a degree by Ross (1991). The overall impression is of a number of independent developments, which take some account of work by others but are more closely linked to local requirements. There are no moves towards the adoption of a national system for excavation records in the United Kingdom, despite various instructions from English Heritage on record keeping (1989, 1991a, and Perring 1992). However the Society of Museum Archaeologists has published a guideline on the transfer of archaeological material to museums (1993).

Developments in sites and monuments records in records kept by the national heritage bodies have become a regular feature in the Computer Applications in Archaeology proceedings (for instance Wilcock and Lockyear 1995 and Huggett and Ryan 1995), and have been exhaustively documented in the paper by Clubb and Lang (forthcoming). Overall in the UK there is a pattern of consistency at the county level (Lang and Stead 1992), encouraged by the national agencies (Royal Commission on the Historical Monuments of England and English Heritage 1989, Royal Commission on the Historical Monuments of England 1993), and coordinated by bodies such as the Association of County Archaeological Officers (1985, 1990 and 1991). There is also increasing co-operation between the national agencies. Concerns regarding database technology have been reflected in papers by Booth (1988), Cheetham (1985), Moffett (1984b), Larsen (1992) and Robinson (1993).

Geographic information systems (GIS) have become (as one would expect) of significant interest to archaeologists, and have been used directly linked to local and national sites and monuments records, and as research tools. Their use is discussed by Harris (1986, 1988), Clubb (1988), Wansleeben (1988), Lock and Harris (1990), Kvamme (1992, 1993), Castleford (1992), Ruggles (1992), Middleton and Winstanley (1993), Chartrand *et al* (1993), and Lang (1993).

Other themes which have become topical include word processing and the use of CD-ROM and other forms of "electronic publishing", and the role of technology in education and communication with the public (Martlew 1988a & b, Jacobs and Klefeld 1990, Ruggles 1988, Biek 1988, Orton and Grace 1989,Ruggles *et al* 1991, Reilly 1991. Whilst Thomas (1991) in an authoritative paper argues for the use of microfiche as a means of disseminating archaeological data, by 1995 interest has switched to CD-ROM (Thomas 1995, McAdam 1995).

The potential of SGML (Standard Graphical Mark-up Language) as a means of tagging archaeological data for publication was first described by Rahtz (1984), subsequently these ideas have been developed by Smith (1992); with the adoption of SGML as a means of formatting data for Internet access this is likely to be an increasingly important tool. The potential of the Internet has been recognised for providing access to archaeological information and as a means of communication (Heyworth *et al* 1995, Champion 1995). For these authors the potential of information technology in archaeology is as much in the dissemination of knowledge as in its recording and analysis.

The archaeological profession at large, particularly the national bodies of English Heritage, the Royal Commission on the Historical Monuments of England, and the Association of County Archaeological Officers, have given much consideration to record keeping requirements. However, apart from the Central Excavation Unit's manual, the English Heritage publications do not give specific instructions on recording for excavation and survey, or the transfer of the archive to a museum. Despite individual initiatives it can be argued that archaeology has yet to make the best use of information technology as a means of disseminating its findings to the wider world (Booth 1995c).

15.6 Pointers for future work

Chapter 14 has drawn together the conclusions from the ARC case study in the light of the questions which were asked at the time when the ARC system was developed, and has attempted to identify aspects of the study which have an applicability for other museum systems. The main conclusions were that the data structures and procedures were effective, but technological changes made some elements outdated. Furthermore there had been a change in the focus of priorities in museums from cataloguing and collections management to collections access and visitor service. In concluding the present chapter the aim is to identify trends in museum systems which need to be taken account of in future work, to identify developments in related disciplines such as archaeology and libraries which will have a bearing on future developments in museums and to identify relevant trends in information technology.

The major developments in computing have at their core a dramatic increase in the ratio of storage and processor power to cost, and a wealth of flexible off-the-shelf software. Together with reliable networks, powerful desktop computers and user-friendly graphical interfaces, these innovations put access to central data resources on everyone's desks. In a museum this means that all staff are able to have instant on-line access to collections, research and management information, including both images and text. Interactive multi-media kiosks can help visitors find their way around the museum, provide information about the collections and improve their overall enjoyment of the experience.

The convergence of telecommunications and computing has involved the academic networks, the traditional telecommunications providers and the cable TV companies in producing seamless worldwide communications linking scholars, commerce and the public. The internet and World Wide Web is one example of this phenomenon which museum are beginning to exploit. On top of the convergence of computing and telecommunications, the convergence of telecommunications and entertainment embraces the users of cable and satellite TV who are not traditionally well represented amongst museum visitors.

Packaged software (particularly in the database and museum specific areas), together with a wealth of guidelines on best practice for developing systems has lowered the risk to museums of making use of IT. Furthermore there is a greater awareness of cost management and of the assessment of cost benefit.

The trends in libraries have a significant bearing on the information element of museums' work, and provide a blueprint for remote access to data and for the concept of information centres to complement the physical access to objects. Through the provision of on-line access, assisted with the necessary interfaces and indexing tools, museums can mirror the facilities provided by libraries.

Particularly in the areas of site specific data and Geographical Information Systems, national archaeological bodies have done much work with data structures and access provision which is of relevance to museums. In archaeology the experimental use of on-line publication, the World Wide Web, and SGML have also demonstrated the potential of these technologies. However with the exception of some projects such as the ARC work described in the first case study, there have been few initiatives examining the transfer of field data to archives and museums.

In museums there has been a change in emphasis from the scholarly catalogue, through to accountability and management, to the present situation where access to collections information, and the overall value of the museum experience are the major areas of concern. In the museum the use of hypertext interfaces and touch screen technology have made public access to information a reality. Externally this is being achieved through the World Wide Web, the Internet and JANET, making possible the realisation of the union databases which have been aspired to for so long. Museums now have clearer objectives, and practice is conditioned by a range of standards, including Spectrum (the procedural standard following on from revisions of the MDA data standard) the LASSI software, and a range of guidelines for curating various classes of object.

The knowledge which will inform the second case study therefore consists of the experience gained from the ARC work, in particular including experience in the collections management field. The second case study will also be able to reflect the change in the emphasis of museum work to its present focus on access and the visitor, and the changes towards a more rigorous and cost-conscious environment. The second case study will also be able to benefit from subsequent experience in the museum, archaeological and library disciplines, and from the many advances in technology.

16 VISITOR INFORMATION AT THE SCIENCE MUSEUM

16.1 Introduction to the second case study

This second case study examines the information requirements of visitors to the Science Museum in London. It is concerned with defining the types of information the Museum's various publics require, the data resources which are necessary to provide this information, and the technical systems necessary to deliver the information to visitors. It builds on the conclusions of the National Maritime Museum case study described in Chapters 2 to 15. In particular the study examines the conceptual structure for visitor information, comparing it with the already established frameworks for cataloguing and collections management.

The Science Museum study illustrates the change in emphasis in museum information handling from detailed cataloguing and collections management to a more outward looking stance stressing access to the collections and the needs of visitors to the Museum. The implications of these changes in priorities are described in the proceedings of two conferences organised by the MDA. The first conference addressed the in-house use of information, particularly via multi-media (Lees 1993). The second examined external use of information via the Internet and similar remote technologies (Fahy and Sudbury 1995).

The present study seeks to reflect advances in technology since the National Maritime Museum work was completed and in particular to address the issues of database design, public access and cost benefit which were not looked at in depth. One of the themes examined in the ARC case study was that data could be transferred to other systems for different uses. This theme is further developed here.

This chapter forms the introduction to the Science Museum study and sets the scene by describing the Museum and its collections, and the overall profile of visitors to the Museum.

Subsequent chapters analyze requirements for visitor information, propose technical solutions, and propose a prioritised programme for implementing these systems.

The case study reviews several surveys of visitor information requirements. The results of these surveys are drawn together to develop an overall requirement for visitor information and the requirement for remote access to information. In putting together the overall requirement experience from other museums is drawn on.

The requirement is then considered in logical systems terms. The different types of location where visitor information needs to be provided are identified, together with the categories of information which are required at each type of location. An overall model for visitor information is constructed. Existing sources of information are itemised, and aspects for which new information will have to be generated are identified. Building on the logical model the requirements for software, hardware and data communications are described.

Having proposed a logical structure for visitor information and provided a technical plan for realising the model, the various options are subjected to a cost-benefit-analysis to identify those areas which should have a high priority for development. Areas requiring further investigation are identified.

16.2 The Museum

The Science Museum, which has its origins in the Great Exhibition of 1851, is one of the worlds foremost museums of science and technology. Together with sister museums at York (the National Railway Museum) and Bradford (the National Museum of Photography, Film and Television) the three museums constituting the National Museum of Science and Industry (NMSI) have over 400,000 three dimensional objects, 3 million images, and several million paper items in their collections. Five to ten percent of the three dimensional objects are on display at any time. There are over 2.7 million visitors a year at the three sites. The Science Museum collections contain the majority of three dimensional objects, whilst most of the two dimensional items are at the Northern museums. About 1.6 million people visit the Science Museum each year.

MISSION STATEMENT The Museum exists to promote the public's understanding of the history and contemporary practice of science, medicine, technology and industry
CORE OBJECTIVES **1 Customers** To exceed our various publics' expectations in all that we do **2 Collections** To build, research and care for the national collections in these fields **3 Communications** To interpret these collections and engage the public in the contemporary issues of science, medicine, technology and industry **4 Resources** To manage our resources and optimise income to support these activities

Figure 127: NMSI mission statement and core objectives

The mission statement and core objectives for the NMSI, together with the performance indicators necessary to measure performance against objectives, are set out in the annually produced corporate plan. The plan includes the financial projection for forthcoming years, and the bid to government for grant funding (NMSI 1995). The mission statement and core objectives are stated in Figure 127 and the performance indicators are summarised in Figure 128.

In common with other museums the Science Museum both displays objects which are of particular importance in their own right (for instance such icons as the "Rocket" steam locomotive), and uses objects and related information to interpret historic subjects to the public. Information provision is however particularly important in this case because of the Museum's need to interpret contemporary (as well as historical) science and technology, often in areas where objects are not self explanatory. A particular priority within the Museum's customer service initiative is to provide the public with the information needed to plan and enjoy their visit.

Customers	
1	The number of users of museum, by category
2	The number of visitor-minutes invested in museum
3	To meet customer service initiative pledges
Collections	
4	The proportion of objects stored and inventoried to the Museums and Galleries Commission's standards
5	To meet the collecting policy objectives, including acquiring the desired proportion of objects dating from post-1960
6	The number of staff publications in journals and books by category
Communication	
7	To achieve planned number of programmes and temporary exhibitions in year
8	To meet the planned standards of quality in permanent and temporary displays
Resource objectives	
9	The ratio of actual to planned current income including sponsorship
10	The ratio of actual to planned expenditure in both running costs and project expenditure

Figure 128: Performance measures for core objectives

Amongst the core objectives the interpretation of the collections to the public is explicitly itemised as an objective, and for other objectives information provision is an important but not explicit component. Similarly information provision is an essential element in achieving the necessary level of performance in the areas of customer service and communication.

Customers	
1	Customer service initiative, including in particular to enhance facilities for visitors - toilets and signposting are paramount
Collections	
2	Acquire and implement a new collections access computer system and to transfer collections data to this system
3	Improve public access to the reserve collections at Wroughton and Blythe House
4	Improve public and research access to collections and archives at NMPFT, including access through new multi-media technologies
5	Promote the use of the Science Museum Library by seeking funding to re-enter our stock onto the computerised catalogue, which is available over the Internet, allowing details of our holdings to be accessed worldwide.
Communications	
6	Add electronic (eg CD-ROM) publications to the output of NMSI
7	Experiment with "on-line" public information services as a way of enhancing our communication with particular publics
8	Create a new range of resources including compact discs, educational packs, information and activity sheets at NMPFT

Figure 129: Objectives with particular public information implications.

The core objectives for the NMSI translate into a number of discrete initiatives and programmes. Those that have a particular implication for public information are summarised in Figure 129. They include improving services to customers through the provision of signposting and information areas. In the collections sphere access to the collections and information about them is a key objective, together with access to the library holdings. On-line access, CD-ROM and other forms of electronic access are important in the communications area. Overall whilst information provision is not an explicit objective in all areas of the Museum's work, it is at the core of many objectives.

16.3 The visitor

The overall visitor profile for the Science Museum has been established through surveys carried out by MORI. These studies have investigated a range of aspects of visitors attitudes to the Museum, and have sought to establish the characteristics of visitors including age, sex, social class, geographical origin, and the composition of visiting parties. Other surveys are commissioned both internally and externally to answer specific questions about the overall visitor population, or to investigate specific aspects of the visitor experience, for instance their reaction to a particular exhibition. The visitor profile is an essential aid to developing the Museum's overall strategy, and in particular is used to:

- aid the process of ensuring that exhibits and facilities are appropriate for the Museum's visitors

- monitor changes in visitor numbers and composition through time, and in response to changes in public programmes

- help in understanding what groups are disproportionately represented in the visitor profile, so that strategies can be devised to encourage such groups to visit more

The 1994 visitor survey (MORI 1994) is summarised in Figure 130. Preliminary results from the April 1996 survey confirm the overall trends (MORI 1996). The overall visitor figure for the Science Museum in financial year 1995-96 was 1.6 million.

Total visitor numbers	1.3 million	
Sex of visitors	Male Female	59% 41%
Age profile	under 5 5 - 12 13 - 18 19 - 35 36 - 50 over 50	3% 30% 20% 25% 15% 7%
Composition of parties	Booked school groups Family & friends with children Not accompanied by children	23% 53% 24%
Geographical origin	London & Southeast England Other UK Outside UK	42.8% 25.5% 31.7%
Social class	A/B C1 C2/D/E	50% 31% 19%
Have visited before	50%	

Figure 130: Summary of visitor profile (after MORI 1994)
(Note: 1995-96 visitor numbers were 1.6 million)

The geographical distribution of visitors is as would be expected for a major London museum. Just over a third are from the Southeast of England, a further third are from abroad, and the remainder from other parts of the UK. In common with other museums the overall visitor profile is heavily slanted towards social groups A/B and C1, with only 19 per cent of visitors from groups C2/D/E (Department of National Heritage 1996). Just under 60 per cent of visitors are male. Just over three quarters of visits are either by school parties or family groups consisting of children and adults. The remainder of adults are visiting for professional purposes (for instance teachers planning visits), for general interest, or are enthusiasts. Teenagers are poorly represented.

The overall pattern is therefore one where three quarters of visitors are either school children or family and friends accompanied by children. There are however a well defined group of specialists and enthusiasts, and there is a further group of general visitors. In framing plans for visitor information these well defined constituencies will have to be catered for. In designing outreach policies to attract those who do not presently visit, and to provide an experience for those who will not visit, those groups that are under represented, including teenagers, females and social classes C2, D and E will have to be targeted.

17 SOURCES FOR THE VISITOR INFORMATION REQUIREMENT

17.1 Introduction

The conventional medium for interpreting museum displays has been labels or text and image panels, supplemented with printed material ranging from short leaflets to a full scale catalogue. Descriptive material on labels varies from the terse artists name, dates and title of the work that can be still be seen in some galleries, to the very full description of the item and its context which can be likened to putting a "whole book on the wall". The disadvantages of these methods of communication have been clearly stated by Roles (1995), who argues that visitors may lack the skills to understand complex written material, or their first language may not be English. Furthermore Roles argues that museums should play a more active part in communicating, informing, entertaining and inspiring, and should aim to reach beyond an audience largely made up of social classes A/B and C1.

In the Science Museum many of the older labels identify the object on display and briefly describe statistics such as capacity, bore, stroke length and so forth, whilst more recent labels give a broader description, putting the object into context. There is increasingly the feeling that the first type of label is only of relevance to a small number of "enthusiasts", and that the second type, although containing much of relevance, is not an effective way of imparting information. Visitors who may wish to see much of the museum in a single visit do not have time to read long labels, however interested they may be in what is being described.

In museums various forms of multi-media technology have been used to enhance conventional labels and illustrative material. Typically such a facility will consist of an audio-visual or multi-media presentation putting the objects into context, or (particularly in Science Museums) an interactive exhibit designed to explain the principles behind what is on display. In some examples of this medium it is also possible to find out more detailed information about the objects on display. Usually such facilities are provided through bespoke software with the information to be displayed encoded within the application, rather than being provided in a separate database. Approaches to these issues using multi-media technologies are described in a publication from the Arts Council of Great Britain (1992).

The simplest form of multi-media is the linear presentation of sound and moving image on video tape or laser disk, such as at the US Golf Museum (Strohecker 1993) or the National gallery of Art in Washington DC (Perlin 1993). If the facility is added to select a branching route through the material, it is possible to provide a "walk through" a virtual world such as that illustrating the city of Malmo, where a "three dimensional" view increases the involvement of the user (Bergquist & Wilhelmsson 1993). Even with the low cost technical solution employed by the Commonwealth Institute it is possible to show both text and images and the information can be updated as required (Ewings 1993).

The applications above are typical of the majority of multi media systems in museums in that they provide either scripted information about a limited portion of the collection, or a few items of information across a broader field. Because of the costs involved in developing an application where each item of information has to be individually incorporated within the programme, this method is rarely used where a major volume of information is to be presented. An exception is Micro Gallery at the National Gallery in London (Ellis 1991, and reviewed in section 17.7.1 below) which employs a hypertext application to provide access to the whole of the displayed collection.

An alternative method of providing access to a large collection is through the provision of an interface to the main database of information. At the National Museum of Denmark (Wanning 1993) the information about objects displayed in "visible storage" is accessed through a touch screen interface using an image depicting the gallery and display cases. Information is provided on where the item is from, how it came to be in the museum, and what it was used for. At the Musee D'Orsay (le Coz and Lemessier 1993) a direct interface into the database is available. Public access to raw data poses technical problems in the design of access and interface software. In addition the data itself may be unsuitable for public access if its primary purpose is to aid collections management or if it has been compiled as a specialist resource rather than for the general user. These issues are discussed in the case studies above, and in the paper by Fahy *et al* (1993) which describes the *Hypermuse Project* - an initiative to develop a hypertext interface to museum data held in relational format.

Several museums employ screen based systems to provide information about exhibitions and events. Non-interactive displays may be static, or change at pre-determined intervals. One such system at the British Museum has a facility to allow information desk staff to change the displayed information on-line. At the Minneapolis Institute of Art the *Visitor Directory* (Sayre 1993) is an interactive system providing information on current exhibitions, daily and weekly events, gallery design and location, self guided tours, and programmes for families and children. About forty percent of the galleries 500,000 visitors use this facility, and on busy days the three kiosks (designed for wheelchair, child and adult users) are in constant use.

Information can be provided through audio tours which give a spoken commentary as the visitor tours the museum or gallery. These may be arranged in a particular sequence which has to be followed by the visitor or controlled by radio to provide locality by locality information. The CD-ROM based audio tour at the National Gallery is controlled by keying in the identification number of the appropriate picture or gallery.

It is unusual to combine information about facilities and events with collections related information. An exception is the Smithsonian Institution where an interactive display provides information about the various constituent museums in the Institution, their facilities, collections, special events and exhibitions, and sources of additional information.

External access to museum information resources is still in its infancy, but internal and external use of museum libraries is often provided through an OPAC, a text based but easily used online public access catalogue (Gelfand and Booth 1993). In London the Natural History Museum is developing online access to scientific data. Although there is some scepticism in the business world of the value of the Internet and the World Wide Web, many museums are now making use of this medium (Gordon 1995). Dufy (1995) argues that with a clear brief to provide information, museum Web sites are ahead of much of commerce. Certainly with over 250,000 accesses per year the Science Museum sees its Web pages as a significant means of communication (Smith 1996).

In the longer term mass-market technologies such as interactive video delivered via cable and public access kiosks may be an effective means of reaching the wider public who do not have direct access to data networks. The potential for the use of collections information over the "information superhighway" is discussed in the proceedings of a conference held at the Science Museum in May 1985 (Day 1995), and the full spectrum of opportunities for external access via World Wide Web and other on-line methods is described in the volume edited by Fahy and Sudbury (1995).

Schools are becoming increasingly interested in remote access to museums. Such technologies can be used for students and teachers to plan their visits, and as a means of access for those who are prevented from physically visiting the museum. Remote interaction via video-conferencing is another option. Through the SMILE (Science Museum Internet Learning

Experiment) initiative the Science Museum is evaluating a range of possibilities (Jackson 1996).

Developments in museums and related areas mirror the wider world, where much has been made of the potential of the new communication technologies in the sciences, humanities and scholarly world (National Science Foundation 1990, National Academy of Sciences 1993, Royal Society 1993, Gould and Pearce 1991, Meadow and Buckle 1992, British Library Board and British Academy 1993, J. Paul Getty Trust 1993, Joint Funding Councils 1993, Michelson and Rothenburg 1992). Governments on both sides of the Atlantic have also seen this area as important (UK 1993, USA 1993, CCTA 1994).

The initiatives described above give an indication of what is possible, and a measure of how useful such facilities can be for museum visitors. Sections below describe initiatives to discover the types of facilities which visitors to the Science Museum require and also outline the findings of formal evaluations of some systems which have been used in other museums and galleries.

17.2 Visitor services evaluation

The visitor services evaluation (Carne Martin Qualitative Research 1994) was carried out for Simons Palmer, the museum's advertising agency. It aimed to "evaluate all aspects of the service provided for visitors to the Science Museum, other than the exhibits themselves, and provide guidance for further development". The study focused on information provision, catering, shops, and cost. Those objectives which are concerned with information provision are summarised in Figure 131. Only adults were interviewed, but the needs of adults accompanied by children were part of the study. The Figure 131 shows those areas where visitor experience of information provision would be assessed, together with suggestions for improvements to be tested. The survey was carried out through the medium of 50 in-depth interviews and a group discussion. The participants were selected to reflect a representative cross-section of the overall visitor profile (Figure 130).

1.	To understand all the elements which contribute to visitor experience of the Museum, for both foreign and UK visitors
2.	To evaluate visitors experience and satisfaction with (amongst others) the following: - finding and entering the Museum - getting around the Museum - the provision of information
3.	To explore the response to a range of possible improvements to the service, including: - improved provision of information throughout the museum - a "What's on" guide - a guide to the "Top Ten Exhibits"
4.	To give clear recommendations on how services provided by the Museum could be improved

Figure 131: Terms of reference for the Carne Martin study which have a bearing on information provision

In addition to answering specific questions about the visitor experience, the Carne Martin study provides qualitative background information on the broad categories of visitors to the Museum. The types of visitors can be summarised as:

- boffins and eccentrics
- professionally interested
- day trippers
- students

The survey found that these groups have different needs in terms of services and information.

These are summarised in Figure 132.

Type	Constituent individuals	Needs
Boffins & eccentrics	Scientists Academics	Knowledge
Professionally interested	Teachers & lecturers Educational advisers Engineers	To learn To plan a visit For interest
Day trippers	Families Couples Tourists	Entertainment Interest Pleasure Experience
Students	School children University students (of science, medicine, engineering, art and design)	To learn Inspiration Fun

Figure 132: Types of visitors identified by the Carne Martin Study

Visitors were in general pleased with their visit, reporting that it was "fascinating, inspiring, and a wonderful museum". Overall they were very satisfied with their experience, but there was felt to be a need for "fine tuning" in some areas, particularly the cafe and in information provision. Findings regarding their experience of existing facilities, including signage, customised routes, information provision and exhibits are summarised in Figures 133 - 136.

The first part of the study identified the need for a range of facilities to help visitors navigate through the Museum. Signage had to be improved, and there was some interest in customised routes and audio-guides. Overall a number of improvements in information provision were proposed including basic location maps, information on today's events, an alphabetic guide, and more detailed information for the specialist visitor. The greater use of technology in the form of touch-screen information and multi-media was welcomed and seen as an appropriate way to provide information.

Overall adequate, but:

- not always easy to see
- needs to indicate where you are, and where gallery leads to
- could benefit with frequent repetition of floor plan "you are here"

Figure 133: Signage

Not popular with some, but others felt they could provide routes for:

- first time visitors
- young children
- exhibits which have had a major impact on history
- medical exhibits
- routes combining different interests

It was felt that they would achieve:

- encourage people to return to the museum
- provide a "finite tour", thus lessening exhaustion
- guide the passive
- provide opportunities for more information for those that are more studious

Could be provided through mini-guide or audio tour

Figure 134: Customised routes

Greater use of technology was generally welcomed, including

- touch screen information
- multimedia presentations

Technology should enhance learning and involve the audience

Figure 135: Exhibits

Basic needs:

- plan of museum
- location of cafe
- location of toilets

However it was felt that the Museum could play a more pro-active role in guiding otherwise passive visitors

There was a need for information on entering the Museum near the admissions desks, particularly:

- what's on
- time and location of special events
- new exhibits and galleries

An alphabetical guide was felt to be useful for those that know the Museum

More detailed information was needed for the professional and educational user

Additional information sources were assessed as follows:

- Science sheets would be mainly suited to students, serious users and educational visitors
- Educational and resource packs would be more relevant to schools and students, though a pack on "space" would be useful for children
- A comprehensive computer network was seen as "information overload"

Figure 136: Information

What's on guide	This was felt to be a good idea
Top 10 Exhibits	This was not felt to be very relevant, particularly as individuals' interests are so varied
Customised routes	These were welcomed by a significant number of visitors
Communication of information	Could generally be improved

Figure 137: Responses to additional facilities

The second part of the Carne Martin study looked at the need for enhanced facilities including additional information, improvements in ticketing, and the provision of financial services, a post office and a cafe in the entrance foyer of the Museum. The results concerning those elements relating to information are summarised in Figure 137.

Overall the Carne Martin study concludes that whilst visitors enjoy their time at the Museum, information provision needs to be substantially improved. The study recommended that the information desk should be resited and enhanced with an associated information area. Better signage should be provided, together with customised routes and other navigation aids. For some visitors a range of additional information would be desirable. Interactive and multi-media technology would be an appropriate way of providing some of these facilities.

17.3 Gallery information system evaluation

In anticipation of developing object-based information systems in the Museum's galleries a study was carried out by the Science Museum Public Understanding of Science Research Unit (Gammon 1994). The analysis was aimed at defining visitor needs in terms of what was required for an information system linked to enhanced displays in the *Land Transport* and *Flight* galleries. The main areas investigated in the study, which was carried out in mid 1994, are summarised in Figure 138.

- what information is required about objects
- how various possible options are ranked
- what objects visitors would like to find out about
- whether visitors would be interested in using a gallery information system
- any additional information visitors expected
- general comments, suggestions and concerns

Table 138: Objectives of Gallery Information System Study

A random sample of 158 visitors were questioned, 86 in *Land Transport*, and 72 in *Flight*. In order to provide a rigorous means of understanding the visitors' requirements they were questioned in two ways. Firstly the sample group was asked what they would like to know about a specific object. The results of this first round of questioning are summarised in Figure 139. Secondly they were asked to rank a pre-prepared list of information about the objects into categories of boring or unhelpful, quite interesting or quite helpful, or fascinating or very helpful. Their responses to these questions are summarised in Figure 140. Those options most found to be boring or unhelpful are summarised in Figure 141.

56%	age of object	
40%	use or purpose	how was it used - what was its purpose was it a one off production or were many built was it used in any other way than as a prototype why was it developed - what were the economic forces behind its development
40%	facts and figures	how fast could it go what fuel was used how many people did it carry how many guns did it have how high could it fly
32%	construction	where was it built and by whom what is it made from how was it constructed how much did it cost to build
21%	invention/inventor	
<20%	provenance, how it works, background history and social history	

Figure 139: Questions visitors would most like to have the answer to

41%	how objects were used and how they worked
37%	stories about the objects, their inventors and the people who used them
35%	where things are in the gallery
29%	how the objects were made and what they were made from
28%	how old are the objects
<20%	ownership, dimensions, why object is in Museum, information about objects in store

Figure 140: Options found to be fascinating or very helpful by visitors

31%	**objects in store**
31%	**dimensions**
24%	**why in Museum**
19%	**ownership**

all other items were found to be boring or unhelpful by less than 10% of visitors

Figure 141: Options found to be boring or unhelpful by visitors

Although there was not a one-to-one correspondence between the types of questions visitors wished to ask, and the types of information they were questioned about, it is possible to draw broad conclusions from the two sets of interviews. The types of information which visitors were most interested in were:

- age
- use
- construction
- stories about the object

There was less clarity in the two sets of results concerning facts and figures (40% asked this question, but only 13% felt dimensions were fascinating/very helpful), and in how objects work (only 15% asked the question, but 41% felt how used/work was fascinating/very interesting). Both tests suggested that information about provenance and objects in store were of little interest.

Visitors were then questioned more closely about particular types of objects they would like to see in each of the galleries and they were also asked whether they would use a computerised gallery information system. The response to this question and the information they would expect to find on such a system are summarised in Figure 142.

Would you use the Gallery Information System ?

Yes - 89%   No - 7%   Not sure - 4%

Of those who said no, the reason most often given was that they wanted to spend time looking at the objects rather than using a computer

Concerns expressed included:

- should be quick and easy to use
- should be plenty of terminals
- should be appealing and easy to use for children

What would you suggest should be included on the Gallery Information System ?

- information on other museums in UK
- old film footage and sound clips related to objects
- a print out facility
- allow access from homes so as to plan visits in advance
- include details of how to get further information on other topics
- provide a keyword search facility

What do you want to know about the museum (sample of 24 from overall group of 158) ?

- a general introduction and plan of the galleries (71%)
- the location of toilets, exits and cafe (17%)
- information about the objects on display (17%)

What would you expect from a computer information service in the gallery (sample of 78) ?

- specific information about objects in the museum (38%)
- information on the history of flight or transport (29%)
- information on science and/or technology behind the objects (17%)
- information on layout of gallery (14%)
- information on layout of museum (13%)

Figure 142: Results of questions about a computerised gallery information system

Overall the gallery information system study established that the key object based information for visitors are the age of the object, its purpose, general factual information and its construction and mode of operation. There was little interest in the objects physical dimensions, objects in storage, why they came into the museum, and their ownership. Visitors were generally positively disposed towards the idea of a computer based gallery information system. In addition to providing information about the objects themselves, visitors felt that a gallery information system could help them to navigate around the Museum, could provide information from other Museums, and could be enhanced with multi-media including film. Visitors were also interested in the possibility of accessing on-line information from their homes to help them plan their visits in advance.

Essential features:	-	attractor sequence
	-	isometric floor plan of level guidepoint is located on
	-	major facilities highlighted on plan
	-	help/instructions
	-	various guided tours
	-	find particular object, subject or person
	-	quick tour
	-	families tour
	-	highlighted exhibits (3 per gallery), including graphic and brief facts about it
	-	directions to selected exhibit
	-	access to other floor plans
	-	access to gallery plans
	-	statistics of usage collected
	-	information updateable
	-	multilingual (English, French, German Spanish)
Desirable facilities:	-	re-routing if gallery/route is closed (eg maintenance)
	-	additional highlighted exhibits (more than three per gallery)
	-	additional languages - Italian, urdu, arabic, japanese
	-	multi-media, speech & animation

Figure 143: Essential and desirable facilities of the guidepoint system

17.4 Guidepoint system

One of the findings from the experimental Science Information Service (SIS) was that the public had difficulty in finding their way round the building and in finding out about the wide range of exhibits and programmes on offer (Ward 1991a-c). Prompted by this analysis the Museum's Interactive Development Unit proposed a *Guidepoint* system of public terminals to provide the public with directions and simple information (Roberts 1992). The essential and desirable features of the public terminals are summarised in Figure 143. They include a plan, and information about facilities and exhibits, together with a range of guided tours to suite different interests. Terminals would be located throughout the Museum. In addition to providing a range of information it was proposed that they could be multi-lingual, and offer the ability to be quickly updated to reflect unplanned changes to what is available. As well as describing the potential uses for such terminals, the study defined the "look and feel" necessary to make the guidepoint easy to use. A sophisticated interface with a graphical approach was recommended.

The guidepoint study provides an overview of the information which would be useful to the general visitor and the technology which could be used to provide this information. It provides a pointer for future work by summarising the SIS conclusions and drawing on the experience of the Museum's interactive development team.

17.5 Analysis of enquiries to the museum

The Museum handles over 100,000 enquiries per year from visitors to the Museum, and by post, telephone and e-mail. The following analysis of enquiries is based on the findings from a three month trial of a Science Information Service (SIS), and on a survey of enquiries carried out to help rationalise enquiry handling.

The Science Information Service operated over three months from February 1991 as a trial public information service to cater for questions on contemporary science and technology (Ward 1991a-c). The service was located in a prominent position near the main entrance to the Museum and therefore attracted a great deal of public attention. Whilst the service itself was not felt to be cost-effective, it provided a wealth of information about the types of information that visitors to the Museum require.

Figure 144 summarises the types of enquiry which were handled. Detailed enquiries, which were either answered by expert staff in the SIS, or forwarded to the appropriate specialist are summarised in Figure 145. A breakdown of enquiry by subject area and form of response required is in Figure 146.

Directional	60%
Request for specific technical and scientific information	17%
Request for information sheets	13%
Teachers request for information packs	6%
Browsing (no specific query)	5%
Total of c. 2,000 enquiries per month	

Figure 144: Summary of types of enquiries to Science Information Service

Enquiries concerning galleries and objects which could be answered by SIS staff	5%
Request for general science information (expected to take away information)	5%
Pupil/student requesting project information	3%
Specific science query	2%
Teachers requesting project information	1%
Enquiries concerning galleries and objects which had to be referred to a specialist curator	1%
Addresses of museums and other organisations	<1%
Existence and location of specific objects	<1%

Figure 145: Breakdown of detailed technical and scientific queries to SIS

The majority of queries handled by the Science Information Service concerned navigation around the Museum. It was felt that with an appropriate range of information sheets and some form of public access database, most queries could be answered on a "self-service" basis, or by non-expert staff. A small number of queries required more expert knowledge, and only 1% which had to be referred to a specialist curator.

Type of enquiry	%	Form of response required
Directional	60	Navigation aids, either in form of map and improved signage, or some form of computerised system, either directly accessed by the public or via the intermediary of non-expert staff
Request for information sheets	13	Provision of information sheets
Educational:		
Request for education pack	6	Provision of education pack
Pupil/student project related	3	
Teacher project related	1	Project related queries from teachers and pupils/students could mainly be satisfied by targeted printed material, or access to a database by non-expert staff
Information on galleries and objects	5	Queries relate to what the Museum has on display and where it is. Most of this type of query could be answered with a database and navigation aids, either directly accessed by the visitor, or via non-expert staff
Specialist information on galleries and objects	1	Response from specialist curator is required
Science queries:		
General	5	Information sheet could answer majority of these
Specific	2	Response required from someone with a good general knowledge of science and the standard reference works
Addresses of museums etc.	<1	Could be answered through a database or non-specialist staff with access to reference works
Browsers	5	Either provide an information centre or direct to the Library

Figure 146: Groupings of types of enquiries to Science Information Service and proposed means of responding to the enquiries

Departmental records, together with those kept by the reception and enquiry desks (which handle enquiries from visitors in person), form a valuable resource on the nature and volume of enquiries. Following on from the SIS survey, the analysis of enquiries carried out by Ward (1992a-c) was aimed at achieving a rationalisation of what was widely perceived to be an unsatisfactorily *ad hoc* situation. The survey identified where enquiries were answered, the volume of enquiries, and the nature of the enquiries. In total the Museum was found to answer nearly 10,000 enquiries per month (Figure 147).

Department	Enquiries per month	%	Nature of enquiries
Information and Reception desks	6,000	64	directional ticket enquiries location of specific object events complaints teacher pack requests specialist information (referred to appropriate staff)
Library	1,300	14	Bibliographic (25%) Historical objects/subjects (50%) Contemporary Science & Technology (25%)
Education (teacher)	1,000	11	Subject based enquiries concerning the Museum's resources. eg "The Victorians", "energy".
Education (pupil/student)	100	1	space (33%) transport (33%) other (33%)
Collections	850	9	Complex questions regarding objects (simple queries are referred to the Library)
Others	<100	<1	small numbers of enquiries are answered in other departments
Total:	9,350	100	

Figure 147: Summary of types and number of enquiries by department

The 1992 analysis showed that over half of the enquiries were received by the information and reception desks, the majority of these being directional, or related to ticket prices, opening times, and the days events in the Museum. Significant volumes of enquiries were also received by the library, the collections department and by the education department.

The results from the Science Information Service experiment and the enquiries survey are broadly in agreement regarding the relative proportion of enquiries, and their nature. The majority of enquiries are concerned with the Museum's facilities, ticketing, navigation around the Museum, and with basic questions about what is on display. The evidence suggests that this type of enquiry could be answered through some form of interactive system which visitors would use themselves, or by non-specialist staff with access to a computer system and the appropriate reference sources. There remain a significant number of enquiries concerning educational facilities and schools projects, specialist queries about the collections and queries related to contemporary and historic science. Some of these could be answered through an automated system or the provision of targeted handouts, whilst others require some skilled staff intervention. A minority of queries require a high degree of specialist knowledge and had to be forwarded to a subject specialist.

17.6 Science Museum World Wide Web

The statistics from the Science Museum World Wide Web pages provide data about on-line access to information about the Museum and its collections. Whilst the World Wide Web has attracted a great deal of media interest and is seeing an exponential rise in use, its importance as a communication medium is as yet uncertain, and the science of interpreting access statistics is still in its infancy. Nevertheless these figures do provide some indication of interest from those educational, enthusiast and business users who have access to this technology.

Use of the Museum's World Wide Web pages was surveyed over a period of four months from mid-September 1995 to mid-January 1996, and an average number of accesses per page per month was calculated. Though page accesses do not give a good guide to the numbers of interested visitors (a single visitor may access one page or many hundreds) the relative numbers of accesses are felt to provide a guide to the relative popularity of World Wide Web sites, and pages within sites. Figure 148 (based on an analysis carried out by Peter Bailes at the Museum) shows the relative popularity of different groups of pages.

The figures show that overall the most used pages are the general introduction to the Museum's collections and the "virtual galleries". Second, by a small margin, are those giving factual information about the Museum (including charges and facilities for visitors and researchers), links to other NMSI pages, and links to external pages. The pages for the Photography Film and Television and Railway museums are also popular. Information about events in the Museum gains 6% of accesses, with lower levels for education, the library and the Information Superhighway conference.

Pages	Av. Access per month	Percentage
Collections and Galleries	23,773	36%
Introduction, What's New, Statistics, Staff, Index to other pages	14,426	22%
Events	3,687	5%
Visitor information	3,328	5%
Researcher information	3,118	5%
Links to other World Wide Web sites	2,031	3%
Education	1,769	3%
Library (including links to on-line catalogue)	1,095	2%
Information Superhighway Conference Proceedings	441	1%
National Museum of Photography, Film & Television (Bradford) and National Railway Museum (York)	11,770	18%
Total:	65,441	100%

Figure 148: Average monthly accesses to Science Museum World Wide Web pages over 4 month period 18 Sept 1995 to 17 Jan 1996.

The high levels of access to the collections pages show the interest in making a "virtual visit" to the Museum to view the objects in display. The lack of a correspondingly high number of accesses in the factual information about opening times and charges may indicate that many of these "virtual visits" are not preparatory to a visit in person. The high levels of access to the "virtual galleries" may also be due to the innovative approach adopted in constructing these pages (Bailes 1995). The pages for the two museums in the north attract nearly 20% of accesses, reflecting interest in these museums which will have their own constituencies.

At a lesser but nevertheless significant number of accesses, are the events pages which list what is available on particular days. There is also a significant level of interest in charges, opening times and visitor facilities, suggesting that some visitors do use this medium as a means of planning their visit, although in apparently fewer numbers than make a "virtual visit".

There is also a significant interest in the pages for research facilities and the library, suggesting that those who want to use these resources use the World Wide Web pages as a means of establishing what is available before making a visit. This interpretation was confirmed by a media researcher at the 1995 MDA Conference (Kocjancic 1995). In her paper Kocjancic described using the Science Museum and Natural History Museum pages as a means of knowing where relevant resources would be located.

The level of interest in the Education pages is surprisingly low, particularly in the light of a major initiative in this area (Jackson 1995). This may be due to the present low level of World Wide Web connectivity in schools. The Information Superhighway Conference Proceedings do not have a high number of accesses, perhaps suggesting a lack of awareness of this event, or that such an offering is not of interest to the main users of the Museum's pages.

Overall the statistics for World Wide Web usage suggest some broad trends. There is a high level of interest from "virtual visitors" to the Museum and there is also significant interest from those who are planning visits to the Museum either to view the galleries or to use the research facilities. Use by schools is surprisingly low. These conclusions provide some indicators regarding remote access to the Museum, but more work is needed on the interpretation of World Wide Web statistics in general and in understanding how and by whom the Museum's pages are being used.

17.7 Comparative material from other museums

17.7.1 The Micro Gallery at the National Gallery

The Micro Gallery at the National Gallery in London is an interactive system providing images and related information covering the whole collection of 2200 paintings (Ellis 1991). The facility consists of 12 workstations each with a touch screen interface and laser printer. The system has been widely acclaimed on technical grounds and has proved to be very popular with visitors. In order to provide some objective information about how people use the system, and whether it helps them to enjoy works of art, the systems' implementors carried out a survey of visitors to the Micro Gallery (Cognitive Applications 1992). The visitor survey was conducted through 500 self-administered questionnaires, of which 374 completed forms were returned. In addition an observer made detailed notes of the use of the Micro Gallery over a single day. The results of this survey are described below.

Figure 149 shows the profile of visitors to the National gallery who used the Micro Gallery. Comparative data for the National Gallery as a whole is not available, but it was felt that the micro Gallery attracts a higher percentage of students, school pupils, and regular visitors. The survey shows that two thirds of users are students in full or part-time education using the Micro Gallery in the course of their studies. Ages range from 10 to 55, either visiting on their own or as part of an organised group. Most have visited the National Gallery before. Most visitors using the Micro Gallery will spend over 1 hour in the National Gallery. Over eighty per cent of users of the Micro Gallery are from the UK.

Key findings from the survey are summarised in Figure 150. Overall most use the Micro Gallery for 10 minutes or more, enjoyed using this facility, and would use it again if they returned to the National Gallery. For most users the Micro Gallery had increased their enjoyment of the paintings and most disagreed with the suggestion that it reduced their desire to look at the paintings, and that it was an adequate replacement for seeing the paintings.

Number of respondents	374	
Age profile	under 11	0.5%
	11 - 18	29%
	19 - 55	63.5%
	over 55	7%
Geographical origin	Greater London	44%
	Other UK	35%
	Outside UK	21%
	uncertain	3%
Full or part-time education	Yes	63%
	No	33%
	Uncertain	4%
Using Micro Gallery in course of studies	Yes	51%
	No	40%
	Uncertain	9%
Visited National Gallery before	80%	
Composition of party	organised group	32%
	friends or family	24%
	on own	44%
Where in visit	start	31%
	middle	36%
	end	32%
	no response	1%
Length of visit	up to 1 hour	14%
	1 - 2 hours	46%
	over 2 hours	39%
	no response	1%

Figure 149: Summary of visitor profile for Micro Gallery users

How many of you used the system together ?	One Two Three or more	48% 28% 21%
How long did you spend with the system ?	under 5 minutes 10 - 15 minutes 15 - 60 minutes 60 + minutes	3% 33% 57% 6%
Did you enjoy using the system ?	Yes No	98% 2%
Did you look up any artists ?	Yes No	92% 5%
Did you look up any paintings you have already seen on your visit ?	Yes No	61% 35%
Did you come to the Micro Gallery for any specific information ?	Yes No	48% 48%
Did you know that you can use the system to print a personal tour ?	Yes No	65% 32%
Did you print out a personal tour ?	Yes No	20% 74%
Did you print anything ?	Yes No	45% 50%
Are you going back to look at the paintings ?	Yes No	62% 31%
Are you going back to look for any of the paintings you found on the system ?	Yes No	57% 34%
Did you learn anything ?	Yes No	75% 14%
If you return to the National Gallery will you use the Micro Gallery again ?	Yes No	92% 2%
The Micro Gallery reduced my desire to look at the paintings	Yes No	4% 74%
The Micro Gallery will do instead of looking at the paintings	Yes No	6% 72%
The Micro Gallery added to my enjoyment of the paintings	Yes No	89% 5%

Figure 150: Results of survey of users of the Micro Gallery

Usage was roughly equally divided between those who are on their own and visitors in groups of two or more. The greater proportion of those going on to visit the gallery had found paintings in the system which they wanted to see, and the majority had printed something out. However only 20% had produced a personalised tour.

The observation study showed average usage throughout the day of 82%, but for much of the day the workstations were all in use and demand was in excess of capacity. The length of session lasted from 2 to 80 minutes, with an average of 23 minutes. From these figures it is inferred that approximately 1 in 40 of the National Galleries 4 million visitors use the Micro Gallery.

The survey shows that around 2.5% of visitors to the National Gallery use the Micro Gallery, and that more than half of them will use it in the course of some type of formal study. Visitors to the Micro Gallery spend about 20 minutes there, and spend over an hour in the National gallery, with 39% spending over two hours. For the majority of users (both scholastic and otherwise) the Micro gallery enhances their enjoyment of the paintings but is not a substitute for seeing them. It is clearly a success as almost all those who used it will do so again on their next visit.

17.7.2 Survey of enquiries to museums

In the summer of 1993 the National Museums of Scotland carried out a survey aimed at testing the assumptions about what information is required to answer enquiries to museums (McCorry and Morrison 1995). In particular the survey set out to questioned the view that museum data should be organised in a similar way to that in libraries. The survey was carried out in the context of the ongoing cataloguing project at the National Museums of Scotland and of the developing national database which combines collections information across Scottish Museums. The survey took place by post and was targeted at those museums (mainly in the

UK but some abroad) where staff were known to the authors and were therefore likely tor respond.

Specific object	30%
Name (maker, owner, institution etc.)	18%
Description (iconography, inscriptions, dimensions, materials, media)	16%
Place (origin, manufacture etc.)	13%
Procedures (acquisition, management, loans etc.)	13%
All other categories (including date/period, culture, events, bibliographic)	10%

Figure 151: Percentage of questions referring to objects

The survey identified the main subjects of enquiries. Respondents were generally concerned to give a report on external requests for information, but most did not contribute information about the types of internally generated questions which they had to handle. Overall 69% of questions concerned objects in the museums' collections, with the remainder covering a wide range of subjects including educational projects, opening hours, and local history.

Queries relating to objects are categorised in Figure 151. The main area of enquiry was for a specific object or object type. Less common were queries relating to people, places, detailed descriptive aspects, and administrative matters (acquisition, loan, etc.) which all had similar scores. Other aspects, including dates, associated events and bibliographic categories had a low incidence.

The object related aspects of the reported questions were then subjected to further analysis to establish which categories of information within the databases were needed to respond to this type of question. Overall it was concluded that the majority of questions referred to a small number of well defined areas (Figure 151) and that this was the data to concentrate on, rather than more obscure categories.

The authors of the report identified a weakness in the value of the results in that internal queries were not reported, and that bibliographic queries were under-reported as they would often be referred to the museum's library. It also seems likely that with a professional bias towards collections related matters the staff who were surveyed tended to concentrate on object related queries. Nevertheless the survey does give an indication of the spread of enquiries, and (more reliably) the range and distribution of queries concerning objects. It shows the majority of questions relate to specific objects, and to people, places, descriptive aspects, and administrative matters.

17.8 Conclusion

Preceding sections of this chapter have described several perspectives of visitor information requirements. The introductory section surveyed what had been achieved already through gallery-based and remote applications. Within museums these systems are mainly used to provide information about the objects on display and the facilities the museum offers, and to provide aids to navigation around the museum. External access is yet to be fully developed, but there is already some interest in OPAC access to specialist information, and in the World Wide Web.

Several surveys which analyze different aspects of the visitor information requirement have been described. The subjects include visitors to the Science Museum, specific needs for gallery based systems, visitor "guidepoints", enquiries to the Museum, and an analysis of use of the Museum's World Wide Web pages. Comparative studies which are described consist of an analysis of visitors to the National Gallery's Micro Gallery, and a survey of enquiries to museums carried out by the National Museums of Scotland. The following chapter draws these strands together to form an outline of the requirements for different types of visitor information, both within the museum and externally.

18 DEVELOPING THE REQUIREMENT

18.1 Background

The previous two chapters have put the Science Museum case study into context and have described the Museum's mission and the individual objectives derived from the mission. It has been demonstrated that information provision is at the core of the mission statement, and that many objectives have a substantial information content, including:

- improving customer service
- initiatives for collections access
- the development of outreach facilities

In addition to objectives which are specifically aimed at providing visitors with information of various types, the surveys outlined in Chapter 17 indicated that improvements were required in signage and navigation aids, and that the Museum could play a more pro-active part in encouraging the public to make the most of what is available during visit. The Museum receives over 100,000 enquiries per year. An investigation of enquiries showed that a modest improvement in the facilities available to enquiries staff, or the provision of interactive terminals for use by visitors, would greatly improve the service.

The surveys summarised in Chapter 17 were each carried out with a specific brief. They cover different areas of interest and do not individually give a complete picture of visitor information needs. However these different bodies of evidence can be combined to suggest the overall information requirement. This combined evidence benefits from the overlap between various surveys, which provides confirmation and validation of the results. Information provision is divided into what is required within the Museum, and remote access. Within these two categories there are the needs of the general public or "typical visitor" and the needs of specialists or "enthusiasts". The overall requirement is summarised in Figure 152, and individual sections below outline in more detail what each consists of.

Inside the Museum		
Entrance	-	to present what is on, opening hours, prices, etc.
Orientation	-	inside the Museum, to help plan visit
Information point	-	information points around the Museum, primarily to help navigation
Support exhibits	-	to provide additional information about the items on display
Visible storage	-	to provide information on exhibits displayed in "visible storage" facility
Study centre	-	facility to provide detailed information for researchers, enthusiasts, etc.
Remote access		
Potential visitors	-	to help plan visit to the Museum
Technical enquirers	-	to provide facility for detailed enquiries
Schools enquiries	-	to provide access for schools to project based information, and to plan visits
Virtual visitors	-	to provide access to those who are unable to visit in person

Figure 152: Summary of visitor information requirements

The present chapter categorises the types of information provision in terms of where the information is needed and what is required at each point. A detailed analysis of what data is needed at each type of information point, together with a discussion of how this can be provided, is in the following chapter.

18.2 Information at entrance to the Museum

The visitor services evaluation (17.2 above) found that at the entrance to the Museum visitors needed to know what was available on the day of their visit, the time and location of special events and information about new exhibits and galleries. The aim of this facility is to help visitors begin to plan their visit whilst they wait to pay for their tickets and to encourage them to visit if they are undecided. As well as providing the information visitors requested, it is also an opportunity for the Museum to advertise any facilities it may wish to draw ti the attention of visitors. These requirements are summarised in Figure 153.

- opening hours
- ticket prices
- what's on
- time and location of special events
- new exhibits and galleries
- alphabetic guide

Figure 153: Information for visitors at entrance to Museum

18.3 Orientation

The visitor services evaluation (17.2 above) found that once in the Museum visitors needed to orient themselves in order to plan their visits. This requirement also emerged from the analysis of enquiries to the information desk in the Museum (17.6 above). The information requirement at a basic level includes an alphabetic list of facilities, galleries and key objects and a range of pre-programmed and bespoke tours. It was suggested that pre-programmed tours should suite different ages and interests, and should be designed to suite different lengths of stay in the Museum. The facility to produce bespoke tours would enable a visitor to build up a tour including the objects and galleries which interest them. Figure 154 summarises the requirement for orientation.

An implied requirement was for something similar to the Micro Gallery at the National Gallery (17.7.1 above) to provide more detailed information about the Museum's collections and related information. This is in contrast to the brief information which most visitors require, and is therefore felt to be more appropriately provided in a "study centre" environment. This is discussed further in 18.7 below.

- alphabetic list
- what's on today
- pre-programmed guided tours
- custom guided tour
- detailed information for professional and educational user

Figure 154: Orientation information requirement

18.4 Information points

The visitor services evaluation (17.2 above) and the "Guidepoint" proposal (17.5 above) identified the need for information points positioned throughout the Museum. The main requirement at these locations is for a plan of the Museum and the locations of the lavatories, cafe, exits, galleries and exhibits but there is also a need for a route into other forms of information. These straightforward requirements, summarised in Figure 155, were also documented by the analysis of enquiries (17.6).

- plan of Museum
- location of cafe
- location of toilets
- exits
- galleries and exhibits
- events

Figure 155: Information point

18.5 Detailed information to support exhibits

The survey of multi-media developments in museums (17.1 above) showed that applications to support exhibits were usually specific to the items on display, and did not usually provide additional types of information. However the gallery information system survey conducted in the Museum (17.3 above) found the need for a broad range of object related information and for facilities similar to those provided by the information points (18.4 above). These requirements are summarised in Figure 156. They include information about the objects, their history, the science behind the objects, information about the layout of the Museum, and a wide range of related information.

- specific information about objects
- information about history relating to objects
- information about science/technology and objects
- information on layout of Museum
- related information
- other information (as in guidepoints)

Figure 156: Object based gallery information system

18.6 Visible storage

The need for an on-line catalogue to support "visible storage" was not noted as an explicit requirement at the Science Museum. However tightly packed displays with little or no room for conventional labels or interpretation, supported by data terminals providing information, have been successfully used at other museums, including the National Museum of Denmark and the Metropolitan Museum of Art in New York (Wanning 1993, Hoover Voorsanger 1992). The requirement is included here as it has from time to time been mentioned as a possibility for the Museum. The information to support "visible storage" consists of basic object details and cross-referencing to connect related items (Figure 157).

- specific information about objects
- information about history relating to objects
- information about science/technology and objects

Figure 157: Visible storage

18.7 Information Centre

This requirement was not specifically identified in any of the Science Museum surveys, but the need for additional information did come out of the visitor services survey (17.2 above) and the gallery information system survey (17.3 above). The indications are that this is a different requirement to the on-gallery or information point facility, because:

- there is a need for a wide range of detailed information

- visitors will want to access this information in a secluded area away from crowded galleries

- visitors are likely to spend longer (perhaps 20 minutes) using the information centre, in contrast to the usual 5 minute attention span for an interactive display (Gammon 1995)

It is suggested that this need is best met by a facility such as the Micro Gallery at the National Gallery (17.7.1 above). The information centre requirement is based on the need for on-line access to detailed object information, and possibly also to information in other museums, libraries and archives. In addition the full range of facilities provided for orientation and at visitor guidepoints (see above) would be desirable. These requirements are summarised in Figure 158.

- detailed object information
- access to information remotely held
- bibliographic information
- educational information
- plan of Museum
- location of cafe
- location of toilets
- exits
- object information
- events

Figure 158: Information centre

18.8 Remote access - to assist in planning visit

The high volume of enquiries handled by the Museum relating to queries from potential visitors (17.5 above), together with the findings of the gallery information survey (17.3 above), and the World Wide Web statistics (17.6 above) all indicate a high demand for information from people planning to visit the Museum. In the main this is concerned with opening hours, prices, events, the main attractions and facilities, and how to get to the Museum. These are summarised in Figure 159.

- opening hours
- prices
- travel to the Museum
- what's on
- special events
- facilities

Figure 159: Remote access - to assist in planning visit

18.9 Remote access - technical enquirers

Around 20% of enquiries to the Museum are of a specialist nature, and require information relating to bibliographic or object related resources (17.5 above). This type of enquiry is usually based around the collections and other resources of the Museum. A second category of enquiry is from researchers who intend to visit the Museum to consult the records at first hand. They will wish to know the range of material and facilities, together with opening hours and ticketing arrangements. The requirement is summarised in Figure 160.

- detailed object information
- access to information remotely held
- opening hours
- prices
- travel to the Museum
- what's on
- special events
- facilities

Figure 160: Remote access - technical enquirers

18.10 Remote access - schools enquiries

Subject based enquiries by schools are documented through the enquiry survey and Science Information Service survey (17.5 above), accounting for around 10% of the total number of enquiries, and there is an additional volume of enquiries (not differentiated from public enquiries) from schools relating to opening hours and facilities in general. There are project related enquiries from both teachers and students, and requests from teachers for information packs to plan visits. The requirement is summarised in Figure 161.

- subject based enquiries from teachers
- project based enquiries from pupils
- opening hours
- prices
- travel to the Museum
- what's on
- special events
- facilities
- on-line booking of visits

Figure 161: Remote access - schools

18.11 Remote access - virtual visitors

"Virtual visitors" who use on-line access as a replacement for a physical visit to the Museum are a recent phenomenon, as the Museum's World Wide Web pages which provide virtual galleries have only been available since April 1995. During this first year there have been over a quarter of a million accesses to the Museum's World Wide Web pages and the weekly access figure of 25,000 continues to rise. Despite concerns about how to interpret such figures there is clearly a demand for this facility. Virtual visitors like to browse the galleries of the Museum, to see images of objects, and find out about those objects and related information. Whilst the virtual visits are at present limited to the three sites of the NMSI it would be relatively easy to seamlessly link the virtual galleries of different museums, perhaps combining several museums of science and technology. The requirement is summarised in Figure 162.

- 3D representation of Museum, with drill down to multi-media information on galleries, objects and science

Figure 162: Remote access - virtual visitors

18.12 Summary of visitor information requirements

This chapter has drawn together the various information requirements for visitors at the Museum and for remote access to information. In the Museum most visitors require some information at the start of their tour on what there is to see and do. Once in the Museum they need aids to finding their way around, and more detailed information to support exhibits. Some visitors also require more detailed information. Potential visitors accessing information externally need to know what the Museum has to offer and practical information about how to get to the Museum, opening hours and ticketing. Teachers, students, specialists and enthusiasts need to query the Museum's information resources remotely and plan their visits to the Museum. Finally there is the group of "virtual visitors" who are unable to visit the Museum in person.

The following chapter is concerned with turning these broad needs into clearly defined requirements and identifying the data and technical implications of implementing these proposed systems.

19 TECHNICAL DESIGN

19.1 Introduction

The previous sections within the Science Museum case study took as their starting point the information needs contained in the Museum's corporate objectives and surveys which showed that there was a need for better information for visitors to the Museum. Several studies describing visitor's requirements have been drawn together in Chapter 18 to produce an overall picture of what is required (Figure 152). The present chapter is concerned with describing an analysis of the data elements and technical options for providing this information, and the evolution of a logical and technical model for visitor information. Paragraphs below outline the rationale for investigating a technological approach for these requirements, rather than the more traditional means of information provision by signpost and printed material.

Experience at other museums (for instance those described at the beginning of Chapter 17), suggests that multi-media technology is often well received by users and can be an effective way of providing information to the public. Studies carried out at the Micro Gallery of the National Gallery in London and at the Philadelphia Institute of Art showed such facilities could be extremely popular, being almost constantly in use. The Carne Martin survey at the Science Museum (17.2 above) found that visitors liked both interactive exhibits in general, and the idea of computer based information provision (Figure 136). This enthusiasm for interactive exhibits has been confirmed by the preliminary results from the 1996 visitor survey (MORI 1996).

The majority of visitors to the Science Museum are schoolchildren and children accompanying adults (Chapter 16). These children are from a generation which has grown up with technology at home and school and which expects to find computer based information provision and navigation aids in public places. Those visitors who are not accompanying children usually have a professional or technical interest in the Museum; again these are groups who would be expected to react positively towards new technology. This subjective view of the acceptability of technology based information for visitors is strengthened by the gallery information survey (17.3 above) which found that 89% of visitors would use such a system.

In the past the approach to providing information for visitors at the Science Museum has been largely through manual means, which have been shown to be inadequate. The perceived advantages of multi-media solutions include the possibility of providing a wide range of information in a readily accessible way, and the potential of telecommunications links to provide remote access to this information. Multi-media can be used to make information accessible to those with disabilities or learning difficulties and multi-lingual facilities can readily be provided. Furthermore such an approach would fit will with the "high-tech" image that many associate with and expect of the Science Museum.

The previous paragraphs have suggested that a technological approach to providing information would be acceptable to the Museum's visitors and have shown that these techniques have been successfully used in other museums. Following sections describe the data and technical elements of such an information system, and the overall systems design. Chapter 20 proposes an implementation plan.

19.2 Sources and types of data

19.2.1 Overview

To date the studies which have been carried out on visitor information needs have tended to look separately at the information requirements at different points in the Museum. For instance orientation on entering the Museum, or information points scattered through the Museum. External access has similarly been seen in terms of a need for several different facilities suited to particular groups of users. The consolidated requirements described in Chapter 18 provide the opportunity to form a comprehensive picture of where information has to be made available and the types of information which are needed at each point.

The evidence summarised in Chapter 18 shows that the same type of information is often needed at different points, although not all information is necessary at all points. For instance details of what's on, current exhibitions and events is needed at the entrance to the Museum, and for external access by the public planning a visit to the Museum, but is of less importance to scholars and enthusiasts who would use a "study centre". Similarly detailed object information is needed in the Museum to support exhibits and in the "study centre" and by certain types of external enquirers, but is not required at the entrance to the Museum.

Whilst it may be technically possible to provide all types of information at all points, some data will not be appropriate and some types of information (for instance video) may require special network or terminal facilities. The different types of information are summarised in Figure 163.

Having identified in broad terms the types of data which are required, following sections identify where the data is located, what form it is in, and whether any special steps need to be taken to extract the data or format it for use. For some types of data there may be problems with the quality or format, or it may not exist at all, and a plan for generating new data will be required.

Type of information	Source and update requirements	Technical observations
Location of Museum, transport	Existing paper records, also on World Wide Web. Infrequent update	Images of map or series of maps, with additional information. Data held locally
What's on, special events, new events and galleries	Existing paper records, also on World Wide Web. Daily update	Text of today's events, with facility for interactive diary of future events and images. Data held locally
Ticketing and opening hours	Existing paper records, also on World Wide Web Infrequent update	Text with facility for additional information and images. Data held locally
Alphabetic list	Not at present available, infrequent update	Text with facility for additional information and images. Data held locally
Guided tours: pre-programmed and bespoke	Not at present available, infrequent update	Both options require interactive application. Pre-programmed is choice from several options, bespoke is more complex and requires database of choices
Educational information	Available in paper form, with some also on World Wide Web Infrequent update	Information resource scanned or in text form, requires simple indexing and search facility
"Popular" object information	Some available on World Wide Web, infrequent update	Limited selection of records in text form with images
Detailed object information	Text in collections database, images not in digital format. Large volume of base data with frequent update	Requires on-line access to data, interface and search facility
Plan showing lavatories restaurant, exits, galleries and major exhibits	Available in paper form, with prototype on World Wide Web infrequently update	Linked plans, with hot-spots for text and images. Search mechanism
information on other museums	Varied formats. When available data is typically in structured database with opac access or via World Wide Web. Large volume of base data with frequent update.	On-line access to local facility required. Interface will be supplied with data, or using common standard
Bibliographic information	Text in structured database, ether accessed through OPAC, or World Wide Web Large volume of base data with frequent update	On-line access to local facility required. Interface will be supplied with data, or using common standard
Virtual visit	Not at present available, though prototype on World Wide Web. Infrequent update	Interactive application
Video	Moving images in compressed video format.	Can be locally held or via high capacity on-line link

Figure 163: Types of data

The data is of various types including text, still and moving images, maps and plans. In some cases, such as the virtual tour, or the creation of bespoke guided tours, a whole interactive application is involved. Data may exist already or it may have to be created, and for the more complex areas a complete computer application will have to be created.

A further consideration (to be reviewed in the technical sections below) is how the data is to be transmitted to where it is used. Data may be accessed directly in its primary location, or it may be held in an intermediate database. There may be the need for a permanent link to the data, or the link may only be used occasionally to update the data at the access point. The individual types of data are discussed in detail below. Section 19.3 takes these individual data types and groups together those with similar characteristics.

19.2.2 Location of museum and transport arrangements

A map (or series of maps) showing the location of the Museum, and access by public transport and road. This information, held as an image file, would require occasional updating. The information could be presented as a simple map, with the facility to zoom into the Museum, perhaps with active areas which lead to additional information.

The information is readily available in paper form, but not in digital form at the moment. The overall requirement is for several maps, with some textual and image data. A single series of maps would probably suffice for all applications. On-line access is not required because of the infrequent updates. The map could be held centrally.

19.2.3 What's on, special events, new events and galleries

A listing of events on a particular day or week, plus highlighted events, galleries and exhibits which the Museum wishes to draw to the attention of potential visitors. Events information is held in a manual form by the Public Affairs Division of the Museum, and is used to produce the regularly published events booklet, which gives a timetable of events and highlights new galleries and other items of interest. Information about events is available on the Museum's World Wide Web server. The data is in textual form, but could be enhanced with images, or even moving images. Data needs to be modified daily (and occasionally more often). Data can be presented in a range of formats, from a simple display, to a fully interactive application giving the ability to browse through topics weeks ahead.

19.2.4 Ticketing and opening hours

This information is held in a manual form by the Public Affairs Division of the Museum, and is made available in numerous ways, including the events booklet, posters, and the Museum's World Wide Web. Data is in text form, and is updated infrequently when changes occur. Data volumes are low.

19.2.5 Alphabetic list

A brief alphabetic guide to the Museum (in line with those at department stores) was suggested by some visitors. As the Museum does not have such a list it would have to be created. Data would be in text form, perhaps supplemented with images. It would be relatively short list permitting the whole list to be displayed in "notice board" format, or easily browsed, with perhaps 50-75 items at most. Updates would occur infrequently.

19.2.6 Self-guided tours (both pre-programmed and bespoke)

Currently the Museum does not have tours for visitors, although these were one of the facilities which were found to be frequently requested by visitors. There are broadly two requirements:

- a range of guided tours which have already been defined - for instance by subject area, age group, etc.

- the ability to put together a bespoke tour, consisting of elements selected by the visitor.

The first requires a base plan (see 19.3.9 below) and tours to be devised. The second requires a database of prominent objects and galleries in the Museum, and facilities for putting these together in a tour via an interactive process operated by the visitor. Data is in the form of plans of the Museum, together with text and possibly images. Data changes infrequently.

19.2.7 Educational information

Schools requirements consist of teachers planning visits, teachers with subject based queries, and students with queries relating to projects.

The Museum's education department has produced a comprehensive range of paper based products to deal with subject and project based enquiries, and to help teachers plan visits. These could be scanned in to produce a database of images, or alternatively the original word-processed files could be used to produce text. This is several Mb of data, either as a scanned image or converted to text. The data changes infrequently, with new material added from time to time.

A comprehensive paper resource exists to help teachers plan visits to the Museum. Facilities which require pre-booking are arranged via the Education Booking Office. The Informix based booking software packages does not at present have an interface which would allow remote interrogation by teachers, but such a facility could be developed in the future. The information to help teachers plan visits changes infrequently, but information on the availability of facilities changes constantly.

19.2.8 "Popular" object information

The types of data about objects which are of interest to the general visitor have been analyzed in the Gallery Information System survey (17.3 above). They include a description of what the object is, how it was used, how and when it was made, anecdotes relating to the object and additional descriptive material about the scientific principles involved.

The number of objects which need to be included in a genera information system are uncertain and data volumes are accordingly not known. However to give a representative sample of objects several hundred items would be required. The main objects data is contained in an Oracle database, but considerable editing and augmentation is needed before the data could be made available to the general visitor. Images of objects are increasingly becoming the norm, and moving images with sound would also be desirable.

19.2.9 Detailed object information

Detailed object information is required by specialist visitors and remote enquirers. Queries may relate to any of the objects in the Museum's collections, and any available information about the objects. As a consequence the volume of information is large. The text records about objects are contained in an Oracle database, which could be provided with a suitable interface, or the necessary data could be extracted. Photographs and multi-media are planned.

19.2.10 Plan with lavatories, restaurant, exits, galleries and major exhibits

The basic plan and associated facilities for the Museum are available in a number of forms including the ticket/plan which is given to visitors. The plan can be presented a simple set of graphic images, or with additional information available via touch screen (as for instance with the present World Wide Web pages). Data does not change frequently, but needs to be able to change to show when galleries and facilities are unavailable. The data would need to be in the form of several plans, with additional information. An application is needed to control access to this information.

19.2.11 Information on other museums

Other Museums make their information externally available in similar ways to those planned for the Science Museum (19.6 below). Many provide an OPAC interface for terminal access, or put their information on the World Wide Web. Kiosk and set-top-box methods are not yet generally available. Typically data is in the form of text, in some cases with images, although moving images are likely to be added in the near future. Data is either in structured databases of various forms, or in World Wide Web applications. It is usual for the data to be provided with the necessary software interface, or through a commonly used medium such as the World Wide Web. However the Z39.50 interface standard is an alternative which is yet to be generally applied (Lynch 1994, NISO 1988).

19.2.12 Bibliographic information

The Science Museum Library has it's post-1984 accessions on OPAC and items acquired before this date are now being added to the database. Through the joint library service provided with Imperial College links to other libraries OPACa are also available. Typically this is data in text form, provided through a structured database. Access to the Museum's library database is also available through the World Wide Web.

19.2.13 Virtual visits

The concept of the "virtual visit" to a Museum has been pioneered at the University of California at Berkeley Museum of Palaeontology (Gaffin 1994). Through a virtual visit it is possible to tour the galleries of a real (or synthetic) Museum remotely, perhaps through the World Wide Web or by interactive video. Development work on the Science Museum's World Wide Web pages is beginning to test the way forward for virtual visits to the Museum. (Bailes 1995, Smith 1996).

The range of facilities provided can vary from a simple plan or axonometric drawing, with additional information (text and images) to a three dimensional virtual-reality tour through the Museum's galleries. To date most work has been of the more basic kind. However the potential exists to have a complete virtual tour, perhaps arranged differently to the physical Museum and including several museums merged together in a single virtual entity. This type of experience is provided through a significant body of data, together with the application software to provide the user interface.

19.2.14 Video

Moving images may be required at varied points to enhance other forms of information. This is strictly speaking a data type rather than a category of data like the others described above. It is itemised here because this form of data requires considerable volumes of disk storage, and high speed network connections.

19.3. Consolidation of types of information

19.3.1 Introduction

The sections in 19.2 have outlined the individual types of information needed to satisfy the requirements set out in Chapter 18. These different types of information fall into several groups which can be conveniently be linked together as they have similar characteristics, or because they are linked in some other way. These groups of linked information types are described below.

19.3.2 Static textual information

This class of information consists of text which (under normal circumstances) changes at most on a daily basis (19.2.3, 19.2.4, 19.2.5 above). The volume of information is low. Information about today's events falls into this class of information, but the forward calendar of events is a more complex requirement outlined in 19.3.3, below. This is essentially static data, displayed for visitors to see without the need for interactivity. The text may be enhanced with static or moving images to make a more attractive display. Whilst this is seen as a static display, the text itself could however be included within an interactive application. The types of data in this class of information are shown in Figure 164.

what's on, special events, new events and galleries ticketing and opening hours alphabetic list

Figure 164: Static textual information

19.3.3 Interactive maps and plans with supporting applications

This class of information includes maps of how to find the Museum and plans of the Museum itself with major facilities (19.2.2, 19.2.10). Information is presented as a series of maps/plans, with more detailed information being available on highlighted features. The information to support the maps/plans will include the Museum's facilities, galleries and key objects, together with programmes of events.

The forward diary of events and simple lists, for instance of popular objects, are included with this class of data (19.2.3). A further information type which is included in this group is the facility to provide pre-programmed and bespoke guided tours (19.2.6). This application makes use of the plans of the Museum, facilities, galleries and objects, but will require special software to enable it to compose and print the tour.

This information could be made available through a touch screen application, or using a mouse. Character input via a keyboard is not necessary. The types of data included in this class are shown in Figure 165. Although it does not have the same complexity and requirement for interactivity, static textual data (Figure 164) is often presented together with interactive maps and plans.

location of Museum and transport plan showing lavatories, restaurant, exits, galleries and major exhibits guided tours, pre-programmed and bespoke "popular" object information what's on, special events, new events and galleries (including calendar of future events)

Figure 165: Interactive plans and maps together with supporting applications

19.3.4 Educational information

This class of information includes the large amount of data which is at present held in paper form, including subject/project based information for teachers and students, information to help teachers plan their visits, and the calendar of school events (19.2.7). Much of the information is a mixture of text and illustrations, together with indexing. The calendar of events is a similar application to the "What's on" diary for the Museum. The types of data in this class of information are listed in Figure 166.

topic based background material for teachers and students material to help teachers plan their visits calendar of events

Figure 166: Educational information

19.3.5 On-line databases

Both internal and external access to on-line databases is required. The types of data included in this class of information are shown in Figure 167.

Two significant internal on-line data resources need to be accessed by visitors; the full database of objects in the Museum's collections, and bibliographic information from the Museum's library (19.2.9, 19.2.12 above). These are substantial text databases. Because the volume of data is too great to be held locally they must be accessed on-line. Images will be included with the object database in the near future, adding to the volume of data, and placing an additional requirement on the communications network necessary to transmit the data from the central data store to users.

Because the date is mainly textual keyboard access would be more appropriate than a touch-screen interface. An OPAC (on-line public access catalogue) interface is already in use for the library database, but public access facilities have yet to be implemented for the collections database. The library database is held in a joint system with Imperial College Libraries, which in turn allows access to a range of external bibliographic resources. For the library systems there is therefore some overlap with external access to information (below).

Visitors have indicated that they would like access to information about other museums and collections (19.2.11). It seems unlikely that the Science Museum will have the resources to abstract significant volumes of information from other institutions and it will therefore be necessary to have some form of on-line link to these external databases. (Information in this format would be accessed either through the interface supplied with the data, through a common medium such as the World Wide Web, or through a standard such as Z39.50.

detailed object information
bibliographic information
information from other museums
external bibliographic information

Figure 167: On-line databases

19.3.6 Virtual visit

At its simplest this class of information is a more sophisticated form of the plan and associated information provided at 19.3.3 above. However with the potential to provide virtual visits to other museums and to combine museums, and to provide a visual three dimensional world, the application becomes far more complex, and for this reason is treated as an information class on its own (19.12.13).

Unless a significant quantity of video images are to be included in the virtual application, data volumes are likely to be sufficiently low to be held locally. This data is likely to be relatively infrequently updated.

19.3.7 Video

Video and moving images in general are not strictly speaking an information type, being more an adjunct to several of the information types described above. Several applications can employ moving images as a component, although for none of those listed above is it essential.

Because of the volume of data involved, moving images of any duration have special characteristics which make them need to be considered separately (19.2.14). To include moving images requires either a high capacity data link or several megabytes of local storage.

19.4 Issues of data availability and reformatting

19.4.1 Introduction

The purpose of this section is firstly to examine the availability and quality of the various types of data which have been identified in the earlier sections of this chapter. Secondly it quantifies what has to be done with the data to put it into a format which would be suitable for use by visitors. Groups of data with similar characteristics are discussed below. These are summarised in Figure 168.

19.4.2 Information available in World Wide Web pages

Much of the data which is required by visitors is held in the 500 or so pages of information on the World Wide Web. The Web provides an interface to this information and a source of text in digital form which can be transferred to other types of system if required.

Included in this form of information are how to find the Museum, the programme of events, new events, exhibits and galleries, ticketing and opening, and summary information regarding objects and galleries. For users of the World Wide Web this interface is adequate interface, but a more accessible interface would be required for visitors in the Museum. Information about educational events and facilities are available on the Museum's World Wide Web pages, together with general information to assist teachers in planning visits.

The World Wide Web pages contain a basic gallery plan with information about the galleries and some key objects, but without information on other facilities of interest to visitors. This information is available through the World Wide Web interface. Guided tours could take as building blocks the gallery plans and key objects, but would require other information to be added. Software would be required to provide the necessary interface to allow visitors to select items of interest and compose the tour. An alphabetic list of facilities is not available at the moment.

19.4.3 Information held in paper form

Detailed information relating to schools projects and to assist teachers in planning visits is available in paper form. Considerable effort has been expended to produce a well designed resource. One approach is to continue to make this information available in paper form with on-line indexing (as is the case now). The paper handouts could be scanned but they have not been designed with this in mind and may lose some of the effectiveness of the design. Alternatively the original word-processing and typesetting files could be used to input text for on-line access - use of digital text would facilitate searching and indexing.

19.4.4 Information held in database form

The Science Museum is one of the few national museums which has a computerised catalogue of the majority of items in its collections. The main priority in the implementation of this database has been collections management, but access is also important. As would therefore be expected administrative data is consistently present and each item has a piece of descriptive text. Other fields are often not used, and a programme of data enhancement is in hand to address this. The data is held in an Oracle database, for which both OPAC and World Wide Web interface modules can be purchased.

As has been discussed above, the Museum's bibliographic data is held in the Libertas library packages which is equipped with an OPAC module. The data has proved to be adequate for library use, but lacks the majority of pre-1984 accessions. Information from other institutions would only be used if it was of suitable quality and had a readily used interface.

Type of information	Format	Observations
Location of Museum and transport What's on, special events, etc. Ticketing and opening hours "Popular" object information Educational events and facilities Plan of Museum and facilities	Available in World Wide Web format.	Can be used within World Wide Web, or text can be extracted to be used in other interfaces. No major programming implications. Plan of Museum requires location of facilities.
Alphabetic list	Not available at present	Straightforward task to create list of facilities. Could be interfaced via World Wide Web or another simple interface
Guided tours	Some of buildings blocks in form of plans of Museum, facilities etc. exist	Some additional information required, and would need significant effort to develop an application
Educational information about projects, and to help teachers plan their visits	In paper form, majority designed and printed to high standard	Indexing requirement is low. Paper could be scanned to provide high quality material, but without text searching, or text could be transferred. Significant volume of paper to be converted.
Detailed Object information	Contained in Multi MIMSY, an Oracle based collections management product	A range of public access interfaces to the database are available, but significant work would be required to make the data suitable for general use
Information on other museums	Where available it is found in a variety of on-line systems, some OPAC based, some World Wide Web	Where direct access is available, little additional effort required. Could also be achieved via Z39.50 or a similar standard. Some telecommunications costs
Bibliographic information	Contained in shared database with Imperial college, using Libertas software	Has OPAC module to permit public access. Data is in accessible format. No programming or interface implications
Virtual visit	Some galleries in World Wide Web format, but otherwise not available at the moment	Significant development implications in terms of data and software
Video and still image	Film, analogue or digital form	No special implications where exists already, but significant number of new images and video are likely to be required

Figure 168: Data availability

19.4.5 Information in the format for a virtual visit

Some of the building blocks of the virtual visit application are available in world wide web format, providing the facility to browse through some virtual galleries. Additional development would be necessary to make a virtual representation of the whole of the Science Museum. Data in video and image format is widely available, but may not be suitable for use in constructing the virtual visit.

19.4.6 Information in video and still image formats

A core of still images of objects is being built up gradually, and there are also some video sequences. However the majority of objects do not have images suitable for electronic reproduction and some new video is likely to be required for a range of different purposes.

19.5 Types of terminals and interfaces for use in the Museum

19.5.1 Introduction

This section reviews in broad terms the types of physical terminal and software interface which are available, their general characteristics, and the appropriateness and benefits of using various types of interface. Costs are discussed.

19.5.2 Notice board format

This type of interface consists of a large scale non-interactive text display, perhaps enhanced with both still and moving images. The main requirement can be satisfied through a matrix display, or a "video wall" of one or more large monitors, supported by a processor with sufficient storage to hold the necessary images and text. This type of display is suitable for the following types of information in the Museum:

- what's on today, and limited future events
- alphabetic list of facilities

- ticketing and hours information

The information would be updated overnight or as necessary, but a continuous on-line connection to central resources is not needed, as the local server will hold all of the necessary information. Sufficient disk storage is required for the image and video elements. Costs for the supporting processor and telecommunications are likely to be under £5k, with the display itself being a high cost because of the one-off element of this type of device and the inherent cost of large video screens. Costs are therefore likely to be of the order of £50k to £250k.

The software for this type of display is not complex. The textual elements need to be displayed, with a facility for scrolling or a change of format at a predetermined interval. The text could be enhanced through the addition of either moving images, or still images changing from time to time in "slide-show" format. There needs to be a facility to quickly change information, for instance if a facility is closed or there is an unscheduled change to the programme of events. Changes are likely to have to be made locally, or according to a change in centrally kept information.

19.5.3 Terminal with touch screen interface

This type of interactive display accessed through a touch screen is suitable for use as a general information point, or to provide orientation information for visitors as they start their tours of the Museum. It is suitable for information consisting of documents with hypertext links or for lists, maps and graphical data with few levels of information. For such information keyboard entry is not required. The types of information which could be provided to the Museum's visitors through this medium would include:

- what's on
- hours, ticketing
- alphabetic list of facilities

- guided tour
- map of facilities
- how to find the Museum
- "popular" object information

Video and images can be supported, providing sufficient disk space is available to store the still and moving images. Alternatively a high capacity on-line link could be used for images and video, but reliability could be an issue of the link has to be continuously available, and in practice this is unlikely to be a cost-effective approach. A printer would be useful in certain circumstances, for instance to provide printed guided tours or other information. reliability, and having staff available to restock consumables are important issues of a printer is to be provided. If a high capacity link is not used a network connection is required to allow information to be updated. Continuous on-line access is not required. This type of terminal can be made robust enough to be provided in unsupervised areas of the Museum where a conventional keyboard could be damaged.

A similar type of terminal is necessary for interactive displays associated closely with exhibits, or to provide additional information where objects are displayed closely together in a "visible storage" facility. In the past support for exhibits has been provided from the analogue and latterly digital video technology, rather than the text-image based PC tradition. For such applications a touch screen interface is required to give access to a range of information, including video footage. Much data can be held locally, but high bandwidth link to video server is required if large volumes of video are to be available. There is little difference to the type of terminal needed for general navigation and orientation, although the material displayed will be different.

Interface software for this type of terminal has to be able to operate through touch screen interaction alone. The hypertext application, such as is used at the National Gallery Micro Gallery is an effective means of providing this - users can select from a menu of options, or touch a highlighted button for more information. A constant group of buttons allows movement backwards and forwards and to return to the opening page. A simpler interface with very limited choices are more often used in a gallery situation. The underlying database for an application such as this will be very rich in terms of the links between material, but should not have too complex a structure if the user is not to become lost.

19.5.4 Terminal with keyboard interface

This type of interface differs from the touch screen variant (above) in that it is provided with a keyboard, which is often enhanced with a pointing device such as a mouse or tracker ball. This type of interface makes it easier to access more complex text based resources. Types of information which could be made available to the Museum's visitors in this way include:

- educational information
- detailed object based information
- bibliographic information
- access to information held by other museums and institutions

This type of interface is more suited for the "study centre" environment, where visitors will sit and use the machine for some time, and where they are unlikely to damage the keyboard. Because of the large volumes of data accessed this type of terminal will require on-line access to a range of data stores. A reliable printer is required. Costs are of the order of £5k per terminal , including telecommunications.

Software to support this type of terminal can be similar to that used for touch screen, but with the addition of keyboard input a more flexible character based approach is possible. Typically interfaces include hypertext linked pages of information, World Wide Web, or the more traditional menu driven OPAC systems found in many libraries. Underlying these will be a database of some complexity to handle the large volumes of data involved.

19.5.5 Telecommunications for visitor information in the Museum

Visitor information will be provided in the Museum through the different types of terminal which have been described in the previous sections. Terminals can either hold data locally with occasional use of on-line links to update the information, or they can be permanently connected to an information resource elsewhere. For reasons of resilience and reliability off-line operation (with locally held information updated as often as necessary) is the preferred mode of operation, as the level of service is not subject to network reliability and a slower, less expensive link can be used for updates. This type of configuration with an intermittent connection is not appropriate where the volume of data to be accessed is too large to hold locally (for instance a large text or image database, or moving images), or where the data is held elsewhere by another institution.

Internal data links can either be of a temporary type using the Museum's telephone system, or through permanently connected cabling. In practice the "dial-up" type can often have reliability and speed problems, and are therefore only used where it is not possible to establish a permanent network connection. The Museum's network consists of "Ethernet" running over fibre optic and Category 5 UTP (unshielded twisted pair copper) cabling. Connections can either share a portion of 10Mb bandwidth, or have the whole of this available using "switched ethernet". The average cost of a simple ethernet connection is £400 per data outlet, and £600 for switched ethernet. Switched ethernet is not significantly costly for individual terminals, but it has not often been found to be necessary. The types of communications for in-house information are shown in Figure 169, together with the information they are suited to.

Terminal type	Network connection
Notice board format	Text requires low-bandwidth communications to allow updates from time to time. Image, and moving image are likely to be provided from a local server, with update via a low or high bandwidth connection.
Terminal based with touch screen	Low-bandwidth communication for occasional update of text and static images. High bandwidth link is required to update moving images, or to provide on-line link to remote moving images.
Terminal based with keyboard	Low-bandwidth with permanent on-line link to internal and external data stores. High bandwidth would be necessary if images and moving images are to be included.

Figure 169: Interface types and network requirements for terminals in the Museum

19.6 External access to the Museum's information

19.6.1 Introduction

When information is made available to visitors in the Museum the interface, terminal, communications network (and the information itself) will all be under the control of the Museum. In contrast for external information provision the user of the information will probably provide their own terminal and will access the information through a third party communications network. The information may also have been provided through an intermediate supplier. Although this makes the situation more complex in terms of the combination of facilities which can be used, there are several well defined routes for external access to the Museum's information. These are set out below.

19.6.2 External access via OPAC

OPAC (online public access catalogue) interfaces have developed (particularly) in the library world to give online access to catalogue information held in a database. The aim is to provide an interface with limited enquiry facilities which can be operated by the general user. In the Museum this type of facility would be most appropriate for providing access to large volumes of data held in text form, such as detailed object information or bibliographic material from the library.

Although different suppliers' OPACs vary they tend to have similar characteristics so as to be utilised by library users without the need for special training. The easy-to-use features of the OPAC interface are often in contrast to the more comprehensive and difficult to use interface which will be used by library staff. OPAC software is typically an add-on to an existing database package and is therefore often supplied with a large structured databases. Initially most OPAC access was provided via a menu driven character interface (typically used via a terminal with keyboard), but graphical interfaces are now becoming available.

To facilitate the external use of an OPAC interface access to the database can be provided via a modem and the public telephone network, or through a privately owned or leased telecommunications connection. Internet access is however now becoming the norm because it is cheaper and easier to manage for the information supplier, and because many potential users, particularly in educational establishments, will have Internet access. For text based access a relatively slow link is required, but faster links are preferable for graphical interfaces. The user will be presented with a similar interface to that which would be encountered in a library.

19.6.3 External access via the World Wide Web

The World Wide Web provides Internet access (and "Intranet" access for internal use) to text and images which have been tagged using the html system and made available on an Internet connected server. For the external user the facilities are similar to those provided in-house via a terminal equipped with a graphical interface together with a keyboard and mouse. Pages of information held on a World Wide Web server can be accessed via the Internet by any computer equipped with the necessary browsing software. For the Museum most types of information can be supplied in this way because of the potential to mix text and images. Detailed information (for instance from the objects or library databases) is less suitable for presentation in this way, but could be provided through an OPAC interface accessed via the World Wide Web.

Passages of text can be loaded unedited into World Wide Web pages, but it is usual to provide hypertext links between pages, and to add illustrations and different typefaces to produce a more attractive product. Large amounts of data can be presented using hypertext links, but the indexing and manipulation are less sophisticated than using a database or database with an OPAC interface. World Wide Web interfaces are now available for many of the major database products such as Oracle.

19.6.4 External access via multimedia kiosk

Public access kiosks are beginning to appear in banks, building societies and car showrooms, where they are used as dedicated marketing aids. Kiosks sponsored by public services such as local authorities and police forces are also undergoing trials. Several suppliers (for instance BT with "Touchpoint") are planning large scale trials of kiosks in public locations towards the end of 1996. Whilst these kiosks provide a variety of information for the general public about tourist attractions and cultural events, they have a commercial basis and will be paid for through advertising and on-line sales. A variant of the BT product is also to be tried in shopping centres and department stores, where it will carry specific material relating to the shopping complex in addition to the normal quota of general information and advertising. The aim is to provide an easily used publicly accessible interface to information held both locally and on-line. Two-way communication is provided so that goods and services can be ordered. Communication via voice or voice and video-phone are also possible.

The usual technical architecture is for the bulk of the application to be held locally, with on-line communication available in order to provide additional information or to facilitate two-way transactions such as purchases. The main applications can be updated via a low bandwidth data-link, but because of the volumes of data involved in video-phone communication a high bandwidth communication channel (for instance ISDN) is usually provided.

The Museum can use this facility to provide locally held low volumes of static data and images, or on-line connection to larger amounts of data, though it should be noted that with the quality of interface similar to touch-screen terminal in-house, keyboard access is not provided. This type of interface would be suitable for providing general information about the Museum (perhaps as part of a presentation of a range of tourism opportunities) and for two-way transactions such as purchasing tickets in advance, or making purchases from the Museum's on-line retail catalogue. The multimedia kiosk is seen by many as a means of democratising the "information society" by providing information access to those who would not have this facility in their homes. Together with the "set top box" (see below) the multimedia kiosk is a way of providing access to the Museum's information for the domestic user.

19.6.5 External access via set top box

The "set top box" is a device which takes data from cable or satellite, and acts in conjunction with a domestic TV set to provide terminal facilities. This type of device has the potential for example to facilitate home access to the World Wide Web, video on demand, or teletext. A graphical interface is provided, to be accessed via a simple keyboard similar to a video remote control. Two-way transactions are possible, and this is at present particularly seen to be applicable to home banking and shopping.

The Museum could use this facility either to provide access to information provided via the World Wide Web, or through teletext or video information supplied via a third party provider. The set top box has as yet only had limited trials. However (together with the multimedia kiosk) it presents an opportunity for remote access from the home to the Museum for the domestic customer who is unlikely to have access to an Internet connection.

19.6.6 External distribution of information via CD-ROM

CD-ROM provides a means of distributing information about the Museum and its collections to outside users. It is particularly suited to information which does not have to be frequently updated. Production costs are high, so the information needs to be of a nature that will appeal to a wide audience. CD-ROM was not particularly successful when it first became available, because most potential users (except for libraries) did not have the equipment to read the disks. However the majority of PCs are now sold with a CD-ROM drive, and this is changing the acceptability. CD-ROMs are able to hold large quantities of text and images, together with moving images.

19.7 Design for visitor information access points

19.7.1 Introduction

Previous sections of this chapter have consolidated the understanding of what types of data are required at each location and the types of terminal and interface that can be used to making the data available to visitors, both in the Museum and remotely. The next stage of the design process is to consider for each location the type of terminal and interface which is required and the data which needs to be supplied.

19.7.2 Museum entrance

The information requirement at the Museum entrance is summarised in Figure 153. It consists of textual information about opening hours, ticketing arrangements, events and special exhibitions. The purpose of this information is to encourage potential visitors to enter the Museum, and to help visitors start to think about how they will plan their time in the Museum. Still or moving images would make this display much more attractive, and would serve to entertain queuing visitors, and encourage hesitant customers.

The terminal requirement is for a large notice-board configuration (19.6.2). The textual information changes on a daily basis, or sometimes more often. The image information is likely have a selection of film and still shots, which would change less frequently. Because of the potential volumes of image data significant local storage is required. An alternative to this capacity of local storage would be a high bandwidth network link to a remote server, but this is unlikely to be cost effective. In any case for reasons of reliability local storage is preferable. The configuration is shown in Figure 170.

Text:	Interface:
Opening hours ticket prices what's on time and location of special events new exhibits and galleries alphabetic guide	Notice board display (non-interactive)
moving and still images	

Figure 170: Configuration for display at entrance to Museum

19.7.3 Orientation

Once inside the Museum visitors require information to help plan how they will spend their time in the Museum. (Figure 154). The main requirement is an alphabetic list of facilities, galleries and major exhibits, a programme of events on that particular day, and the ability to provide either a pre-programmed or bespoke guided tour. The starting point of the interaction would be "what do you want to see and do today". In addition it is likely that the range of facilities provided at information points (see 19.7.4 below) would be desirable. Specialist and educational visitors require more detailed information than can readily be provided at such an orientation point - their requirements are assessed in section 19.7.5.

The orientation terminals will have to be capable of providing information to visitors who have not had any special training or experience of the use of similar facilities. Visitors will not wish to spend a long time at the orientation terminals, as they will be keen to start their tours. A touch screen based terminal with suitable software seems the most suitable interface for the majority of this information. A printer is required to print guided tours. Information will be held locally, with updates from time to time. Figure 171 summarises the orientation configuration.

Text: What's on Ticketing and opening hours alphabetic list **Application:** Guided tours, pre-programmed and bespoke. Plan with facilities etc.	**Interface:** Touch screen terminal Printer

Figure 171: Configuration for orientation

19.7.4 Information point

The Information point is similar in concept to the orientation facility described in 19.7.3 above, but provides information for visitors as they tour the museum (Figure 155). The categories of data are similar to those for orientation, with the addition of limited object information. The plan and list of facilities are probably the most important element of information, whilst the facility to provide guided tours is less necessary. The starting point of the interaction is most likely to be "You are here".

The interface considerations are almost identical to those for the orientation points. Non-skilled visitors will need to interact with the terminal to provide the information they need. They will not wish to spend a long time at the terminal, as this they will want to move on to the next point on their tour. A touch screen based terminal with suitable software seems the most suitable interface for the majority of this information. The option to provide guided tours is not essential, and for this reason a printer does not have to be provided. In any case servicing printers scattered throughout the Museum is likely to be costly. Figure 172 summarises the information point configuration.

Text: What's on Ticketing and opening hours alphabetic list **Application:** Plan with facilities etc. "Popular" object information	**Interface:** Touch screen terminal

Figure 172: Configuration for information point

19.7.5 Support for exhibits

This category of information point is primarily concerned with providing supporting information to the items on display. In the past such information has tended to consist of scripted material, perhaps with narrative films, and interactive programmes or models designed to demonstrate the scientific principles involved. The gallery Information survey (17.3) identified a range of material which visitors would like to see at this point, including more information about the objects, the science involved, and related information. Altogether this appears to mix of what is at present is provided on galleries, with the requirements for information point, study centre and visible storage.

Support for exhibits could continue to be closely linked to the items on display, but also be enhanced to provide general information and orientation information. A disadvantage in providing this additional information is that users could become distracted from the primary purpose of the interactive exhibit, which is to interpret and enhance what is on display. This is particularly an issue as users tend to spend only a few minutes at each interactive display. For this reason it is suggested that rather than try to duplicate orientation and information facilities, the gallery information point should continue to provide closely scripted material linked to the specific gallery displays. Visitors should be directed to the nearest information point, or the study centre for additional material.

The specific type of terminal and interface will depend on what is appropriate for the particular location. However a touch screen interface is likely to be most appropriate, with either a local capacity to store a significant volume of text, applications and images (moving and still), or a high speed communications link (19.6.3). A suggested configuration is illustrated in Figure 173.

scripted material relevant to the particular exhibit (text, applications, images and video)	**Interface:** Touch screen terminal

Figure 173: Configuration for support for exhibits

19.7.6 Information centre

The requirements for an information centre are set out in Figure 158. The main categories of information are detailed object information, educational information, bibliographic information and for facilities providing access to information held remotely. In addition the facilities provided from the orientation and information point locations are desirable. An issue which is discussed below (19.8.5) is whether there should be separate information centres for specialist and educational users.

Text: What's on Ticketing and opening hours alphabetic list **Application:** Guided tours, pre-programmed and bespoke. Plan with facilities etc. **From remote databases** object information educational information bibliographic information information from other museums	**Interface:** Interactive terminal with keyboard and mouse printer

Figure 174: Configuration for information centre

The majority of the information is in text form, and text with images. Much of the information will be provided through an OPAC or World Wide Web interface. Users are likely to have some experience of this type of facility. Character input will be necessary for retrieval purposes. As this facility will be in a supervised area, a terminal with keyboard and mouse can be provided without risk of damage.

Basic information about the Museum is likely to be available locally, but the majority of information will be obtained from databases elsewhere, so a network connection to information on databases within and outside the Museum is required. Figure 173 shows the configuration for the information centre terminal.

19.7.7 Support for visible storage

The data required to support visible storage is set out in section 18.6. This facility is necessary where objects are presented in a compact display where it is not possible to provide conventional labelling and interpretative material. Usually access to information will be provided by a simple code number. The main categories of information are those aspects of object information which are of interest to visitors (17.3 above). This facility differs from others in that there will be information about a relatively large number of items, but the information must be accessible to the general visitor. Some additional scripted information, similar to the general support for displays may be needed.

This type of facility requires a touch screen interface because of its unsupervised position, and because visitors will need to easily access the information. Although a large number of items will be included, an on-line connection is not needed, as it should be possible to keep all of the information on the access terminal. The information will need to be updated from time to time.

Information on objects on display: - particularly categories identified in 17.3 scripted material relevant to the particular exhibit (text, applications images and video)	**Interface:** Touch screen interactive terminal

Figure 175: Configuration for support for visible storage

19.7.8 Remote access to plan visit

The information requirements for remotely planning visits to the Museum are set out in section 18.8. Queries are mainly to do with opening hours and ticketing arrangements, together with what's on, the main attractions and facilities, and how to get to the Museum. The information could be supported by a virtual visit which would market what is available to visitors in the Museum. It would be advantageous to be able to order tickets and items from the Museum's catalogue. The interface needs to be readily utilised by inexperienced users.

The means of accessing this data will depend on the technical facilities which are available to potential visitors. At the moment the World Wide Web is most widely used, but remains limited to academics and enthusiasts, although more businesses and homes are becoming connected. In the future teletext may be used via cable or satellite may be used, together with public access kiosks. For World Wide Web and cable access a direct on-line link is likely to be provided to the Museum or an intermediary, whilst for a Kiosk application much of the information will be held locally. For on-line booking and ticket sales a network link is required. This information could be distributed in the form of CD-ROM. Telephone access to the Museum's information desk is likely to be the main means of access for some time. Figure 176 shows the options for remote access for planning a visit.

Mostly text with some images: opening hours prices what's on and special events facilities travel to the Museum	**Interfaces:** World Wide Web Set top box Public access kiosk CD-ROM Telephone (voice)
Supporting application: Virtual visit	
Interaction: On-line ticket sales and booking	

Figure 176: Configuration for visit planning

19.7.9 Remote access for technical enquirers

The requirements for technical enquirers are set out in Chapter 18. In most respects the facilities to be provided are like those needed in a "information centre" (19.7.5) in the Museum. This category of remote user will require access to the Museum's object and bibliographic information and to other sources of information both in the Museum and externally. Additional information about opening hours and facilities will also be useful as enquirers will often wish to visit the Museum to see the material at first hand. An OPAC interface, or a combination of World Wide Web and OPAC would give the necessary facilities for data interrogation and display. Specialist users will be familiar with these interfaces. Select portions of the Museum's databases could be distributed on CD-ROM.

This information can be provided either via the Internet or over the public telephone network. As most remote users of this type of information are likely to have an Internet connection (either at work or at home) it is unlikely that it would be cost-effective for the Museum to provide access via the telephone network. Enquirers without Internet access will continue to contact the Museum by telephone, letter or in person. The configuration for specialist access is shown in Figure 177.

On-line access:
Object information
Bibliographic information
Information at other locations

Mostly text with some images:
opening hours
prices
what's on and special events
facilities
travel to the Museum

Interfaces:
World Wide Web
OPAC
CD-ROM
Telephone (voice)
letter

Figure 177: Configuration for specialist access

19.7.10 Remote access for schools

Teachers and students need to access a range of subject related information, and teachers require information to help them plan visits. Schools also need to book facilities. At the moment some general information for schools is on the Museum's World Wide Web pages, but most is supplied in paper form, and booking is by telephone.

Standard visitor information:
location of museum and transport to Museum
ticketing and opening hours
what's on, special events and new galleries
access to more detailed information

Schools information:
information on schools facilities
booking of facilities
subject based information for teachers
project based enquiries for students

Interfaces:
World Wide Web
Teletext
CD-ROM
telephone (voice)
printed paper

Figure 178: Configuration for schools access

Although few schools have Internet connections at the moment, this situation is changing and the World Wide Web is likely to be the most convenient way to access this type of information. Students may also wish to access this information from home via a direct Internet connection, or through teletext or World Wide Web supplied through a set-top-box. CD-ROM would be a means of distributing this data, particularly as schools now generally have the equipment to read the disks.

19.7.11 Remote access for virtual visitors

The "virtual visit" enables someone who for various reasons is unable to visit the Museum in person to experience a computer generated tour, either of all or part of one museum, or of a virtual museum composed from several physical museums. Whilst in one sense the virtual visit is a substitute for a visit in person, it also has the potential to draw together a range of exhibits which could not physically be placed together. The needs of the virtual visitor are described in section 18.11. They consist of the facility to browse through the virtual exhibits, and to find additional information about what they see.

In order to provide a virtual visit a three dimensional representation of the Museum is needed, together with a linked database containing additional information, including text and still and moving images. This differs from other forms of information access and should be considered is a type of application on its own. The high volumes of data mean that for remote access either cable with the capability for interactive video, an ISDN connection, or CD-ROM are suitable media. However the Museum's World Wide Web virtual galleries provide something of this experience and have proved to be very popular. The configuration for a virtual visit is set out in Figure 179.

Application:	**Interfaces:**
Virtual visit	World Wide Web Set-top-box Kiosk CD-ROM

Figure 179: Configuration for virtual visit

19.8 Issues for access

19.8.1 Introduction

The previous section has taken the requirements identified in Chapter 18, and proposed technical solutions to how visitors can access this information both in the Museum and remotely. Before going on to propose an overall logical and technical architecture for visitor information, in some cases there needs to be clarification of the types of information to be provided.

Whilst the different information points are aimed at different audiences and therefore have discrete information requirements, it is also possible to provide additional non-core information. For instance at information points aimed at educational visitors it would also be possible to provide general information about the Museum. However in deciding what additional information to provide it is necessary to ensure that the data is in a suitable form for display at the particular type of terminal which is being used at the location and that the additional information will not detract from the main purpose of the information point. Resolution of these aspects will lead to better targeted information and is also likely to lead to a simpler and more easily maintained and understood overall architecture. These issues are discussed below.

19.8.2 Orientation for specialist and educational visitors

The initial requirement which was developed in Chapter 18 suggested that information for specialists and detailed educational information should be available at orientation points just inside the Museum, and by implication also at information points scattered throughout the Museum. The overall scheme for the orientation points and information point is for an easy to use system which would be briefly called at by visitors as they enter the Museum, or as they are on their way round the Museum. This type of facility is not appropriate for detailed queries, firstly because the interface (touch screen) would not be as suitable for this purpose as a keyboard and mouse, and secondly because the orientation and information point terminals are designed for use of short duration by many visitors. Visitors carrying out lengthy detailed enquiries would inhibit this flow.

One way of satisfying this requirement would be to direct specialist and educational users to the information centre, which will have the facilities to aid them in carrying out detailed enquiries. An alternative would be to provide an orientation area for specialist and educational use - either a single facility or separate areas for specialist and educational orientation. On balance the best solution may be to provide an information centre for specialist users, and educational information points should be installed at the entrance to the Museum used by schools and booked parties.

19.8.3 Characteristics of orientation and information point terminals

Closer investigation suggests that facilities required at both orientation and information points are similar, although the orientation point will focus on what there is to see and do, whilst the information point will stress navigation around the Museum. It is suggested therefore that the overall design for visitor information will gain in simplicity if the same facilities are provided at each location, resulting in an easily maintained and cost-effective solution. The software will need a configuration switch which can be set for "information point" or "orientation point" variant, and whether a printer is available (see below).

At the orientation point location it will be necessary to print out guided tours and other information, but it may not be necessary to provide a printer at information points around the Museum. Printers need to be kept stocked with consumables and experience has shown that even the most reliable models can be prone to mechanical failure when they are in constant use in a public area. Whilst the maintenance of a group of printers in an orientation area is likely to be able to be justifiably resourced, printers scattered around the Museum at information points could present serious maintenance problems and would lead to visitor dissatisfaction if they are not in working order. It is therefore proposed that printers should not be provided at information points. However if commercial developments in multi-media kiosks lead to a low-cost and low-maintenance printing facility this should be reconsidered.

19.8.4 Object information

Information about the objects in the Museum has always been seen as a core component of visitor information. However in developing the visitor information requirement it has become apparent that the range of object information which is required at different points is rather more complex than initially envisaged. Several different types of object information have been identified, and are described in sub-sections below.

Each of these types of information has a particular implication for resources, which need to be reflected in the programme of work which will be required to enhance the object records. It should be noted that at the National Gallery researching and composing the high quality records for the 2,000 paintings cost over £200,000, or £100 per item.

19.8.4.1 Object information for the general visitor

For orientation and information points, and non-specialist external access, basic information is required about a small number of items. This is similar in scope to the present World Wide Web object related pages and virtual galleries. This is high quality and topical information on a small number of key objects, perhaps 100-200 items in total. Textual information about the objects will be complemented with images and multi-media.

19.8.4.2 Object information to support exhibits

To provide supporting interpretative information on exhibits a range of scripted multi-media information is required about the objects on display, together with information on related items not in the Museum, and relevant scientific topics. This is the type of multi-media display that the Museum has traditionally provided. Whilst a limited amount of basic object information may contribute to the display, it is usual to develop special material for each exhibit. Because the material will have been developed especially for the display, an on-line link to other information is not usually appropriate, and it is unlikely that the information can be fed directly back into the main object record.

19.8.4.3 Object information to support visible storage

In a visible storage display objects will be packed closely together with little or no labelling except for an identifier. Where an information system is required to support visible storage it will need to provide limited categories of information about all of the objects on display. In the first instance the information will be those categories identified in section 17.3, which are concerned with what objects were used for, how they were made, what their significance is and stories about them. In particular the database to support visible storage will provide the opportunity to show links between related objects.

19.8.4.4 Object information for specialists

For specialist access the basic fields of information identified in section 17.3 need to be provided for as wide a range of objects as possible. In addition categories of information which are of less general interest like dimensions may also be required. The survey reported in section 17.3 showed that general visitors are not interested in objects in store, whereas specialist enquirers are likely to be interested in the full range of objects in the Museum's collections, whether or not they are on display.

The present range of object information varies considerably and significant resources will be required to bring all items up to a single uniform standard. One approach would be to establish a basic standard of information about all objects, and then enhance the records in specific areas. In preparation for any project on this scale it will be necessary to undertake research aimed at finding our what categories of information are of most interest to specialist enquirers, and which areas of the collections are most in demand.

19.8.5 Role of the information centre

The various studies of Museum visitor and enquiries which are described in Chapter 17 identified a relatively small number of visitors (perhaps under 10%) who had a detailed interest in the Museum's collections which extended beyond the basic information required by others. In order to satisfy this group of users an area needs to be set aside where they can access the Museum's object and bibliographic records, and other sources of information. It likely that this would be established as part of the existing library or records centre facilities.

Unlike the National Gallery's Micro Gallery, which offers high quality information about a small number of objects, the Science Museum information centre is likely to have a broader sweep of information from the Museum and beyond, and it will be up to the user to assess the quality of what is provided. Whereas it is a practical proposition to revise and link records on 2,000 paintings at the National Gallery, the several hundred thousand objects in the Museum's collections will not be able to have such treatment.

19.9 Overall data architecture

19.9.1 Introduction

This section is concerned with proposing a technical model to describe how the necessary data stores, communications networks and terminals can be linked together to provide the different types of visitor information described in the earlier sections of this chapter. The cost-benefit analysis described in Chapter 20 will determine the order in which parts of the overall visitor information system are developed and it is likely that not all of the proposed systems will be built at once. Some elements may not be implemented at all. The intention at this stage is to describe the whole system, so that as parts are developed independently they can be linked into the overall structure. The aim is to ensure that where data and computer systems can be shared by different components of the overall visitor information system, thus reducing costs and improving reliability through ease of maintenance. A particular objective is to avoid the problems of consistency which can occur if the same data is kept separately in different parts of the system.

The first section describes the overall logical structure for visitor information, the second describes the technical design. It is expected that the logical design will evolve as requirements change. The technical design reflects the present infrastructure and the technology which is currently available. It will need to be reviewed each time an element of the visitor information system is to be implemented.

19.9.2 Logical structure for visitor information

The logical structure for the system sets out how the necessary information is collected, stored and disseminated to the various groups who will use it. There are three main groups of information for general visitors, educational visitors, and specialists. For each of these groups some data is already available, and in some case will be provided from outside the Museum. Information needs to be available in the Museum, and externally. The logical structure for visitor information is described in Figure 180.

19.9.3 Technical structure for visitor information.

The proposed technical architecture consists of data stores connected to the Museum's network infrastructure, which is used to distribute information to the various user access points in the Museum. Telecommunications links connected to the network are used to distribute information to external users. Much of the necessary infrastructure is already in place.

Although it would be possible to keep all of the new data required for visitor information on a single computer, management of the data will be imporved if the main groups of data are kept separately. Some types of data (for instance images and video) have different characteristics, and should therefore have their own server. The main server is the core data store for visitor information which contains static textual information and maps and plans with supporting applications. For reasons of storage volume video and image resources are kept on a separate server. Educational information is logically separate, although it could be kept on the main visitor information computer. Because of the potentially large volumes of data involved and the complexity of the application software it is suggested that virtual visits should be kept on the image and video server. The Museum already has a server connected to the network for the main collections database and there is a connection from the network to Imperial College where the Museum's library database is on a system shared with the College. External links are provided from the Museum's network to enable other sources of information to be accessed.

The technical structure for visitor information is centred on the Museum's network infrastructure known as NEWNET (NMSI Enterprise Wide NETwork). This network provides a fibre-optic and twisted copper pair link to all office areas in the Museum, and has the capability of being extended to public spaces as required. NEWNET also has connections externally to JANET, the public telephone network and ISDN. Additional types of external links may be required, and the Museum may also wish to develop a CD-ROM capability. It will be necessary to extend NEWNET for visitor information points in the Museum, but the main fibre-optic backbone covering the whole Museum will connect this local cabling to the data servers. Various types of information points will need to be installed in the Museum, including the main display in the Museum entrance, visitor orientation and information points, the information centre terminals and terminals for educational information.

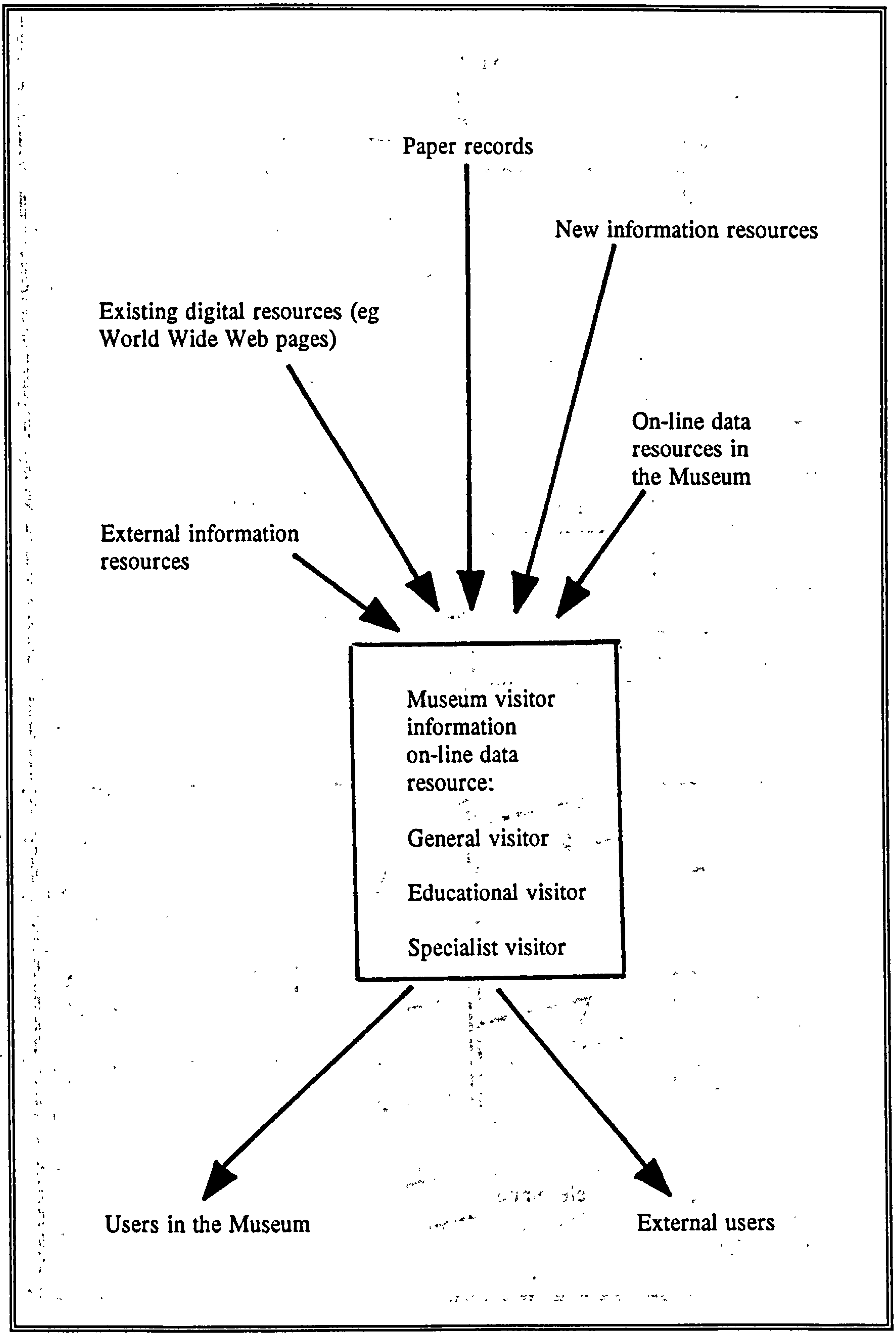


Figure 180: Logical structure for visitor information

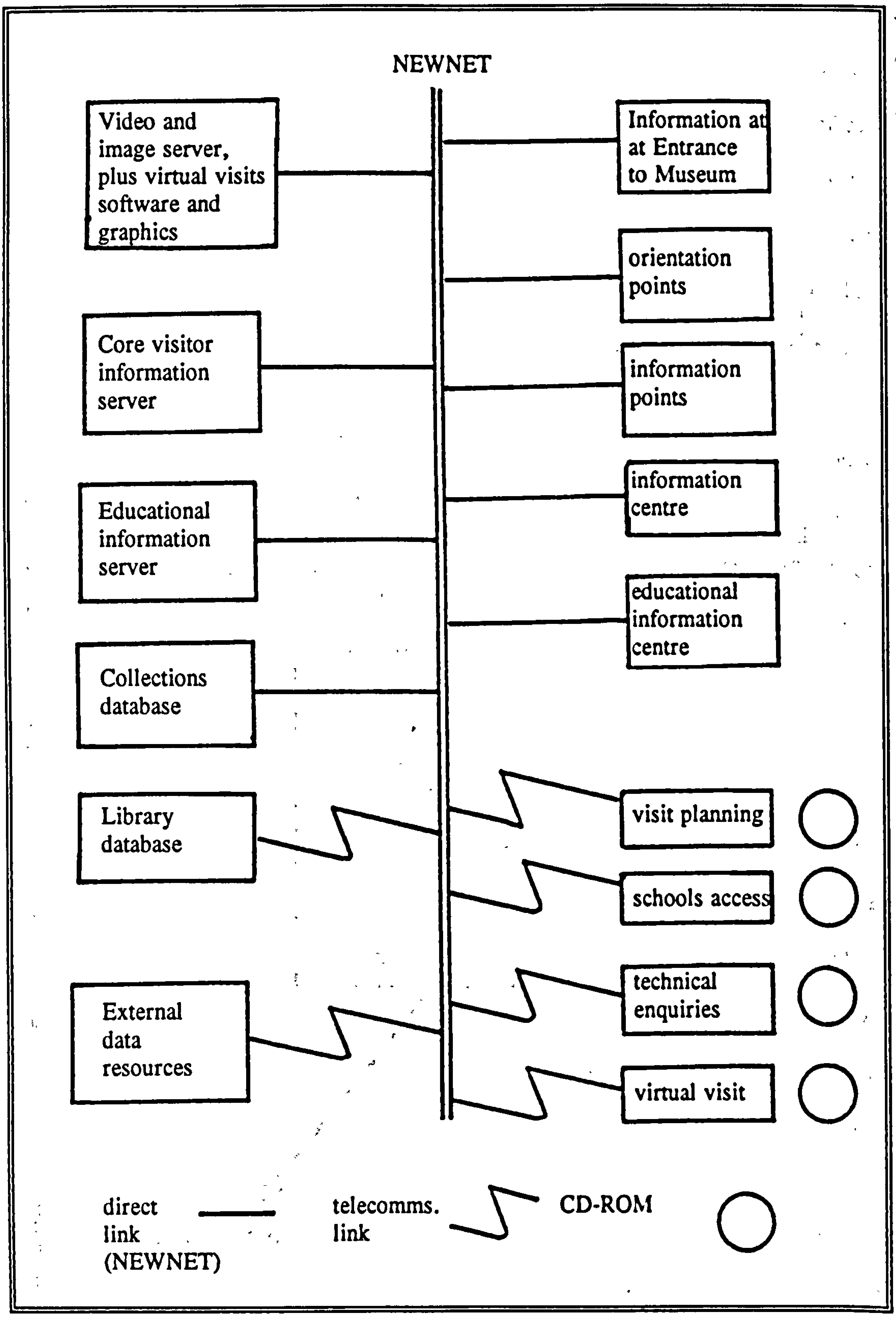


Figure 181: Technical structure for visitor information

20 IMPLEMENTATION

20.1 Introduction

This chapter takes the requirements defined in Chapters 17 and 18 and the technical options outlined in Chapter 19 and proposes an implementation plan for visitor information. A key element in setting out the prioritised plan is the equation of cost and benefits, based on the cost of providing a particular information service and the number of visitors who would benefit. Also taken into account are "added value" items such as the ability to provide better services for non-English language speakers, to increase visitor numbers, to raise revenue for the Museum or other benefits associated with the Museum's mission and objectives. Negative factors such as technical complexity or lack of available data are also assessed in the costs and benefits equation.

At this stage the aim is to provide budgetary figures so as to give a feel for the overall order of costs for a particular service, and to inform the process of setting priorities. A detailed feasibility study would be required for each option to give more precise costs. Nevertheless the cost models expressed here are based on experience of similar developments, and are therefore claimed to provide the necessary broad indicators. Costs are expressed at June 1996 levels.

The chapter starts by outlining the component costs for data, software, terminals and communications for information provision both inside and outside the Museum. Each internal information point is then discussed, with the cost components, number of visitors served, "added value" advantages, and technical and other constraints. External information supply is then reviewed. It is more difficult to estimate costs for external access to the Museum's information because such costs are likely to be shared between the Museum, users of the information, and third parties.

20.2 Building the cost model

20.2.1 Introduction

This section is concerned with developing a cost model for each component within the visitor information service. These component costs can then be drawn on when composing the cost for each type of information point. Costs consist of the following elements:

- development of data resources and the development or acquisition of software to access and display the information

- physical terminals and data communication

For external access the same elements apply, except that data communications become more significant in terms of the type of service and the costs involved, and the costs are split between the Museum, the user of the information and any third parties. For technical elements annual maintenance and support costs are included at 20% pa.

The costs for data and software follow the identification of main data types set out in section 19.4, above. Information costs are based on editing existing data to a form where it would be useful in the visitor information application, or creating the data if it does not exist already. In some cases the quality of the data will be adequate, but it will require reformatting. Annual costs are included for keeping information up to date.

Software costs are either based on any necessary enhancement to existing software, buying in a package, or (in the rare cases where this is necessary) on developing a bespoke solution. Costs are included for software maintenance at 20% pa.

20.2.2 Core factual information and orientation aids

This section looks at the costs for basic factual information and aids to navigation around the Museum. These are considered together as they are the main facilities which the general visitor needs and because much of the data and software is shared between application areas.

The core information includes the location of the Museum, ticketing, opening hours, events, the main galleries and objects and a plan of the Museum. Much of the data is already available in printed form or on the World Wide Web. Development of data on a selected group of objects is in hand. Some design work will be necessary on an interactive location map and plans of the Museum, and the facility for producing tour plans (both pre-programmed and bespoke) needs to be developed. The alphabetic list of facilities and major exhibits needs to be compiled.

Overall the data implications are relatively slight, and can be comfortably obtained within a £15k budget. There is a significant design and programming task, amounting to £25k. Much of the data such as events information is live, and will require daily update. In order to keep the data up to date a portion of a networked server will be required at £5k, and a quarter of a clerical post at a maximum of £5k. These costs are summarised in Figure 181.

Setup costs	
Data	£15k
Software and design	£25k
Infrastructure	£5k
Total setup	**£45k**
Recurrent costs	
Server maintenance	£1k
Data maintenance	£5k
Total recurrent	**£6k**

Figure 182: Costs for basic information and orientation aids

20.2.3 Educational information

Educational information on individual topics, and themed packs to help teachers plan visits, are already available in high quality paper form. To convert this to an electronic format, it could either be made available in text form extracted from the original word-processed text, or by scanning the printed sheets. Indexing, and some limited software provision would be necessary for either route. Scanning 1000 A4 pages with a cost for scanning and indexing of £10 per image (a high estimate) puts the total cost for this information at £10k, with an additional maximum of £10 for software. In addition there would also be an infrastructure cost for a portion of a server at £5k, and a data maintenance cost of a quarter of a clerical post at £5k pa.

Setup costs	
Data	£10k
Software and design	£10k
Infrastructure	£5k
Total setup	**£25k**
Recurrent costs	
Server maintenance	£1k
Data maintenance	£5k
Total recurrent	**£6k**

Figure 183: Costs for educational information

20.2.4 Object information

Unit costs for developing object records which are in a suitable format for public access can be very high. For instance for the Micro Gallery at the National Gallery records for the 2,000 works of art are rumoured to have cost around £100 each in research time to correct and enhance, with an additional cost for images. Whilst for the few hundred objects required for "popular" object information, or to support a particular display such costs are likely to be sustainable, the enhancement of large numbers of object records will have significant cost implications. The number of objects to be treated in this way at the Science Museum could be limited to the number included in a particular visible storage area (perhaps 1,000), through the total on display (20,000), to the total on display and in store of 200,000. For this costing exercise the figure of 20,000 objects is used, partly as a major record enhancement on the total of 200,000 objects seems unlikely at the moment, and partly as the gallery information system survey suggested that the majority of visitors were not very interested in those objects not on display. (However it should be noted that the Museum does have a publicly stated objective to increase access to the collections not on display).

The set of object data required by the general visitor is taken as that defined in Chapter 17, and includes age, use, construction and "stories about the object". Putting a cost on bringing the existing data up to this standard is difficult without further research. However it must range between the extremes of a few pence to transfer the present records across "as is" to the £100 per record of the Micro Gallery at the National Gallery. If we take a researcher costing £20k per year, working 200 days, and updating 20 records per day we arrive at a figure of £5 per object record. Bearing in mind the need to research four or five data items per object this is probably on the low side. However it does give us a budgetary figure of £5k for the 1,000 records of visible storage, £100k for bringing the 20,000 records for objects on display up to standard, and £1million for bringing all 200,000 records up to standard. However it should be noted that a thorough estimate of costs could put the figure at double this level. Many users will expect images (and also moving images) to be available with the textual records about the objects.

In addition to the data costs there is likely to be the need for visitor access software in addition to the present collections management software which is used for the main database of object information. This additional module to the main software suite is estimated to cost £20k. The high data volumes in the public access database and the need to provide a security barrier between the public and the main data archive, will probably dictate the need for an additional server at £10k. Recurrent costs will include software and hardware maintenance £6k, and data maintenance at one clerical staff at £20k. Costs for object data, based on the 20,000 objects on display are summarised in Figure 184.

Setup costs	
Data	£100k
Software	£20k
Infrastructure	£10k
Total setup	**£130k**
Recurrent costs	
Server maintenance	£2k
Data maintenance	£20k
Total recurrent	**£22k**

Figure 184: Costs for object information
(based on 20,000 objects, ie the number at present on display)

20.2.5 Information from other museums

It is assumed that where data about or from other museums and archives is used it will be available from the external institution in a format that makes it useable directly by the Science Museum, perhaps through OPAC or World Wide Web software. In addition to the quality and relevance of the material itself, the need to have the data in a suitable format will be the major factor in making information from another institution available to visitors, as it is unlikely to be cost effective to reformat another museum's data for visitor access.

In accessing information from another institution there will be a communication cost, and there may also be the cost of a license to use the data, although this may be taken care of through a reciprocal arrangement. Such data should not be costly to provide. For budgetary purposes a nominal cost of £10k is used, which includes setting up communications and interface software.

Total setup	**£10k**
Total recurrent	**£2k**

Figure 185: Costs for information from other museums

20.2.6 Bibliographical information

The Museum's bibliographic records are maintained in the Libertas software package operated by Imperial College. Public access is a core requirement for this system, and an OPAC module is provided for users in the library itself, and who access it via the Internet. Except for increased licensing to accommodate more users, there should be no cost attached to making this resource available. A nominal cost of £10k is assumed, together with an annual cost of £2k.

Total setup	**£10k**
Total recurrent	**£2k**

Figure 186: Costs of bibliographic information

20.2.7 Virtual visit

To develop a virtual visit facility, a virtual model of the Museum has to be developed, together with displays, objects and related information. One technique for doing this would be to use virtual reality markup language (VRML). At a more basic level a walk through the Museum has been developed using World Wide Web software, but this is likely to need considerable enhancement to be acceptable to users who will be accessing it via cable or other technology outside of the present internet capability. Putting a cost on this is difficult, but it is unlikely that content, design and software could be developed for under £50k. Unlike plans of the real Museum the virtual museum does not have to be updated every time a gallery is closed for maintenance. However regular updates would be desirable to keep it fresh and interesting. A notional figure of £10k is assumed for annual updates.

Total setup	**£50k**
Total recurrent	**£10k**

Figure 187: Costs of virtual visit

20.2.8 Video

Image and moving image resources are likely to be an increasingly important adjunct to other forms of information. Putting a cost on video is difficult, depending on the length and type of coverage. However experience in the Museum has shown that a promotional film ten minutes long can be made for about £20k, so this is our initial benchmark. There are no obvious recurrent costs, but new material will be needed from time to time to reflect changes in what is on show and therefore an annual refresh at £5k should be allowed for.

Total setup	**£20k**
Total recurrent	**£5k**

Figure 188: Costs of video

Type of data	Initial cost	Annual recurrent costs
Basic information and orientation aids	£45k	£6k
Educational information	£25k	£6k
Object information (20,000 records)	£130k	£22k
Information about other museums	£10k	£2k
Bibliographic information	£10k	£2k
Virtual visit	£50k	£10k
Video	£20k	£5k

Figure 189: Summary of data costs

20.3 Costs of terminals and data communication

20.3.1 Introduction

Costs are divided between the development and purchase cost for a particular type of terminal and the annual costs of maintenance and data communications. For most hardware and software combinations the annual cost is at 20% of purchase price. Terminal costs are summarised in Figure 193.

20.3.2 Notice board format display

This requirements, which is discussed in full in 19.5.2 above, is for a large scale display for the main concourse of the Museum. Costs are composed of a server and communications connections, and the large screen display itself. These devices are inherently costly because of their size, and because they are only manufactured in small numbers. Options could include LED display, an electro-mechanical device, large video screens, or a combination of all of these. Costs are likely to range from £50k to £250k plus. Setup costs are likely to be a minimum of £55k, with an annual cost of £11.

Setup costs	
Server and communications	£5k
Display	£50k
Total setup	**£55k**
Recurrent costs	
Maintenance and support	£11k
Total recurrent	**£11k**

Figure 190: Costs for notice board display

20.3.3 Costs for touch screen based terminal

Costs for a touch screen terminal consist of the computer, the touch screen display, a printer, and a secure and attractive housing. A tough housing is required because experience has shown that equipment located in public areas of the Museum can be subjected to A communications connection is required so that the information held on the computer can be updated. A cost of £10k is used for budgetary purposes.

Multi-media kiosks are becoming widely used in shops, banks, and railway stations. In the past touch screen terminals have been expensive because they have been built to order, but as these devices become commodities rather than one-off constructions costs are certain to fall. Furthermore, providing that a certain amount of advertising is carried, suppliers are now providing kiosks free of charge, and are even paying a commission to the site owner based on electronic sales and accesses to advertising.

Setup costs	
PC, touch screen, printer	£4.5k
Housing	£5k
Communications	£.5k
Total setup	**£10k**
Recurrent costs	
Maintenance and support	£2k
Total recurrent	**£2k**

Figure 191: Costs for touch screen terminal

Setup costs	
PC, standard monitor, mouse, keyboard, printer	£4.5k
Communications	£.5k
Total setup	**£5k**
Recurrent costs	
Maintenance and support	£1k
Total recurrent	**£1k**

Figure 192: Costs for keyboard terminal

20.3.4 Costs for keyboard terminal

For a keyboard based terminal the costs consist of a standard processor, display, keyboard, mouse, and printer. A secure housing is not required because this facility will be used in a supervised area and does not therefore have to be protected against rough usage and vandalism.

Type of data	Initial cost	Annual recurrent costs
Notice board	£55k	£11k
Touch screen terminal	£10k	£2k
Keyboard based terminal	£5k	£1k

Figure 193: Summary of terminal costs

20.4 Costs for remote access

20.4.1 Introduction

Costs for remote access to data are divided between the cost of the Museum making the data accessible, communications costs (usually either paid by the user of the information or shared with the Museum), and the costs of having an appropriate terminal and software to access the data. In some cases there may also be a third party who provides the information on behalf of the Museum. In the areas of new technologies it may be difficult to state firm costs.

20.4.2 External OPAC access

To make information available via an OPAC interface the Museum needs to put the data on a computer equipped with appropriate software. This server has to be made available to external communications in such a way that the Museum's main data resources are protected from unauthorised external access. The cost of server, software and OPAC interface is likely to be of the order of£20k.

Communications to the outside world can be provided through the Internet, through the public telephone network, or via ISDN. Internet access can be provided through the academic network (JANET in the UK via UKERNA), or from one of the many commercial providers. Access via the public telephone system is not the preferred option, as it involves maintaining large number of incoming telephone lines and modems, and is an expensive and labour intensive process.

Costs to Museum	
Setup costs	
Server and OPAC software	£20k
Telecommunications and security	£10k
Total setup	£30k
Recurrent costs	
Maintenance and support	£6k
Telecommunications	£5k
Total recurrent	£11k
User costs	
Setup costs	
PC & software	£2k
Communications (min)	£.1k
Total setup	£2.5k
Recurrent costs	
Maintenance and support	£.5k
Telecommunications (min)	£.1k
Total recurrent	£.6k

Figure 194: Costs for OPAC access

The telecommunications will need adequate security to protect internal systems, and to protect the data from being corrupted. For costing purposes a setup cost of £10k is assumed, with an annual cost of £5k. This would be adequate either for a "secondary" link to JANET, or for 10 ISDN lines, with appropriate security for both. Standard telephone lines would be cheaper, but as has been discussed above, is not a preferred option.

The user of this service will either require Internet access or a telecommunications link. Internet access could be via a commercial provider, or via a company or academic institute connection. Many of the users of specialist data via OPAC are likely to have an Internet connection at work or home. The user will also require a terminal, typically a PC handling both the communications protocol and user interface. Because only text is transmitted, a high speed link (such as ISDN) is not required.

20.4.3 Internet World Wide Web access

To make the Museum's information available via the World Wide Web the requirements for the Museum are similar to the OPAC access described above, in that the data needs to be placed on a computer equipped with appropriate software and the computer needs to be connected to the Internet.

The Museum has recently established a World Wide Web server, and would not need to incur significant extra costs in order to provide this service. However these costs are included here for comparative purposes. The computer and World Wide Web software, together with implementation costs, totalled £20k, although it would be possible to provide a lower capacity server for less. Implementing security and the JANET connection totalled £10k. The Museum's JANET link is a "secondary connection" via Imperial College. This direct fibre-optic connection provides an upgradeable capacity of 10 megabits per second at an annual cost of £4k. An alternative means of connecting to JANET would be via a leased telecommunications line and a commercial provider, but this is unlikely to be as cost-effective. A low cost solution would be to contract the whole World Wide Web service from an Internet provider. This has the advantage of low capital outlay, and is an attractive option for the initial stages of a small site where the technical issues may seem daunting. However for a large World Wide Web this route would probably be more costly in the long term, and lacks the control and immediacy that accrues from in-house management.

Costs to Museum	
Setup costs	
Server and World Wide Web software	£20k
Telecommunications and security	£10k
Total setup	**£30k**
Recurrent costs	
Maintenance and support	£6k
Telecommunications	£5k
Total recurrent	**£11k**
User costs	
Setup costs	
PC & software	£2k
Communications (min)	£.1k
Total setup	**£2.5k**
Recurrent costs	
Maintenance and support	£.5k
Telecommunications (min)	£.1k
Total recurrent	**£.6k**

Figure 195: Costs for World Wide Web access

Users will require an Internet connection, either via their academic or corporate affiliation, or through a commercial provider. In the longer term an Internet connection may also be available via the cable companies, complete with a set-top-box for World Wide Web access.

20.4.4 Public access kiosk

Public access kiosks offer an opportunity to reach the public who would not otherwise have an on-line link to the Museum. However these facilities are at an early stage of development and the costs to the Museum are as yet unclear.

As presently proposed the provider puts the kiosk in a public place, together with telecommunications access (typically both a standard telephone line and ISDN connections). The owner of the space is paid commission. The provider pays for installing the standard information on the Kiosk, and pays commission (calculated on sales and accesses to advertising) to the owner of the site. The Museum can advertise (perhaps through a "virtual visit") and sell tickets through kiosks installed around London and the South East. Kiosks could also be sited in the Museum. Projected costs of using this media are likely to include the preparation of the data and application software (perhaps using HTML) and a fee to the provider. The levels of these costs are uncertain at the moment.

20.4.5 Set top box

The set top box is a computer without a disk drive or monitor, which facilitates domestic access to cable and Internet resources. The Museum could use this media in a variety of ways, including:

- video, as part of a programme of science videos
- teletext information
- Internet access to the Museum's World Wide Web site

For the Museum the set top box presents several different opportunities with distinct costs. Like the public access kiosk (above) this is a very new technology and the commercial basis of the service is still a little sketchy. In all cases the cable or satellite provider will bare the costs of the telecommunications, which are passed on to the consumer. Likely charging regimes are as follows:

- video - cable company pays Museum for material which the Museum will have to have developed. Consumer pays cable company. Cost to the Museum perhaps recouped) is in developing the material.

- teletext - either offered as public service by the cable company, or a charged service to consumers. The Museum may be allowed to advertise at no charge, or will have to pay the cable company. Limited cost to the Museum in developing and updating material.

- World Wide Web - cable company provides an Internet connection and set top box to the consumer to access services such as the World Wide Web. The consumer is charged for this service. The Museum provides World Wide Web material on the internet in the usual way.

Consumer costs will be installation (typically c.£100), the set top box itself (today priced at £600 but this is felt to be unacceptably high for customers), and a monthly rental of £20 or more for a range of services including terrestrial TV, cable, satellite channels and a high speed Internet connection.

20.4.6 CD-ROM

CD-ROM provides an alternative means of distribution. Provided that the data is already available the costs are mainly in putting together indexing and navigation tools through the material, and in distribution once the disks have been produced. The authoring of the disk can cost from £10k to as high as £350k. The current economics of distribution are that over 60% of the price (typically £20-£30) will go to the distributor, so considerable savings can be made if the copyright for the material is owned by the Museum, and the Museum handles the distribution itself.

20.5 Cost comparisons

20.5.1 Introduction

Sections below outline the costs for each type of information provision, together with the number of users who are estimated to use the information. Various "added value" advantages to the particular solutions are itemised. Each facility is costed over 5 years, including maintenance and support.

20.5.2 Information at the entrance to the Museum

Setting up this facility requires the basic data about the Museum's facilities, prices and hours, and what is on today. These are costed at £10k. In addition an element of moving film would be advantageous to make the display more attractive and inviting. The physical display can be very varied in cost, from as little as £50k up to £250k. The high cost of the display unit is particularly due to the high costs of large video monitors. Costs are summarised in Figure 193.

The number of visitors who will benefit from this facility are all those who enter the Museum via the main entrance. This is all visitors except booked parties, a total of around 1.2 million per year.

The main benefits are to provide visitors with initial information to help them start planning their visits, and to provide information on attractions they may wish to pay extra for on entry, thus speeding up the process of ticket sales, and increasing sales. A further benefit of this attractive display is to sell the Museum to those who have come into the foyer and have not decided whether or not to visit.

Setup costs	Data	£10k	
	Video	£20k	
	Display and server	£55	
	Total setup:		**£85k**
Recurrent costs (pa)	Data	£2k	
	Video	£5k	
	Display and server	£11	
	Total recurrent pa	**£18k**	
	Total recurrent (5 years)		**£90**
Total:			**£175k**
No. of visitors to benefit (pa)			**1.2 million**
Total no of visitors to benefit (5 years)			**6 million**
Cost per visitor:			**£0.03**
Benefits:	Provide basic information visitors require at entrance Sell tickets for additional attractions Entice undecided visitors into Museum (an extra 20 full price visitors per day would cover cost)		

Figure 196: Costs for information at entrance to Museum

20.5.3 Orientation points within the entrance to the Museum

Visitor orientation points are required to help visitors plan their stay in the Museum. The information costs for visitor orientation are discussed in Section 20.2.2.2 above, and total £45k. Touch screen terminals total £10k each. The main concern here is to provide enough terminals, and to fund this. Costs are set out in figure 194.

The total number of users will be a percentage of those 1.2 million who use the main entrance to the Museum. Of these 1.2 million visitors perhaps 40% (based on study at Minneapolis

Museum of Art, Chapter 17) would use the facility. These 480,000 visitors average 1,333 per day. If we assume these visitors arrive over a 4 hour period approximately 340 per hour will require use of an orientation point. Visitors are mainly in groups of two or more, so 170 groups will require a 5 minute orientation session per hour. At 12 sessions per terminal approximately 14 terminals will be required. For costing purposes a total of 20 terminals is assumed. However it should be noted that at peak times as many as 10,000 people a day visit the Museum. Orientation points could be located in assemblies of 4, but even so there could be a problem in finding space for the terminals, and in preventing them from causing a bottleneck of visitors. A concern is that if these prove to be a popular facility at peak times there would not be enough orientation terminals for the visitors who wish to sue them. Printer maintenance could also be a problem.

Setup costs	Data	£ 45k		
	Touch screen terminals (20 @ £10k)	£200k		
	Total setup:		**£245k**	
Recurrent costs (pa)	Data	£6k		
	Maintenance and support for terminals	£40k		
	Total recurrent pa	**£46k**		
	Total recurrent (5 years)		**£230**	
Total:				**£475k**
No. of visitors to benefit (pa)			**480,000**	
Total no of visitors to benefit (5 years)			**2.4million**	
Cost per visitor:			**£0.20**	
Benefits:	Better information for visitors to plan time in museum Multi-lingual cater for disabilities sell secondary charged facilities sell goods etc. (mail order)			

Figure 197: Costs for orientation points

A major issue is that the setup cost is high because of the cost of the touch screen terminals themselves. However this could be recovered by making a 20p charge for the use of the facility, which would perhaps be free to season ticket holders with the requisite smart card. The 20p could be refunded if a purchase is made. An alternative would be to sell advertising space on the terminals, or to obtain the terminals from one of the commercial undertakings which will supply them free of charge providing they carry advertising and direct sales material.

Additional benefits would be the facility to provide a multi-lingual interface, and an interface suitable for those with disabilities and learning difficulties. The Museum's mail-order catalogue could be accessed through the terminals for direct sales, and tickets could be ordered for those parts of the Museum where there is a secondary charge.

20.5.4 Information points in the Museum

Information points in the Museum provide visitors with information to help them find their way around. The information requirement is similar to that for orientation points. The costs for the terminals themselves are also similar, except that there is a modest saving through not providing printers (see 19.8.3 above).

In order to calculate the number of information points which are required it is necessary to look at the geography of the Museum so as to provide points at sufficient intervals so that visitors can use them conveniently if they are lost or require information. The Museum's total display area is around 40,000 square metres - a figure of one point per 1,000 square metres is used for planning purposes (ie 1 per 40m by 25m exhibition space). 40 terminals are required at this density.

Setup costs	Data	£ 45k		
	Touch screen terminals (40 @ £10k)	£400k		
	Total setup:		**£445k**	
Recurrent costs (pa)	Data	£6k		
	Maintenance and support for terminals	£80k		
	Total recurrent pa	**£86k**		
	Total recurrent (5 years)		**£430**	
Total:				**£875k**
No. of visitors to benefit (pa)			**1.2 million**	
Total no of visitors to benefit (5 years)			**6 million**	
Cost per visitor:			**£0.15**	
Benefits:	Better information for visitors during visits Multi-lingual Disabilities Sell secondary charged facilities Sell goods etc. (mail order)			

Figure 198: Costs for orientation points

Secondly the density of points needs to be determined in relation to the number of visitors. There are a total of 1.6 million visitors per year, all of whom may wish to use this facility. This is around 4,500 per day (over double at peak times) or 2,250 visiting groups with an average 2 visitors in each group. A single terminal will provide 96 5 minute sessions per day, requiring 24 terminals to provide for the 2,250 groups. Some may not wish to use this facility, and at peak hours there will be many more people in the Museum. The planning figure of 40 points therefore seems to be more than adequate for the number of visitors.

The initial cost for 40 terminals is very high, together with a high annual maintenance charge. As with the orientation points, it may be possible to sell advertising space, or to obtain touch screen terminals free of charge from a commercial undertaking. A charge could be made for using the information points, but whilst this could be acceptable for orientation points it may not be well received by visitors who feel they are lost because of poor signposting in the Museum.

20.5.5 Support for exhibits

Because such displays tend to be "one off" designs the costs vary considerably, and there may be little value in including them here. However as a benchmark a cost for a simple interactive with four separate touch screen terminals is included here. Additional information (as for information points) could also be available on the terminals, but this would detract from the display related side of the interactive. Cost per visitor figures are difficult to calculate, depending on the specific gallery. The main benefits are to do with aiding interpretation, and it is not thought to be particularly appropriate to overload the display support terminals with other facilities.

Setup costs	Develop data	£15k		
	Images (commission and purchase rights)	£10k		
	Develop software	£30k		
	Touch screen terminals (4 @ £10k)	£40k		
	Evaluation	£5k		
	Total setup:		**£100k**	
Recurrent costs (pa)	Data	£4k		
	Maintenance and support for terminals	£8k		
	Total recurrent pa	**£12k**		
	Total recurrent (5 years)		**£60**	
Total:				**£160k**
No. of visitors to benefit (pa)			**varies**	
Benefits:	Provides multimedia enhancement to static display			

Figure 199: Costs for gallery system to support exhibits

20.5.6 Visible storage

Support for visible storage is aimed a providing additional information for objects which are displayed in tightly packed cases, with perhaps no label except for an identification number. Broadly speaking the information requirement is for an electronic label, with links to other items of information. Each implementation of visible storage is likely to have its own characteristics, but some budgetary figures are provided. There is the possibility of providing additional information (for instance the information provided at information and orientation points) in addition to visible storage application, but this could detract from the main use.

Setup costs	Develop data (2000 objects)	£10k		
	Touch screen terminals (4 @ £10k)	£40k		
	Total setup:		**£50k**	
Recurrent costs (pa)	Data	£2k		
	Maintenance and support for terminals	£8k		
	Total recurrent pa	**£10k**		
	Total recurrent (5 years)		**£50**	
Total:				**£100k**
No. of visitors to benefit (pa)			**varies**	
Benefits:	Provides information to support objects displayed in visible storage			

Figure 200: Costs for system to support visible storage

20.5.7 Information centre

The main purpose of the information centre is to provide access for specialists and enthusiasts to additional information about objects, bibliographic information, and information from and about other museums. Because users are expected to spend some time at this facility, it is felt to be appropriate to also provide the basic data about the Museum and other information from the orientation and information points. Educational information is provided through a separate facility (see 20.5.8, below). The main cost in setting up this facility is in providing access to object records. A charge could be made for using the facility.

The number of users and length of session are calculated from the figures for the usage of the Micro Gallery at the National Gallery. It is estimated that 2.5% of the 1.2million visitors who have not come as part of an educational group would use the facility, and the average session would be 20 minutes. At most times 5 terminals would be sufficient for these numbers, but ten are allowed for peak visitor numbers.

Setup costs	Basic data	£ 45k		
	Object data	£130k		
	Bibliographic data	£ 10k		
	Connection to other museums	£ 10k		
	Terminals with keyboard /mouse (10 @ £5k)	£ 50k		
	Total setup:		**£245k**	
Recurrent costs (pa)	Data	£32k		
	Maintenance and support for terminals	£10k		
	Total recurrent pa	**£42k**		
	Total recurrent (5 years)		**£210**	
Total:				**£455k**
No. of visitors to benefit (pa)			**30,000**	
Total no of visitors to benefit (5 years)			**150,000**	
Cost per visitor:			**£3.03**	
Benefits:	Provide specialist information			
	Better information for visitors during visits			
	Multi-lingual			
	Disabilities			
	Sell secondary charged facilities			
	Sell goods etc. (mail order)			

Figure 201: Costs for general information centre

20.5.8 Educational Information centre

The main purpose of the educational information centre is to provide the information required by teachers planning visits, and by teachers and students working on projects. It may be appropriate, particularly to help those planning visits, to make available the basic data about the Museum. Educational and basic information about the Museum are required. Some consideration will need to be given to whether a touch screen or keyboard and mouse terminal would be most suitable.

The number of potential users is calculated as 2.5% of the 400,000 booked group visitors, with an average session of 20 minutes. A total of 4 information points is required at peak times.

Setup costs	Basic data	£ 45k		
	Educational data	£ 25k		
	Terminals with Keyboard/mouse (4 @ £5k)	£ 20k		
	(Note: calculated at peak time - 2 would be adequate otherwise)			
	Total setup:		**£90k**	
Recurrent costs (pa)	Data	£6k		
	Maintenance and support for terminals	£8k		
	Total recurrent pa	**£14k**		
	Total recurrent (5 years)		**£70**	
Total:				**£160k**
No. of visitors to benefit (pa)			**10,000**	
Total no of visitors to benefit (5 years)			**50,000**	
Cost per visitor:			**£3.20**	
Benefits:	Provide information for educational users			
	Better information for visitors during visits			
	Multi-lingual			
	Disabilities			
	Sell secondary charged facilities			
	Sell goods etc. (mail order)			

Figure 202: Costs for educational information centre

Additional facilities include interfaces suitable for disabled and foreign visitors, and facilities for on-line sales of mail-order goods and tickets. On-line booking of educational facilities would also be an option, although this is a complex process because of the variety of options available. Such is the complexity of this area that there have been difficulties in getting software the booking office staff can use, so there may be difficulties in obtaining software for visitors to use themselves. An alternative would be to provide a video-link to the bookings office from the educational information point.

20.5.9 Remote access - planning visit

Visitors planning to visit the Museum need to remotely access information about opening hours, ticketing, what's on and what there is to see. At the moment for most people the facilities for doing this are limited to conventional paper and telephone methods, but the information is also available on the World Wide Web. In providing for remote access the need is to formalise the basic information which is provided already, and make it accessible.

Potential access methods are public access kiosks, and the World Wide Web, either accessed from the Internet or via cable and a set top box. The costs of these different methods are discussed in section 19.4 above.

It is difficult to assess the number of potential visitors who would use such a service, but we can get some pointers from present figures:

External enquiries by conventional means	72,000 pa
World Wide Web accesses to general information	264,000pa
Total:	336,000pa

Costs to users will vary, depending on how they access the information. They will need to establish an Internet connection, or use the connection provided by their cable service. Both these will have a cost. Kiosks will probably be free of charge, as they are used by us to sell the Museum, and others to sell services. Estimated costs are set out in Figure 200.

Setup costs	General information	£45k	
	WWW setup	£30k	
	Kiosk setup	£uncertain	
	Set-top-box	£uncertain	
	Total setup		**£75k**
Recurrent costs	Data	£5k	
	Server maintenance	£1k	
	World Wide Web support	£11k	
	Kiosk	£uncertain	
	Set-top-box	£uncertain	
	Total recurrent (pa)	**£17**	
	Total recurrent (5 years)		**£85k**
	Total:		**£160k**
No. of visitors served pa.			**336,000**
No visitors served over 5 years			**1.68million**
Cost to Museum per visitor served:			**£0.10p**
Cost to visitor:	World Wide Web	Connection £10 per month Telephone charges Hardware	

Figure 203: Costs for remote access for planning visits

20.5.10 Remote access - technical enquiries

The costs of setting up remote access for technical enquirers are broken down into collecting the information (similar for study centre), and making it available, either through an OPAC, or via the World Wide Web.

The number of users is calculated from the number of enquiries received through conventional means, plus the number of accesses collections and specialist information on the World Wide

Web. (Some of the World Wide Web users may be more appropriately classed as virtual visitors). Totals are:

Specialist enquiries	26,000
World Wide Web queries:	340,000
Total specialist enquiries:	**366,000**

Setup costs	Basic information	£45k	
	Object data	£130k	
	Bibliographic information	£10k	
	Connection to other museums	£10k	
	OPAC hardware & software	£30k	
	World Wide Web	£30	
	Total setup		**£255k**
Recurrent costs	Data	£32k	
	World Wide Web	£11k	
	OPAC	£11k	
	Total recurrent (pa)	**£54**	
	Total recurrent (5 years)		**£270k**
	Total:		**£525k**
No. of visitors served pa.			366,000
No visitors served over 5 years			1.8million
Cost to Museum per visitor served:			£0.30p
Cost of access:	World Wide Web	Connection £10 per month Telephone charges Hardware	
	Dial in OPAC	Similar to above	

Figure 204: Costs for remote access for technical enquirers

20.5.11 Remote access - Schools

The provision of schools information is similar to providing remote information to researchers, in that information is provided either via OPAC or the World Wide Web. Numbers of users can be inferred from the numbers of schools enquiries, and World Wide Web interrogation. However we can infer a rise in the number of schools accesses as the necessary technology becomes available. Present access to the schools pages on the World Wide Web are relatively low, and some of the general World Wide Web accesses probably originate from schools. With these caveats the current numbers of schools enquiries are:

- Conventional enquiries: 13,000
- World Wide Web accesses: 21,228

Costs are made up of the schools data, and in providing access via World Wide Web and OPAC interfaces.

Setup costs	Data	£25k	
	OPAC hardware & software	£30k	
	World Wide Web	£30	
	Total setup		**£85k**
Recurrent costs	Data	£6k	
	World Wide Web	£11k	
	OPAC	£11k	
	Total recurrent (pa)	**£28k**	
	Total recurrent (5 years)		**£140k**
	Total:		**£225k**
No. of users served pa.			**34,228**
No visitors served over 5 years			**171,140**
Cost to Museum per visitor served:			**£1.31**
Cost of access:	World Wide Web	Connection £10 per month	
		Telephone charges	
		Hardware	
	Dial in OPAC	Similar to above	

Figure 205: Costs for remote access for schools

20.5.12 Remote access - virtual visitors

It is difficult to calculate the cost of providing a virtual visit, as this is a very new medium. However it is possible to provide some broad indicators. The virtual visit could be accessed via the World Wide Web, and the high speed data transmission capabilities of cable and set top box may have much to offer. Kiosks could also provide this facility, either off-line or via ISDN, although we do not yet know whether users will wish to spend long at public kiosks, and kiosk providers may wish to encourage a high throughput. Potential user numbers are also hard to define, but we do have some figures from present World Wide Web usage, which give a lowest figure.

Setup costs	Data	£50k	
	Set-top-box	unknown	
	World Wide Web	£30	
	Total setup		**£80k**
Recurrent costs	Data	£10	
	World Wide Web	£11k	
	Set top box	£unknown	
	Total recurrent (pa)	**£21k**	
	Total recurrent (5 years)		**£105k**
	Total:		**£185k**
No. of users served pa.			**285,000**
No visitors served over 5 years			**1.4million**
Cost to Museum per visitor served:			**£0.13p**
Cost of access:	World Wide Web	Connection £10 per month	
		Telephone charges	
		Hardware	
	Cable set top box	c. £20 per month	

Figure 206: Costs for remote access to virtual visit

20.6 Cost Comparisons

The sections above have established broad costings for each type of information provision. These are summarised in the table below. However this table considers each type of information provision in isolation, and information which is used in several locations will be costed for several times.

In some areas it is difficult to arrive at reliable costs. For gallery support and visible storage there are considerable uncertainties, as these applications could have a range of potential costs, and these are likely to be specialist applications which only use a small amount of information shared with other areas. These applications are therefore excluded from further discussion. For "Virtual visits" we have little information at the moment on what is needed or possible, so these are also excluded.

Type of information	Setup cost	Running cost (5 yr)	Total cost	Visitors served (5 yrs)	Cost per visitor
Entrance to Museum	£85k	£90k	£175k	6 m	£0.03
Orientation point	£245k	£230k	£475k	2.4 m	£0.20
Information point	£445k	£430k	£875k	6 m	£0.15
Support for exhibits (eg)	£100k	£60	£160k	varies	varies
Visible storage	£50k	£50k	£100k	varies	varies
Information centre	£245k	£210k	£445k	150k	£3.03
Educational information centre	£90k	£70k	£160k	50k	£3.20
Remote - planning visit	£75k	£85k	£160k	1.68 m	£0.10
Remote - technical queries	£255k	£270k	£525k	1.8m	£0.30
Remote - schools	£85k	£140k	£225k	171k	£1.31
Remote - virtual visit	£80k	£105k	£185k	1.4m	£0.13

Figure 207: Raw costs for different types of information

The analysis in the previous chapters has shown that there are broadly three types of visitor information - for the general visitor, educational visitor, and specialist. Once a particular type of information has been collated it can be made available in a number of ways. For instance information of interest to the general visitor will be provided in the Museum at orientation and information points, and externally to those planning their visits.

Costs can therefore be revised so that the creation and updating of the data and applications for each type of visitor only needs to be included once, as the costs are shared between the several applications which use the data. These revised costs are shown in Figure 205. For illustrative purposes data costs are shared equally between each application. Of course if some applications are developed alone the cost of data will increase accordingly.

Type of information	Data (5 years)	Hardware & Running cost (5 yr)	Total cost	Visitors served (5 yrs)	Cost per visitor
General visitor:					
Entrance to Museum	£25k	110k	£135k	6 m	£0.02
Orientation point	£15k	£400k (note 1)	£415k	2.4 m	£0.17
Information point	£15k	£800k (note 2)	£815k	6 m	£0.13
Remote planning visit	£15k	£90k	£105k	1.7m	£0.06
Specialist visitor:					
Information centre	£75k (note 3)	£100k	£175k	150k	£1.17
Remote - technical queries	£75k (Note 3)	£85k (Note 4)	£160k	1.8m	£0.09
Educational visitor:					
Educational information centre	£12.5k	£40k	£52.5k	50k	£1.05
Remote - schools	£12.5k	£85k (note 5)	£97.5k	171k (note 6)	£0.57

Notes: 1 & 2 Could be reduced to £0 if supplied under commercial arrangement
3 Assumes cost of basic data born by general visitor facilities
4 Assumes only WWW or OPAC, not both
5 Assumes only WWW or OPAC, not both
6 Based on numbers of queries - actually serves 2m schools visitors over 5 years

Figure 208: Adjusted costs for different types of information

In the previous sections where costs have been reviewed in detail the added benefits of each application have also been reviewed. These aspects of "added value" such as the ability to generate extra sales or income, or to provide information for non-english speaking visitors are important, but difficult to put a cost against. Each area of visitor information has several aspects of added value. These are summarised in Figure 207.

General information:	Multi-lingual Disabilities Sell secondary charged facilities Sell goods etc. (mail order)
Specialist information:	General information as well: Multi-lingual Disabilities Sell secondary charged facilities Sell goods etc. (mail order)
Educational information:	General information as well: Multi-lingual Disabilities Sell secondary charged facilities Sell goods etc. (mail order) Book educational facilities

Figure 209: Added benefits of visitor information

20.7 Developing an implementation plan

Chapter 19 has provided a technical framework for implementation, and the previous sections of Chapter 20 have provided "order of magnitude" costings, an indication of the number of visitors served and the added benefits of each area of visitor information. The merits and priorities within each area are discussed below. Multi media exhibits to support gallery displays and systems to support visible storage are not discussed here, as they are one-off projects to be considered individually on their merits.

20.7.1 Information for the general visitor

The evidence above has shown that the majority of visitors will use this information to help them enjoy their visit to the Museum, and that there is an added benefit for non-english speaking visitors, and for those with disabilities. Costs in developing the information resource are low for the numbers who will benefit.

The cost of a display in the entrance to the Museum is low for the numbers served, and is probably within range of likely internal expenditure, and is a good target for sponsorship. Facilities for the remote planning of visits are also at a modest cost for the potential numbers served.

Costs of terminals for orientation and for information in the Museum are high in capital terms, unless the costs can be defrayed through sponsorship, or a commercial arrangement with the kiosk provider.

20.7.2 Information for the specialist visitor

The costs of providing information for the specialist visitor are divided between capital outlay in equipment and the cost of developing the information resource. In practice the cost of the information is likely to be the major component. Costs are relatively high, but the Museum may decide that this service is a sufficient priority for the costs to be acceptable. Alternatively a charge could be made.

20.7.3 Information for educational visitors

Costs for developing educational information resources are relatively low, although the numbers immediately served are also low. However the usage figure is misleading as the figures they are based on mainly relate to the leaders of parties, rather than the number of visitors in the parties themselves.

20.7.4 Strategy

The visitor information strategy aims to provide the best value for money, and suggests the following approach:

- the core visitor information should be developed. This resource has a relatively low cost, has the potential to serve the most visitors, and is provided as an "added value" component with other types of visitor information for educational and specialist enquiries.

- sponsorship or capital funding should be sought for a large information display in the entrance to the Museum.

- experiments should be done with information kiosks to see how they are received by visitors in the Museum. If successful a commercially based means of providing this facility should be sought. This facility is too costly to be funded from the Museum's own resources.

- further work should be done on developing the understanding of the needs of specialist visitors, and of the financial basis for providing what is (on a number of users basis) a relatively expensive service. If a this application can be shown to be justified a major initiative is required to develop the data resources. In the meantime what information is already available should be made available on-line for specialists.

- educational visitors are numerically a large and important sector of the Museum's visitors. Developing their information resources is low cost, and should be pursued.

- new media for remote access should be investigated to gain an understanding of the costs and benefits.

- a further investigation should be made into what is required to create a "virtual visit".

The strategy presented above is achievable within present resources, and would have considerable benefits. Because there is a full technical and cost model, various different combinations of forward plan can be tried. As the plan develops the models can be altered to reflect this better understanding. In any case most areas are of such a scale that a full feasibility study will be needed before proceeding.

21 SUMMARY OF THE SCIENCE MUSEUM CASE STUDY

The Science Museum case study has aimed to gain an understanding of the types of information which visitors require, the data resources necessary to provide this information, and the technical systems needed to provide this information. The case study is described in detail in the previous chapters. The present chapter describes the main findings in relation to the Museum's requirements for visitor information. The following chapter presents general conclusions from the two case studies.

School parties and family groups consisting of children accompanied by adults account for about 75% of the public who come to the Museum. Of the remainder the majority are visitors with a general interest and a small percentage have either a professional or specialist interest. The first part of the case study provides an initial understanding of visitor information needs. It consists of a review of experience of visitor information provision at other museums and galleries, an analysis of several detailed surveys of visitor information needs at the Museum, and some detailed case studies of work elsewhere.

Overall the picture which emerges is the need for a range of different information outlets in the Museum, including:

- an information display at the entrance to the Museum
- orientation points inside the entrance and information points throughout the Museum
- information centres for specialist and educational visitors
- systems to support exhibits and visible storage

External access to information was required to:

- assist in planning visits to the Museum
- answer specialist queries

- answer queries from schools and to help schools plan visits to the Museum

- provide a "virtual visit" experience

The case study goes on to examine in detail the information needs for each type of outlet and how this data can be obtained. Some data is already available in digital form, some is in paper form, and some will have to be created. Online access is required to existing databases in the Museum and there is also the need for access to external online resources. The different types of terminal and software interface for use in the Museum are described, and external methods of dissemination including OPAC, the World Wide Web, public access kiosks and cable are reviewed. The information, communications and interface elements of the visitor information system are assembled in a conceptual and technical structure at the end of Chapter 19.

It was found that information is required to support three different types of visitor:

- the general visitor whose main concerns are to know what the Museum has to offer on the day of their visit, to see the items on display, and to navigate around the Museum

- educational visitors (both teachers and students) who require information about specific topics and help in planning their visits

- specialist visitors who require detailed information about the Museum's collections and access to a wide range of information resources both in the Museum and elsewhere

Chapter 20 provides "order of magnitude" costs for the components of the proposed visitor information system and aggregated costs for each type of visitor information. Costs are balanced by estimates of the numbers who will use the resource, and "added value" opportunities for each type of outlet. In developing costs it was found that both multi-media support for exhibits and support for visible storage displays were likely to be one-off applications for which both data and software would be specially constructed (although visible storage may draw heavily on existing object information). Because of the difficulty in putting a cost on these and because such applications are likely to be individually justified on their merits, support for displays and visible storage were excluded from further consideration. Similarly because of the uncertainty in costing the creation of a "virtual visit" this potentially exciting development was left for future investigation.

In conclusion it was found that the package of information for the "general visitor" was relatively inexpensive to develop, would have wide benefits, and would also be of use to those with educational and specialist interests. The capital costs of making this information available through multi-media kiosks in the Museum appeared at first sight to be prohibitively high and it is not certain how this form of information provision wold be received by visitors. It was suggested that trials should be undertaken to ascertain the effectiveness of this medium and commercial funding of the kiosks should be pursued.

Conversion of the present paper educational resources to digital format would be inexpensive and the capital costs of making this information available are not high. It was argued that this initiative could be pursued within present resources. The opportunity to provide the online booking of educational facilities should be pursued.

Specialist information was found to be costly to develop, and to have a relatively small user base. On the other hand the capital costs of provision were relatively low. It was felt that before enhancing the information resource a study should be carried out to establish the needs of specialist users, and whether they would be prepared to pay a charge for using such a facility. In the meantime the information which is already in a suitable format should be made available.

A selection of technologies including the World Wide Web, public access kiosks and cable seemed to offer great possibilities for communication with all of the Museum's publics, although at this stage they are poorly understood. CD-ROM also has potential now that most new personal computers are sold with a CD-ROM drive. These technologies were felt to be worth further investigation.

Overall the review of visitor information requirements at the Science Museum has established the types of visitor and their requirements, and how these can be met. A logical and technical structure has been proposed for these linked systems, such that individual elements can be developed on their own, whilst retaining the savings and added consistency of being part of a larger vision. The structure can evolve in the light of experience gained in its use. Many new technologies have been reviewed, particularly in the areas of multimedia kiosks and external access to information. Whilst their usefulness and costs are at present uncertain, they are likely to have much to offer in the future.

22 CONCLUSIONS

This dissertation is based around two case studies which examine museum information needs from different perspectives. The first at the National Maritime Museum looks at museum curators' requirements for integrating archaeological material within a museum's collections, and at the information systems requirements for managing those collections. The second takes the museum visitor's viewpoint and looks at the information required by different types of visitor both within and externally to the Museum. There is a detailed description of each case study in previous chapters, together with full description of the operational conclusions. This concluding chapter is concerned with drawing out the broad themes and conclusions from the case studies.

The aim of this concluding chapter is to draw the two studies together to produce a balanced overall picture of the those aspects of information systems which are particular to museums. The systems described here are at the core of museums' twin roles of preserving and presenting collections to the public. Museums will have other information systems concerned with the whole spectrum of their work including financial, personnel, estates, retail and marketing activities, amongst others. The collections management and visitor information systems discussed here are particular to museums and central to their function.

At the National Maritime Museum the system which was developed provided a thorough testing of the requirements of a collections management system, including recording media, computer software, procedures, numbering systems and terminology control. Chapters in the ARC case study describe in detail how this was achieved. The approach which was adopted was based on the MDA data standard, which later evolved into the SPECTRUM standard for museum documentation. It thus forms a test of the procedures and data structures which are described in *SPECTRUM*, and shows them to be successful.

The second strand of the ARC system was to test the transition of material from archaeological fieldwork to museum curation, the aim being to have a seamlessly integrated data structure which avoided the need for data to be restructured or reentered. Although there was little fieldwork undertaken by the Museum, this part of the system was modelled and shown to work. In broader terms this test suggested that structured data can easily be transferred from one system to another.

Thirdly, anticipating the relational model for database management systems, and the ability to link information together through methods such as hypercard, the ARC system included both explicit links between records via their record numbers and subject dossier, and implicit links through controlled terminology, which enabled links to be constructed between related records. For instance an automatic link could be created between all items from a particular locality or period. Because the use of the ARC system concentrated on the collections management rather than research or access aspects, this facility was not tested, but was modelled successfully.

The system developed at the National Maritime Museum included both elements of the traditional data structures aimed at producing a conventional museum catalogue, and elements targeted at collections management. Those aspects of the system which contained concise factual information for collections management were found to be most used. At the time when the ARC system was developed the prevailing technology did not easily facilitate universal online access to the system, or image storage.

The focus of the system developed at the National Maritime Museum reflected a general trend away from cataloguing to collections management, which is in turn being superseded by collections access. The second case study pursues this trend and investigates requirements for access.

A fundamental conclusion from the Science Museum case study concerns the complex and diverse nature of what is broadly described as "collections access". At the Museum the study found that there were broadly three different types of visitor, each with different information requirements.

- **The general visitor:** Most visitors came to see the objects themselves and the interpretative material presented by the Museum to help their enjoyment of the items on display. The additional information which they required mainly concerned major exhibits, events on the day of their visit, and how to find their way around the Museum.

- **School parties:** The Museum has a large number of visitors in organised parties from schools who make up a distinct body of users of information. They need to know about specific matters relating to projects they are undertaking, and how to make sure they get the most out of their visits to the Museum.

- **Specialists and enthusiasts:** A third and much smaller group has a technical or specialist interest, which require detailed information about the collections and access to other data resources.

Access would therefore appear to be most concerned with providing the means for visitors to enjoy a museum experience based around objects and supporting materials. The three constituencies itemised above have different needs, but there is some overlap, and in particularly the general information is required by all classes of visitor. In general visitor information needs are not met by categories of data which are provided from conventional collections databases, and even for the specialist enquirer the present collections database, with its emphasis on collections management rather than access does not serve their requirements particularly well. The three groups of visitor enquiry translate into three overlapping sets of data. Other museums may have additional constituencies, but most will probably have (in different proportions) the three described here.

Cost models for visitor information at the Science Museum are presented in Chapter 20. They show that the set of general information which is needed by all types of visitors is relatively inexpensive to generate, store and keep updated, but making it available internally via electronic means was on the face of it prohibitively expensive, except for a large scale display at the entrance to the Museum. Various commercial approaches to this cost problem are presented. Educational information seems to be very good value in assisting the many educational parties to get the most out of their visits. Specialist information of the kind traditionally derived from the collections data resources seems to be expensive, and the case study suggested that a further investigation of specialist needs should be undertaken before making a substantial investment in this area.

The study touched on multi media support for exhibits, and support for "visible storage" where large numbers of items are displayed with minimal labelling. It was felt that information systems had an important role to play in this area, but that they were likely to be one off constructions targeted to a particular display, rather than part of the overall visitor information scheme. Indeed it was felt that these displays should not be cluttered with additional more general information derived from the visitor information system.

Like internal visitor information, external access to these resources was found to have several different audiences, for which different technological approaches may be appropriate. To date OPAC access has been the favourite for specialist information, and the World Wide Web (with 25,000 accesses a week to the Science Museum site) is a popular medium, although we know little of who uses it and why. In the longer term public access kiosks, CD-ROM and a variety of media such as teletext, the World Wide Web and video on demand delivered to peoples homes via cable are likely to be important. The case study showed that all of these could have some applicability, but that it was necessary to use the appropriate technology. In common with other museums the Science Museum visitor profile is heavily skewed towards social groups A/B and C1. These new technologies, particularly cable, may have some applicability to reaching groups C2 D and E who make the most use of this medium at the moment.

Virtual tours were found to be potentially of great use in providing for those who are unable to visit the Museum, and in providing a means where several related but geographically dispersed collections can be brought together. This was judged to be an area where further investigation is required.

In addition to defining the conceptual structure of museum information the case studies have also served to emphasise that the traditional model of a single text database, or optionally a text database with linked images, is no longer adequate. There are likely to be several linked databases of museum information, which will include still and moving images, together with sound, and whole applications environments to aid navigation on the museum or to provide virtual tours.

Physical access to this information is now possible in a variety of different ways. The second case study reviewed the variety of different types of terminal for use in a museum, and the options for external access discussed above. Internally these included large data displays, touch screen kiosks and keyboard driven interfaces. Each has different characteristics and is suited to different audiences.

In the Science Museum we found that having a strategic data infrastructure already in place would greatly facilitated these developments, by both providing internal communications and external connections. To install afresh would be very costly, and difficult to justify for any individual project. A strategic view is necessary for such large scale infrastructure developments.

A further aspect to be pursued in the Science Museum case study was the option for "added value" applications to take advantage of the main purposes of a particular service. For instance many of the systems provide the opportunity to serve the main groups of visitors, but also to provide for those with language difficulties or disabilities. Many also present options for selling or booking the Museums services, goods and events, thus maximising the use of these facilities and where appropriate generating revenue.

The main results to come from this research are firstly the body of information about the design and operation of the systems involved, which provides a valuable resource to anyone working in this area. Secondly a coherent logical structure for museum information is presented, providing in parallel for both curatorial and visitor requirements. Collections management requirements based on the MDA and *SPECTRUM* standards are tested in full, and a model for visitor information is proposed. The full potential of modern technology is assessed for visitor information. The research presented here also poses a number of questions and makes suggestions for where further investigation is required. Particularly in the area of visitor information it is hoped that the findings presented here can form the basis of more in-depth studies of visitor needs, and the foundation for the type of systems which museums must have in order to serve their ever more discerning publics.

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A1 RESULTS OF SURVEY OF EXISTING ARC RECORDS

1 Objects

Items range from a single artifact to a large and complex item, such as the Brigg raft. They relate to all areas of the departments interests, including a large selection of ethnographic material. These items have all been either acquired by, or loaned to, the museum. There are approximately 1000 objects.

Documentation consists of an A4 card (for almost all objects). In addition some Objects have an information file, and some have museum acquisition slips. Objects which have been formally acquired or loaned in have a museum file (series X or Y). There is a list of loans in, but it is not complete. There are established procedures, described in the departmental memos, for the documentation of objects.

Object documentation has an acquisition number consisting of the departmental code (ARC), the year, and the number of the acquisition within the year. In addition loans are suffixed with an L (eg ARC1979-1, ARC1977-13L). Some objects have the number marked on or attached to it.

Objects are cross referenced to all other sources of information.

2 Slides

There are 3000 photographic transparencies relating to the work of the archaeological research centre.

Writing on the mount will generally include the subject matter, and the museum negative number, if applicable. There is no accompanying documentation.

Slides are not numbered.

Cross referencing of slides is to information files, and to the negative number if applicable. They may also be cross referenced to sample records and conservation records.

3 Drawings

This material includes drawings, maps, dyelines, photographic prints and other similar items.

There are 1000 items.

Documentation consists of a card index arranged by subject and storage location.

The items are numbered with the storage location, and sequentially within that location. This number consists of a letter followed by a number.

These items are cross referenced to information files, and to negative numbers for photographs.

4 Information files

These dossiers are kept on a variety of subject, ranging from objects in the collection, to conservation matters, to boat finds elsewhere. There are 1000 information files.

There is no accompanying documentation.

Files relating to logboats are numbered according to McGrail's (1978) publication.

Little cross referencing to other types of information, but much cross referencing to these.

5 Sample records

Information concerning samples which have been obtained for some form of analysis (eg identification, C14 dating, etc.). It is not usual for the sample to be retained after the analysis has been undertaken. There are approximately 1000 sample records.

Sample records consist of a log of numbers issued, with a brief description, and the sample record form which is an A4 card. There are established procedures for the documentation of samples.

Samples are numbered with the letter S, followed by a number. Numbers are arranged in blocks for various sites etc.

Samples are cross referenced to information files, conservation records, other samples, contexts, and photographic negatives.

6 Conservation records

Conservation records describe the processes used for objects undergoing conservation. There are 2000 conservation records.

Conservation records consist of a log of numbers used with a brief description, an A4 record card, and an information file where applicable. There are established procedures for completing conservation records.

Conservation records are numbered with a letter C, followed by a number.

Conservation records are cross referenced to objects, information files, sample records, and photographic negatives.

7 Contexts

These are records describing archaeological strata encountered during excavations. There are approximately 100 of these records.

Context records consist of an A4 card.

Context records are numbered sequentially within each excavation.

Context records are cross referenced to objects, information files, and sample records.

8 Photographic negative records

These are negatives held by the museums central negative store. About 1500 negatives are documented in the archaeological research centre.

Documentation consists of a card index arranged by subject, and negative number. A register of negative numbers and subject is held by the NMM negative store; there is a PETREL project to computerise this register.

The negatives are numbered according to the museum system, this consists of a number (up to four figures) for the film, with a / and letter or number for the frame. After the first 9999 they are preceded by an A, and so on.

Negatives are cross referenced to information files.

9 Bibliographic references

Author and subject card indexes to the bibliographic holdings in the department, and author and subject indexes to material not held in the museum.

These are books, offprints and periodicals held in the archaeological research centre. There are approximately 1500 in all.

Documentation consists of a card index arranged by author, and also by subject. This is split between the laboratory, where some items are kept, and the library. There is also a card index to maritime publications which are not held by the museum. There is also a PETREL project to computerise the NMM library catalogue; all the items in the ARC library have been formally accessed to the NMM Library. A location number (shelf number) is recorded on the card.

There is cross referencing to information files.

10 Radiocarbon dates

There is a card index of C14 dates, many of them gleaned from the pages of Radiocarbon.

There are a little under 500 dates recorded in this way.

The index is arranged by date, and subject.

Dates are not numbered.

Dates are cross referenced to information files.

A2 ARC DOCUMENTATION REPORT (FEBRUARY 1981)

Archaeological Research Centre, National Maritime Museum, Greenwich. Information Storage and Retrieval - a possible outline for future work 2/2/81

The work of the Information Archaeologist in the ARC can broadly be divided into two areas:

i) The physical arrangement of all sources of information.

ii) The indexing and cross referencing of this information.

Additionally, and in conjunction with this work in the ARC is the organisation of information derived from excavation by the ARC. This includes the methods of collecting and recording information on site, its processing whilst in the field, and its absorbtion into the main ARC and NMM information retrieval system after returning from the field.

This document attempts to define the aims in each particular area, and to outline a possible way of achieving this. It also attempts to define approximate periods of time which each stage should require for completion, and to suggest what equipment should be purchased.

The author is engaged in part time research at the Institute of Archaeology, London, and the section on Excavation recording constitutes an outline of this proposed research.

Appended to this outline is a summary of information in the ARC, the numbering system in use in the ARC, and a proposed timetable for this work.

Ben Booth

Physical Storage of Information in the ARC

Aims: i) To enable any item to be rapidly found after it has been located in an Index or Catalogue.

ii) Wherever possible items relating to each other (for instance items documenting a single find) should be kept together.

iii) To minimise storage requirements, and to aid rapid retrieval, items of similar physical dimensions and character should be kept together.

iv) Wherever possible information should be kept together, rather than being scattered about.

v) The best use should be made of available space and facilities.

Detailed arrangements:

Drawings, maps etc. (At present stored in Plan chests).

At present there are various sorts of information stored in the plan chests; these vary from size AOO drawings to 10" by 8" photographs. It is proposed that these are stored as follows;

Oversized drawings and maps (larger than AO)	Plan chests
Drawings and Maps	Vertical plan file
Large photographs	Together, perhaps in a drawer of the plan chest.
Artwork mounted on card	Shelved in the drawing office
Small items (A4 or foolscap)	In the appropriate research file
Miscellaneous items	In the plan chests

Slides

Stored in the slide cabinets. As we have two copies of each slide they can be stored as follows:

i) Arranged thematically (as at present)

ii) Arranged sequentially by negative number

Photographs

At least one print of each negative to be stored sequentially in order of negative number in a filing cabinet. Prints too large for this to be stored sequentially in order of negative number in a drawer of the plan chest.

Bibliographic

Books; stored by subject, and alphabetically within each subject - most to be in Room 6, but those required frequently there to be kept in the Drawing Office.
Periodicals; As books, but space will not at present permit all archaeological journals to be kept in Room 6.
Xerox and ephemera; The present complex system to be abandoned - stored arranged alphabetically by author, or title where there is no author cited.

Research Files

To contain all material of A4 or Foolscap size, excluding items above. Where a Xerox applies to one research file the Xerox may be kept in that file rather than with the other Xeroxes (possibly a copy with the other Xeroxes).

Conservation Records

To be kept (as now) in sequential order, but a copy of photographs to be kept sequentially in the file of archaeological photographs.

Sample Records

As conservation

Acquisitions

Acquisition records should be kept sequentially as they are now, but more careful control over the precise whereabouts of the objects should be maintained.

Time scheme

The physical arrangement of information should proceed with the indexing and cross referencing by Petrel. Both should be finished by December 1982 (See Appendix III).

Indexing and cross referencing

Aims:

i) To facilitate the day to day retrieval of material in a simple fashion; for instance a specific document or photograph might be required.

ii) To enable the information system as a whole to be used as a research tool; for instance it should be possible to retrieve all references to a particular phenomenon.

Our present system is able to accommodate (i) above (although it is rather incomplete in some areas), but it is not able to do (ii) because;

i) There is not much cross referencing.

ii) Indexing is poor or non existent.

Project Petrel is able to accomplish these tasks; it is able to provide the following;

i) Catalogue: A complete listing of the contents of one file; for instance all the research files, or all the drawings.

ii) Indexes to these catalogues.

iii) Cross referencing between these catalogues.

The following is an outline of the catalogues, cross referencing and indexing which might be required. (Additionally the increased use of microcomputers will make it possible to retrieve information in response to demands not catered for by these indexes).

Research files

Catalogue:	arranged alphabetically by file name
Indexing:	place time Identification of object/site
Cross referencing:	drawings slides photographs conservation files sample files acquisitions bibliographic museum files

Drawings

These are essentially a sub-group of research files, which are too large to be stored in a foolscap folder. However a catalogue and index might be useful.

Catalogue:	arranged by drawing number (See appendix II)
Indexing:	research file/subject storage location of drawing
Cross referencing:	research files conservation/samples (where applicable) photographs (of drawings)

Slides/Photographs

Catalogue:	arranged by negative number
Indexing:	research file subject
Cross referencing:	research file conservation file sample file acquisitions drawings (photographed)

Conservation files

Catalogue:	arranged by conservation number
Indexing:	research file acquisition material of object type of treatment storage location of object identification of object
Cross referencing:	samples museum files research files photographs drawings acquisition

Sample files

Catalogue:	arranged by sample number
Indexing:	research file material type of analysis acquisition storage location identification of sample
Cross referencing:	conservation file museum file research file photographs drawings acquisitions

Acquisition file

Catalogue:	arranged by acquisition number
Indexing:	by storage location of object by place time identification
Cross referencing:	drawings slides/photographs conservation files sample files research file museum file bibliographic

Bibliographic

Catalogue:	author/title
Indexing:	author keywords storage location
Cross referencing	research files acquisitions

Time scheme

Indexing, cataloguing and cross referencing information should be done at the same time as organising the physical arrangement of information. Both should be finished by December 1982. (See appendix III).

Information from excavation

Aims:

i) Collection of as complete a record as is practical.
ii) Improving methods of data collection on site.
iii) To allow decisions on site to be aided by a readily available summary of the information gathered so far.
iv) To facilitate the rapid production of an indexed catalogue of what was found (stratigraphic, artifactual and so forth) - Level III.
v) To aid the interpretation of the excavation - Level IV.
vi) To produce information formatted so that it can be assimilated into the information system in the ARC.
vii) To aid the rapid dissemination of information.

Areas to be investigated:

i) Types of data to be collected.
ii) Best means of collecting this in the field.
iii) Means of storing and retrieving this data whilst in the field.
iv) Means of storing and retrieving this data in the ARC (within the already available information system).
v) Production of data in a usable form.
vi) Extraction of salient information.
vii) Means of making the data available to others.

Equipment

Whilst the equipment available in NMM is quite adequate for our needs in the ARC at the moment, it is clear that the collection of data on an excavation will require some computing facilities to be available adjacent to the site. It is also possible that data might be entered directly from the excavation, thus removing the need to fill in forms which are then transcribed later.

Equipment for use on an excavation might include;

Microcomputer
Visual display unit
Floppy disk storage
Printer

Devices for data entry to the computer might be desirable, but it is not possible to say how best this might be achieved without further research.

Appendix I: Summary of information held in the ARC

Acquisitions	A file containing basic information on the origin, type, and storage location of the object.
Drawings etc	Drawings, maps, pasted up artwork, large photographs and other material which cannot be fitted into a foolscap folder.
Slides	Slides arranged by subject, with a duplicate set which could be ordered by negative number.
Photographs	Mostly 10" by 8", stored in a variety of locations. Also some large stored with the drawings.
Bibliographic	Books, journals and Xerox of small articles.
Research files	Files on a wide range of subjects, stored variously at the moment.
Conservation records	A single sequence of forms, sometimes with photographs and drawings attached.
Sample files	As conservation (above).

Appendix II:	Numbering systems of information in the ARC
Acquisitions	Departmental code, year and item number within that year. (eg ARC 1981/3).
Drawings etc.	A letter, followed by a number, (eg N94) - numbers are unique for that letter.
Slides	Most numbered with museum negative number, others (colour slides, and slides obtained from elsewhere) are unnumbered.
Photographs	Most numbered with museum negative number, others unnumbered.
Bibliographic	Books are numbered with the museum catalogue number, and with a single number to indicate the location (usually a shelf number). Within this location books are arranged alphabetically by author. Journals do not have a location code, but this would be useful. Xerox have a location code like books. (Locations each have a unique number, at present from 1 to 28).
Research files	Two series, both arranged alphabetically - plank boats, and log boats; the logboats are also numbered, in a single series.
Conservation records	A single series of numbers, preceded by C.
Sample records	A single series of numbers preceded by S.

Appendix III: Time Scheme

ARC

Both organisation of information in the ARC, and the indexing and cataloguing of this information to be complete by the end of 1982. Suggested order (earliest first) for this work is:

- Acquisitions (already in progress)
- Drawings
- Photographs
- Slides
- Research files
- Bibliographic
- Conservation records
- Sample records

Excavation

Research into types of information to be collected, means of collecting this, and useful ways of analyzing this information to continue from now on. We should attempt to operate a prototype system in the field in the summer of 1983. Work on the computing aspects to start towards the end of 1982 using the NMM microcomputer - ARC should have its own hardware by the summer of 1983.

Timetable:

Research into information to record	Early 1981 - late 1982
Research into analysis of information	"
Research into means of recording information	"
Development of on-site computer system	Late 1982 - Summer 1983
Field trials	Summer 1983

Information retrieval within ARC

The ARC is a research body, holding approximately 10,000 items of information, which are continuously being added to. It is essential for the proper functioning of ARC that this information is accessible; and it is the principal concern of the Information Archaeologist that an information retrieval system is designed and implemented within ARC.

Aims

The system as devised will encompass three spheres (see Annex A for detailed breakdown of what is involved). These are:

i) Cataloguing and indexing of information within ARC.

ii) Collection of data for fieldwork, and integrating it with (i) above.

iii) Quantitative analysis of information.

Item (i) must have at least passed the design stage before either (ii) or (iii) can be attempted.

Methods

Where there has already been useful work done the ARC information retrieval system will incorporate this work. In particular this includes the work of the MDA, and Project PETREL within NMM. However in some cases it will be necessary for the ARC to undertake research into information retrieval, where little work has been done by other bodies. As one of the foremost bodies engaged in information retrieval work for archaeology the ARC will have to be conversant with what other work is going on in this field; and in most cases this will involve visiting other bodies engaged in similar work, and receiving visitors from other bodies.

Because of the ARC involvement in fieldwork in remote locations, and of the expected move of ARC to a new location, the ARC should develop an independent computing capability. This will involve a powerful microcomputer capable of performing routine operations, a link with the University of Cambridge computer for exceptionally large operations, and provision of hand-held microcomputers for data collection in the field.

Timetable

After one years work it is possible to estimate the amount of time required for the design and implementation of the system. We should have the system designed, and all our present information catalogued before any projected move of ARC. The earliest projected date for this (?1984) should be our target for completion. It is intended that the system will be extended for fieldwork. All the design work for part (i) above must be completed before any fieldwork application is attempted. We should aim to have a prototype system in the field by the summer of 1983.

Annex B outlines the amount of time required. At the present rate of progress it is unlikely that parts (i) and (ii) above will be completed by 1990. This is clearly unsatisfactory, and resources should be reallocated to meet the target of 1984. Annex C describes how this might be achieved. Annex D shows a suggested timetable.

Conclusion

ARC requires an effective information system for its proper functioning as a body engaged in research into the archaeology of boats, and their conservation. This system should be operational for use in the field by 1983, and work should be completed before the ARC moves to its new location. This work should be made a high priority, as the future effectiveness of ARC depends on it.

B.K.W.Booth
29.1.82

Annex A

Detailed Programme

i) Cataloguing and indexing of information within ARC

a) Develop a thesaurus of terminology

b) Set up the following projects:
   - Objects (done)
   - Slides
   - Drawings
   - Photographs
   - Information (research) files
   - Samples
   - Conservation
   - Bibliographic

each project requires the development of computerised formats; procedures for documentation, labelling, and storage; and the production of a catalogue and indices (by subject, storage location, etc).

ii) Collection of data from fieldwork

This will involve the design of recording media (forms, on-site computer, etc.) methods for rapid analysis and presentation of data on site; and integration within the main system in ARC.

iii) Quantitative analysis of information

Research into appropriate techniques of analysis; means of processing our data with already developed packages, and for developing our own analytical packages where there are no suitable ones available.

Annex B

Time required

i) Cataloguing and indexing of information within ARC

	Developing thesaurus	4 weeks
Setting up projects:	Objects (mostly done)	1 week
	Slides	3 weeks
	Drawings	3 weeks
	Photographs	3 weeks
	Information (research files)	3 weeks
	Samples	3 weeks
	Conservation	3 weeks
	Bibliographic	4 weeks
	Total	27 weeks

ii) Collection of data from fieldwork

This will involve the following:

Design of format
Setting up of computer system
On-site analysis
Post-excavation analysis
Integration within ARC system

50 weeks

iii) Quantitative analysis of information

Without being more precise about what is required it is difficult to make a meaningful estimate. It could vary from several weeks for simple statistics, to full time work for a statistician.

iv) Incorporating backlog of data into system

It is calculated that typing in, checking, and editing of records can be achieved at a rate of about 250 per week (if it is done by an unskilled typist ie the Information Archaeologist).

Objects	450 records	done
Slides	3000 records	12 weeks
Drawings	1000 records	4 weeks
Photographs	1500 records	6 weeks
Info. files	1000 records	4 weeks
Samples	1000 records	4 weeks
Conservation	2000 records	8 weeks
Bibliographic	1500 records	6 weeks
Total		44 weeks

Annex C

Suggested reallocation of resources

In order for the information retrieval system to be designed and implemented within the time scale suggested the following measures should be taken.

1) Increase time spent by Information Archaeologist on this work from the present 20 percent to c 40 - 50 percent. This could be achieved by reducing the amount of non-information administrative work undertaken by the information archaeologist, and some minor reductions in the administrative work associated with information retrieval.

2) Half of the development of the system for the collection of data from fieldwork to be done in the Information Archaeologist's own time as part of his research at the Institute of Archaeology. This would represent a saving in time of 6 months; but for the Information Archaeologist to direct his research to this end the basic system in ARC must have been already designed. This research intends to undertake trials in the field in 1983, and therefore the internal system in ARC must have been designed by this date.

3) Majority of backlog of data preparation for slides, drawings, photographs, Information files to be farmed out to MDA. This would represent a saving of 6 months time at a cost of c £2000.

4) A member of archaeological conservation staff be trained to type up and edit conservation and sample records. This would save about 3 months time.

Annex D

Suggested timetable

1982 - early 1983	Design system for information in ARC
1983 - 1984	Design system for fieldwork
1984	Begin work on quantitative analysis

****

DOCUMENTATION OF OBJECTS IN THE ARC - MANUAL 26 30.12.81

Contents

2.0 Procedure for Acquisitions and Loans in

The museum procedure for acquisitions is set out in PM 13/76, and for loans in PM 25/76. These procedures are summarised below.

2.1 Acquisition procedure

1. In consultation with Dr. McGrail's secretary open a V file
2. Follow the action on the sheet attached to the file
3. H.O.D. complete NMM 37 (Request for approval for purchase)
4. On receipt of object relevant curatorial staff check its condition
5. H.O.D. returns V file to registry via financial office with two copies of NMM 35
6. Registry returns file (now X) to H.O.D. who will draft letter of thanks (for gift)
7. Complete form NMM35 - Master record of acquisitions, send to registry with X file.
8. Curatorial staff, with information archaeologist, complete documentation

2.2 Loans in Procedure

1. In consultation with Dr. McGrail's secretary open Y file
2. Follow the action on the sheet attached to the file
3. H.O.D. to write to potential lender with form NMM 2a
4. H.O.D. completes three copies NMM 2a, two to lendee, one to file
5. If value is over £3000 H.O.D. to send NMM 2 to DD and D
6. Complete form NMM35 - Master record of acquisitions, and send to registry with Y file.
7. Relevant curator and information archaeologist complete documentation

3.0 Documentation procedure

At present the object documentation consists of form NMM35 (Master record of acquisitions), and the ARC Acquisition card, to which is attached a photograph of the object. Project PETREL will mean that the main object record is held in the computer, and will be available in the form of a catalogue and indices. In addition there will be the object photo and Location form; this form will have attached to it a photograph of the object, and movement of the object, and the annual muster of objects may be recorded on this form. The item master record card is completed at this time when the object is first acquired. It is a means of formalising the collection of data concerning the object, and is a temporary record of the object before the data concerning it has been computerised. Once the data has been put onto the computer the computer record should always be consulted, there is no need to retain the item master record once the data has been put onto the computer and checked.

The following steps should be taken to document the object:

1. Mark the object with its item number, and any other appropriate numbers
2. Fill in the item master record card
3. Fill in the item photograph and location form
4. Open an information file for the object (if one does not already exist).

4.0 Numbering of objects

The acquisition/loan may consist of one or several objects. For instance this might be a model boat, or several finds form an excavation. As well as the acquisition number, which refers to the transactions of the acquisition, each object has an item number.

4.1 Acquisition number

The acquisition number consists of the year of acquisition, the departmental code, and the number of the acquisition in that year. It is followed by an 'L' if it is a loan. The acquisition will receive the next number in the year. There should be a '-' between the year and the number, and the 'L' for loan is written after the number.

Example

ARC1980-5L
ARC1979-36

4.2 Item number

Each individual object has an item number. The item number consists of a letter, followed by a number. Quoted in its full form it is preceded by AO to show it refers to an Archaeological Object, and NMM.

Example

NMM AO A9674

For the moment the objects are numbered in a single series preceded by A. The information archaeologist keeps an up to date list of these numbers.

4.3 Marking of numbers

Acquired objects should be permanently marked with the item number. If the object has easily detached pieces each of them should be marked individually. The Senior Archaeological Conservator will advise on permanent numbering of objects.

Acquired objects and loaned objects should carry a label where it can be easily seen. This label must be securely fastened but detachable. As well as the Item number the label should be marked with the acquisition number, Conservation number and any previous numbers which might be useful in identifying the object. Printed labels suitable for this purpose can be obtained from the Information Archaeologist.

5.0 Item master record cards

5.1 Information to be recorded about the object

The bulk of the information about the object will be contained in the Information file; the Item master record should thoroughly document the acquisition of the object, and provide a cross reference to other sources of information.

The curator responsible for the object should discuss what to record with the Information archaeologist, so as to provide an adequate record without needless duplication.

Part 2 of this manual contains information on what can be recorded. This is summarised below.

5.2 Summary of information which can be recorded

Identification:	type of object, unique name, status
Find location:	where, when, by whom, how
Production:	process, by whom, where, when
Original (models etc.):	type, unique name, date, where made, by whom made
Physical description:	part, description, dimensions, condition
Inscription:	text, how inscribed, where inscribed
Transfer:	type, when, files, by whom, location
Acquisition:	from whom, when, acquisition number, files, how
Reference:	all types of reference to object
Location:	when moved, where, why
Association:	type of association, associated item, associated person
Reproduction:	reference number, type of reproduction
Use:	type, by whom, where, when, notes
Exhibition:	title, place and dates of exhibition, number in exhibition, reference to catalogue
Notes:	

5.3 Filling in the item master record cards

Wherever possible the item master record card should contain information on the following:

- Identification
- Find location
- Production
- Transfer
- Acquisition
- Reference
- Museum location
- Reproduction

The card should always have a photograph of the object attached to it. The information on the card will be transferred to the computer by the information archaeologist.

6.0 Item photograph and location card

This card has attached to it a photograph of the object, a brief description , and information about the movement of the object and the annual muster of objects.

6.1 Filling in the item photograph and location card

The card should have a photograph of the object attached to it, which would enable the object to be identified. Additionally the card should have a description of the object (duplicating that on the Item master record card), and the location of the object.

6.2 Location of objects

An items location should be recorded on the item photograph and location card. The location should be abbreviated according to the list at 21.0 below, and should enable the object to be located within a few minutes. 'K' is not adequate, But 'KS1 Bay 14' is.

6.3 Movement of objects

If an object is moved the Information Archaeologist should be informed of its new location so that the record can be updated. If an object is moved to be conserved the Information Archaeologist should be told that it has gone to be conserved, after which the responsibility for its location rests with the conservators. When it has been conserved and is returned to storage or display the Information Archaeologist should be informed of its location.

7.0 Updating the record

Alterations to the record (such as the movement of the object, or the discovery of new information) should be given to the Information Archaeologist in writing. Alterations to the computer record will be made when there is sufficient new information to make it worthwhile. In the meantime new information on an object will be written onto the printout of the catalogue, except for new locations which will be found on the Item photograph and location card.

Part 2: Formats for computer input of master records of objects in ARC

10.0 Scope of record

Each record contains data on an object held by the ARC. Such objects have either been acquired by, or loaned to the museum. An object may be a boat, model, archaeological material, drawing, etc.

The record type is 'O'

11.0 Summary of statements

i	- identification	
hf	- find	how and where the object was found
hm	- production	its manufacture
hi	- original	if the object is a copy or model
dc	- description	what its made of etc.
dk	- inscription	inscriptions on the object
hq	- acquisition	by NMM
ht	- transfer	of ownership or custody
n	- reference	books, files etc.
hl	- museum location	in NMM
hs	- association	associated with the object in the past
pr	- reproduction	negatives, slides etc.
hu	- use	what it was used for
hx	- exhibition	exhibition of the object
z	- notes	

Note: In the examples below spaces are inserted between the data and tags to aid readability. When entering data the spaces should be omitted.

For names, places, references and time you should refer to sections 30.0, 31.0, 32.0 and 33.0.

There is an example complete record at 35.0.

12.0 Identification statement <s i

This is used to give the general type of the object and its unique name, if any. The identification may have more than one term of equal weight, eg <d brick <d tile. It may also be hierarchical, eg <d boat # canoe # oru. Status is used if the object is not the original, eg for a model or replica. Unique name is used where the object has a name by which it is known, eg Brigg raft.

<d - identification
<d $0u - unique name
<d $0s - status
<d z - note

Example:

<s i <d boat # canoe # oru <d $0u Prince Charles' Oru
<d $0s model

13.0 Find statement <s hf

This is used to say where the object was found, and how. It can also be used to give the date an object was excavated, and the name of the excavator.

```
<c      - where found
<t      - when found
<p,o,f - person organisation or firm involved
<d      - how found (eg excavation, gravel extraction)
<r      - reference to finding of the object
<z      - note
```

Example

```
<s hf <c Brigg # Lincolnshire $g NG $b TU $c 1134 $d 5478
      <t 1887  <p Thropp, J  <d clay digging
      <r $pThropp, J $t 1887 $w Ancient raft found at Brigg
      <z first discovered, re-excavated by McGrail in 1974
```

14.0 Production statement <s hm

This is used for the manufacture or creation of the item. Activity is only used where something other than 'built' or 'made' is involved. Similarly 'builder' or 'maker' is assumed for person.

```
<a      - part (if more than 1)
<d      - activity
<p,o,f - person organisation or firm involved
<c      - where produced
<t      - date produced
<m rc  - date produced in radiocarbon years
<r      - reference about production of item
<z      - note
```

A separate sub-statement should be used for each part, and a separate sub-statement for each stage of production of each part.

Example

```
<s hm <d designed  <o Corys Bargeworks
      <c Charlton # London  <t 1973
      <r $rNMM file $k A1/4/16
      <z to specification by E McKee
```

15.0 Original statement <s hi

This is used when the object described in the record (and therefore held by NMM) is a model, replica, fake etc. It gives details of the original. Do not try to enter more than a summary as full details of the original will be held in the appropriate information file, or in the object record if NMM holds the original.

```
<d      - identification of original
<d $0u - unique name of original
<t      - date of original
<m rc  - radiocarbon date for original
<c      - where original was manufactured or found
<p,o,f - person involved, and role
<x i   - item number of original
<r      - reference to original
<z      - note
```

Example

```
<s hi <d boat # raft <d $0u Brigg raft <t $a Bronze age
     <m rc 680 bc $z+-100, Q1199 <c Brigg # Lincolnshire
     <x iAO A132
```

16.0 Physical description statement <s dc

This statement is used to describe the object and its component parts. It is capable of being structured to record complex descriptions, but it should be kept simple at the moment. Do not use the <a to identify an object, this is only used when the object has several parts, each of which will be described in a separate statement.

```
<a      - part being described
<d      - descriptive words
<m      - dimensions
<d c    - condition
<z      - note
```

The dimension component may be followed by l (length), w (width), or h (height). Additionally any other terms (eg surface area, scale, depth etc.) may be used. A separate statement must be used for each part being described.

Example

```
<s dc <a plank  <d material # wood # oak  <m weight 27.4kg
     <m 155cm  <d c # gribbled
```

17.0 Inscription statement <s dk

This is used to describe a piece of text on the object, or perhaps a label associated with it. The <a should be used to indicate the general location of the inscription (eg base, plate, etc.) with any detail in the note.

```
<i      - the text
<d      - mark (hallmarks, collectors marks etc.)
<d      - method (labelled, etched etc.)
<d      - materials (ink, paint, etc.)
<m      - dimension of inscription
<a      - part where inscription is
<z      - note
```

Example

```
<s dk <i BACINUS M  <d stamped  <m l 18mm  <m h 7mm
     <a base
```

18.0 Transfer statement <s ht

This is used for transfers before the object was acquired by NMM, for transfers between departments in NMM, and for loans and disposals by NMM. Activity is assumed to be assumed to be transfer, but loan, sale etc. may be used when appropriate. A sub-statement is used for the old owner and for the new owner.

```
<d       - activity (loan, sale etc.)
          $z length of temporary loan
<t       - date of transfer
<r       - museum file referring to transfer
<p,o,f - person and role (not 'owner')
<c       - location of transfer
<z       - note


<s 1 <htp - substatement for previous owner
<s 1 <htn - substatement for new owner

<p,o,f  - owner
<c        - location of item
```

Where there are several transfers it is not necessary to duplicate information on ownership and location. The 'new owner' in the first transfer is assumed to be the 'old owner' in the second transfer and so forth.

Example

```
<s ht <d sale  <t 1936  <f Sothebys  <c London # England
<s1 <htp  <p Brown, S  <c Banbury # Oxfordshire # England
<s1 <htn  <p Jones, H J  <c Devizes # Wiltshire # England

<s ht <t 1946  <htn  <p Teague, C I T
      <c Wallamalloo # Australia
```

19.0 Acquisition statement <s hq

This statement refers to acquisitions by NMM, but not to transfers to ARC if the museum first acquired the object through another department. It is a special case of the ht statement where the new organisation acquiring custody is known to be NMM. <p is therefore used for the previous owner, thus saving a statement.

```
<p,o,f - previous owner
<t       - date of acquisition
<x a     - acquisition number
<r       - museum file referring to acquisition
<d       - method of acquisition (eg purchase, loan, gift)
          $z length of loan
<m       - price or value ('@s' is used for the pound sign)
<z       - note
```

Example

```
<s hq <o Lincoln Museum  <t Dec 1972  <x aARC1972-1L
      <r $r NMM file $k A1/14/6
      <d loan $z 2 years  <m @s 400
```

20.0 Reference statement <s n

```
<r   - items not formally numbered (see Format for references)
<x   - items with NMM numbers
```

This is used to refer to other sources of information. <r is used to refer to documents without a formal numbering system, <x is used to refer to those with NMM numbers.

```
<r      - items not formally numbered
```

Example

```
<s n  <r $p McGrail, S $t 1975
       $w The Brigg Raft re-excavated
       $r Lincolnshire History and Archaeology
       $k 10 $n 5-13
```

A complete list of subtags for bibliographic references is to be found at 32.0 below - format for references.

<x - items with NMM numbers

Items in the ARC with item numbers are preceded by 'A' to show that they are ARC numbers. This is followed by a letter to show what type of item it is. The present range of types is:

Conservation	- AC
Drawings	- AD
Information files	- AI
Negatives (not NMM)	- AN
Objects	- AO
Prints (photo)	- AP
Samples	- AS
Transparencies	- AT

Examples

```
<x i AD F44
<x i AC C4967
```

21.0 Museum location statement <s hl

This records where the object is currently located, and where it has been located in the past.

<t	- when at location
<x l	- location (see list below)
<c	- place located if outside NMM
<d	- reason for being there
<z	- note

A code is used to indicate which room the object is kept in. This is followed by the precise location. The location code is preceded by 'l' to avoid confusion with other types of number.

The present list of codes is:

Feathers place	
Chief Archaeologists Office	- FCAO
Room 6	- FR6
Corridor	- FC
Dark Room	- FDR
Lab	- FL
Drawing Office	- FDO
Tank Room	- FTR
Secretaries Office	- FSO
Room 4	- FR4
Yard	- FY
Unspecified	- F

Kidbrooke
Spur 10A - KS10A
Spur 10B - KS10B
Spur 1 - KS1
Boat store - KBS
Unspecified - K

For locations not in the list above, use an appropriate name until a complete list of codes for the museum is available.

Example

<s hl <t 19 Mar 1980 <x 1 FC <d storage
<s hl <t Jul 1980 <x 1 FL Box 14 <d conservation
<s hl <t 4 Apr 1981 <x 1 K <d storage

22.0 Association statement <s hs

This statement is used to indicate previous numbers which the object may have had, persons previously associated with the object, and the NMM curator responsible for the object. Previous numbers would include royal models (RM) and native craft (NC), but not acquisition numbers allotted by another department before the object was transferred to ARC. The role of person is assumed to be 'associated with'. The number is assumed to be 'old number'.

<d - type of association
<x - number (preceded by 'g' if not an NMM item number)
<p,o,f - associated person
<z - note

A separate statement is used for each association.

Example

<s hs <d Cambridge Museum acquisition number <x g XYZ15
<s hs <x b NC15
<s hs <d similar item <x iAO A1432
<s hs <d Curator responsible <p $h Medieval Archaeologist
<s hs <p Wright, E V

23.0 Reproduction statement <s pr

This is used for negative numbers, prints, etc. that illustrate the object. It is restricted to things which can be reproduced in quantities. It would include replicas on sale, but not illustrations in a book which would go in a reference statement.

<x - reference number (preceded by 'n' for NMM negatives)
<d - type of reproduction
<z - note

Several reference numbers may be contained in one reproduction statement, but separate statements should be used for reproductions which are not NMM negatives.

Permitted formats for negative numbers are:

n1345
nB1345
nB1345/c
nB1345/12

Example

<s pr <x n B1234/c <x n 1345 <x n 1986/13

24.0 Use statement <s hu

This statement is used when there is detail about how the object was used; but not for obvious uses implied by the name of the object.

<d - use
<p,o,f - by whom
<c - where used
<t - when used
<r - reference to use
<z - note

Example

<s hu <d racing <o Cambridge University Boat Club
<c Thames(River) # London # England
<t 1978 <z sank at Barnes

25.0 Exhibition statement <s hx

This statement is used for any exhibition in which the object was shown.

<d $0u - title of exhibition
<c - place of exhibition
<p,o,f - person involved and role
<t - date of exhibition
<x g - number in exhibition
<r - reference to catalogue
<z - note

Example

<s hx <d $0u Maritime Archaeology 1950-1980
<c Greenwich # London <o National Maritime Museum
<t 1982 <x g 134

26.0 Note statement <s z

This statement is used for long notes which would not fit in elsewhere.

<z - note

Example

<s z <z This tedious chunk of text would be inappropriate anywhere else

30.0 Format for names of people, organisations and firms

A full description of these formats is contained in Manual 23. Personal names should be kept as simple as possible. Normally only surname and forenames or initials need be given. Initials should be separated by spaces and not full stops. The address may be added as a detail.

Example

<p jones, A B $z Chasey Road, Caversham, Reading, Berkshire

Titles and ranks should be tagged with a '$d', but 'Sir' and 'Mrs' are left untagged and are inserted before the forenames.

Example

<p Waterhouse, Sir Frederick
<p Bellasis, O $d Commander

Organisations can be used to indicate 'culture' or 'tribe'.

31.0 Format for places

Places are normally written as a sequence of names, starting with the smallest, and working up to the largest. If necessary the type of place may be indicated after the name. It is usual to omit the UK from locations in the UK, and for all other places the country should be included.

Example

<c Ribble (river) # Lancashire
<c Wallamaloo # New South Wales # Australia

Grid references may be included in the same statement as place names.

Example

<c Brigg # Lincolnshire $g NG $b TU $c 1425 $d6478

Further information on formats for places may be found in Manual 13, 7.0.

32.0 Format for references

All the data must be given subtags (see list below). Data following $p up until a $p, $w, $t, or $r is treated as being pertinent to the author, provided that this is noted the subtags may be in any order. Further information on the format for bibliographic references may be found in the Library Manual - 02.

Example

<r $p McGrail, S $t 1975 $w The Brigg raft re-excavated
$r Lincolnshire History and Archaeology $k 10 $n 5-13

The reference component may also be sued to refer to museum files.

Example

<r $r NMM file $k Y81/015 $z loan of canoe

The following subtags are available:

$p - author
$t - date
$w - title of book or article
$r - journal
$e - additions to title
$k - volume number or part in series
$l - issue or part number of journals
$m - identification of issue or part
$n - detailed reference to page, plates, etc
$f - edition
$b - place of publication
$c - publishers name
$g - pagination
$i - description
$u - ISBN
$j - price
$z - note

33.0 Format for time

33.1 Calendar dates

Calendar dates should be written in the form:

day month year

Day, or Day and Month may be left out. The month should be written as a three letter code, and the elements of the date should be separated by spaces. The first two digits must not be left out. Doubt may be indicated by 'ca' or '?'.

Example

```
<t 20 Jan 1980
<t Jan 1980
<t 1980
<t 0980
<t ca1937
<t 1937 ?
```

Detail may be added after the whole component.

Example

```
<t 1856 $z before
```

BC dates should be preceded by 'BC', which should come before 'ca' if this is appropriate.

Example

```
<t BC0830 ?
<t BC2000
<t BC ca1900
```

Dates derived from dendrochronology may be indicated by using the detail.

Example

```
<t 0936 $z dendro
```

33.3 Radiocarbon dates

Radiocarbon dates (bc, ad and bp) are shown with the dimensions component and detail; the detail may also be used to give the lab number. Data after the '$z' will appear exactly as it is typed.

Example

```
<m rc 1900 bc $z +-200, QU-634
<m rc 2000 bp $z +-932
<m rc 874 ad $z +-50, H-568
```

33.3 Periods of time

A range of dates may be given by separating the dates by '-'. Both dates must be either AD or BC.

Example

```
<t 1300-1400
<t BC2000-BC1100
```

Cultural periods may be used with the '$a' tag.

Example

```
<t $a Bronze age, early
<t $a Iron Age # Belgic
```

35.0 Example record

```
<co a456
<s i  <d boat # raft <d $0u Brigg raft model <d $0s model
<s hf <c Brigg # Lincolnshire $g NG $b TU $c 1324 $d 7465
      <t 1887  <p Thropp, J  <d clay digging
      <r $p Thropp, J $t 1887 $w Ancient Raft found at Brigg
      <z re-excavated by McGrail in 1974
<s hm <p Lees, J  <t 1978  <z made at NMM
<s hi <d boat # raft  <d $0u Brigg raft  <t $a Bronze age
      <m rc 680 bc $z +-100, Q1199  <c Brigg # Lincolnshire
      <x iAO A132
<s dc <d material # wood # oak  <d c # fragmented
<s dk <i Made in Hong Kong  <d stamped  <a base
<s ht <d sale  <t 1976  <c Lincoln
      <s1 <htp  <o Glanford Boat Club
      <s1 <htn  <o Lincoln Museum and Art Gallery
<s hq <o Lincoln Museum and Art Gallery  <t Dec 1978
      <x aARC1979-16L  <r $r NMM file $k Y79/17
      <d loan $z 5 years  <m @$ 200
<s n  <r $p McGrail, S $t 1975 $w The Brigg Raft re-excavated
      $r Lincolnshire History and Archaeology $k 10 $n 5-13
<s n  <x iAC A1043
<s hl <t 1979  <x l FDO  <d storage
<s hl <t 14 Mar 1980 <x l KS10  <d storage
<s hs <d curator responsible  <p $h Prehistoric Archaeologist
<s hs <d similar model  <x i AO A134
<s pr <x n B1054/c  <x n B1054/d
<s hu <d illustrating lecture  <p McGrail, S
      <c University College # London  <t 1980
<s hx <d $0u The Brigg Raft <c Lincoln Museum and Art Gallery
      <t Jun 1978
<s z  <z model exhibited by Lincoln, but model 4 preferred by NMM
*
```

State of ARC documentation at end of March 1984

1 Administration of Acquisitions and Loans

Items discussed at the previous meeting, and some newly in the Museum require the proper procedures to be carried out. Curators are aware of which these are.

2 Individual projects in ARC

2.1 Objects (Number in collection c. 1000)

Photography - some objects still require photography

Muster cards - all now have muster cards

Labelling - all except those in the gallery are now labelled

Computer record - all (except recent acquisitions) are now on the computer, and have been checked. A catalogue has been produced.

Information files - all ethnographic material now has an information file, others are patchy (see Info files, below).

Recommendations: some tidying up to do, and Information files now need to be created for the majority of objects.

2.2 Information files (number in collection c. 1500)

Inventory - numbers and names of all information files now recorded.

Computer record - has been set up, but not tested.

Recommendations:

a) The "R" series should be extended to cover all objects (not just the ethnographic ones).

b) Sites and vessels and Underwater need to be developed to comprise a Sites and Monuments record for maritime archaeology.

c) Essential information about information files (in addition to name and number) should be recorded on the computer.

d) Major archives (eg Brigg, Graveney) need to be thoroughly sorted and indexed (to Frere Level III or current equivalent).

2.3 Slides (number in collection c. 4000)

Numbering and storage - most now properly numbered and stored, new slide cabinet yet to be brought into the system.

Computer record - set up and tested. About a third of the slides are now recorded in this way.

Recommendations:

a) Locations and numbers of all to be checked and recorded.

b) For remaining two thirds minimum information should be recorded on the computer. This should comprise location, Information file number, and if time permits a note on the subject.

2.4 Drawings (Number in collection c. 1500)

Numbering and location - all (except for some Brigg in plans chest) are now properly numbered and stored.

Computer record - all now to computer, but record not checked by custodians.

Recommendations:

a) Brigg drawings to be catalogued

b) Computer record to be checked by custodians

2.5 Contexts (number recorded c. 100)

Manual record - OK

Computer record - set up but not tested

Recommendations:

Do not computerise unless a project generates a sufficient quantity to make it worthwhile.

2.6 Samples (number recorded c. 2000)

Manual documentation - complete but unchecked

Computer record - set up but not tested

Recommendations:

Transfer all to computer, checking at the same time.

2.7 Conservation (number recorded c. 3000)

Manual record - complete but unchecked

Computer record - some design work done

Recommendations:

Consider computer record when Samples record (above) has been thoroughly tested.

2.8 Photographic (number recorded c. 3000)

Manual system - card index is active, but unchecked

Computer record - this is the subject of an NMM project, and a complete catalogue for checking by departments is due soon.

Recommendations:

Continue to maintain card index until NMM catalogue is available.

2.9 Bibliographic (number in collection c. 3000)

Manual system - all books, and most xerox now recorded on card index.

Computer record - NMM system has catalogued all books except those held secretly by ARC, and a proportion of xerox.

Recommendations:

a) Locate missing xerox - there is still some theft of incoming xerox, and a considerable number of past ones are stored in information files.

b) Have all books and xerox catalogued by NMM.

c) Store books and xerox in UDC order, eliminating need for ARC staff to re-catalogue them.

2.10 Equipment (number recorded c. 2000)

Computer record - all now to computer except clothing, and SMcG's black box.

Recommendation:

Last few items to be recorded.

2.11 Overall recommendations

Within the recommendations outlined above the proper documentation of the information files should be the highest priority.

3 Statistical project

The logboats statistical project has not been started because:

a) Need for the information archaeologist to be given statistical training.

b) Lack of curatorial input to the project.

4 Programmes

The present programmes should be adequate for the foreseeable future. Some tidying up, and the addition of some "user friendly" facilities should be achieved during the course of work on my thesis.

5 Future involvement of BB

Minor tinkering will be necessary from time to time, and Dr. Cutbill has indicated that he will allow this to be done during the course of my work in the IPG.

Major new projects will have to be either undertaken as part of the work of IPG, or by BB in his own time (paid).

6 Equipment

Cromemco microcomputer facility
This is likely to be sufficient for the foreseeable future, except that the printer, which is slow and aged, will need to be replaced during the course of this financial year. Cost c. £1,000.

Epson portable micro
It appears that this machine is unlikely to be used by ARC, and I would recommend that it is transferred (loan, gift, sale) to the IPG.

7 Microfilming of archive

For security our paper records should be copied. This is discussed on the file 7.16 - Microfilming of Archive.

8 Word Processing

Bearing in mind the amount of publication produced by this department I think this would be a useful facility, although I can foresee management problems in its efficient use. This is discussed on the file 9.4 - Office Equipment.

9 Keeping all records in one place

The efficient use of the system would be greatly facilitated if (where practical) all information could be kept together. This was agreed in principal some time ago, and I would suggest that the new office in the extension would provide an opportunity for this.

10 BASIC programming language

BASIC is now available on the CROMEMCO microcomputer. It is invoked by typing BASIC. The manual for CROMEMCO 16K extended basic explains its facilities (in great detail !).

11 Responsibility with publications

Missing publications cause a considerable amount of wasted time, and the permanent retention of xerox obtained by ILL and other means (at some cost) can only be described as theft. This is a matter for all members of the department to behave in a responsible manner and follow the proper procedures.

Ben Booth
30.3.84

A6 FORM FOR POST-IMPLEMENTATION SURVEY OF ARC SYSTEM

ARC Record System - Post Implementation Survey

(Note: there is a separate form for each class of item)

1 Procedures

A set of procedures has been designed to guide the processing of items and records when they arrive in the collection, and to guide the management of the record. Are the procedures for this class of item satisfactory, and what improvements could be made ?

2 Numbering, Location Recording, Labelling and Storage

2a Numbering

Are you happy with the system of item numbers, and (where applicable) acquisition numbers. How could they be improved ?

2b Location Recording

Is the system for recording the location of items satisfactory ? How could it be improved ?

2c Labelling

Is the system used for labelling items satisfactory ? How could it be improved ?

2d Storage of items

Do you have any observations on the storage of items ? How could it be improved ?

2e Numbering etc. - General remarks

Is there anything else you would like to say about numbering, labelling and storage of items ?

3 Paper Records

3a Data Content

Does the paper record contain all the categories of data you require for this class of item ? What additional data would you like recorded in the paper record ? What could be left out ?

3b Structure

Is the structure of the paper record helpful ? (is there enough space for particular items, are they in the right part of the form, etc.) How could it be improved ?

3c Media

Is the material the paper record is made of satisfactory ? How could it be improved ?

3d Storage

How are the paper records stored ? How could this be improved ?

3e Paper Record - General remarks

Do you have any other observations to make on the paper record for this class of item ?

4 Computer Record

4a Content

Does the computer record contain all the categories of data which are required ? Are there some which are never used ?

4b Terminology control and validation

Is there sufficient automatic checking of the data as it is entered ? Are there data categories which do not have a list of permitted terms which could benefit from one ? Are there improvements which could be made to the lists of permitted terms ?

4c Size of data categories and records

Are there any data categories which require more space ? Is the space available for each whole record adequate ? Have you experienced any problems with the system accommodating the number of records you need to store ?

4d Structure

The system as it stands allows the record for an individual item to contain a number of data categories. Where the data category needs to be repeated (for instance museum negative numbers), this is achieved by entering several values separated by a comma. Is this structure adequate, or would it be desirable to have a more complex structure within records, and a more complex structure linking related records together ?

4e Outputs - Printed

What printed outputs are produced ? How useful do you find them, and how could they be improved ? Are they produced routinely, or in response to specific requirements for information ?

4f Ad-hoc Queries

Is the computer system used to produce answers to ad-hoc queries ? Please state the type of query, and try to quantify the frequency of the query.

4g Storage of Computer Output

How are the computer generated\records stored ? How could this be improved ?

4h Computerised record - General Remarks

Are there any other remarks you would like to make about the computerised record ?

5 General remarks

A7 RESULTS OF POST-IMPLEMENTATION SURVEY OF ARC SYSTEM

Objects

1 Procedures *Satisfactory.*

2 Numbering, Location Recording, Labelling and Storage

2a *Very useful to have both - acquisition numbers used for groups, item numbers for individual objects.*

2b *System is OK. In practice a considerable backlog builds up (lack of discipline !).*

2c *Very good.*

2d *Storage locations could be subdivided - rather than whole rooms at Kidbrooke to parts of rooms.*

2e -

3 Paper records

3a *Yes. No need to leave anything off the printed forms - a useful aide memoire & can be left blank if not applicable.*

3b *Space is generous. having got used to them, everything seems to be in the right place.*

3c *Waterproof paper is excellent. Stiff card for muster form is unnecessary.*

3d *In individual object research files. No.*

3e -

Objects (continued)

4 Computer record

4a *Yes. Yes but potentially useful.*

4b *Don't know.*

4c *Computer record is regarded as a summary of the information contained on the paper record, & for this length is perfectly adequate.*

4d *The structure is satisfactory.*

4e *Produced in response to specific requirements. Could be improved by having fields numbered - easier to scan than text headings. EG to find loan renewal date rather than location date.*

4f *Normally go to paper record, except for object location, size, and expiry date of loans.*

4g *In files in filing cabinet. Individual item records also kept in research files. No improvement required.*

4h -

5 General remarks -

Slides

1 Procedures

Satisfactory.

2 Numbering, Location Recording, Labelling and Storage

2a *System is OK*

2b *Located by racks. fine as long as storage system does not change.*

2c *Satisfactory*

2d *Present rack system is satisfactory - although much of collection is kept boxed up at present because of accommodation moves.*

2e *Apart from the rack numbers, which allow slides to be put back in the right place, & neg. nos., for ordinary copies item numbers are not useful in practice because selection is always made by visual inspection.*

3 Paper records

3a-e -

4 Computer record

4a-h -

5 General remarks

Computer and paper records not used - see 2e above.

Drawings

1 Procedures

Satisfactory.

2 Numbering, Location Recording, Labelling and Storage

2a *Satisfactory*

2b *Satisfactory*

2c *Satisfactory*

2d *Vertical plan hanger adhesive strips lose their adhesion after about 7 years. Drawings fall off.*

2e -

3 Paper records

3a-e -

4 Computer record

4a-h -

5 General remarks

Paper records and computer record not used.

Information files

1 Procedures -

2 Numbering, Location Recording, Labelling and Storage

2a *Satisfactory*

2b *Satisfactory. Kept Sequentially in drawers.*

2c *Satisfactory.*

2d -

2e -

3 Paper records

3a *Most important use is cross-reference to drawings, photos. etc.*

3b *Tends not to be used as information required is more easily assimilated by thumbing through file rather than reading record.*

3c *Adequate*

3d *In information files. No improvements needed.*

3e -

4 Computer record

4a-h -

5 General remarks

-

Samples

1	Procedures -
2	Numbering, Location Recording, Labelling and Storage
2a	*Satisfactory.*
2b	*Room numbers for the whole of the museum. (This has been implemented).*
2c	*Satisfactory.*
2d	*Satisfactory.*
2e	-
3	Paper records
3a	*Satisfactory.*
3b	*Satisfactory.*
3c	*Waterproof paper is useful for on-site work.*
3d	*Stored in binders.*
3e	*A4 format of paper desirable to facilitate xeroxing.*
4	Computer record
4a	*Satisfactory. No fields never used.*
4b	*OK.*
4c	*Bigger memory desirable on hard disk so as to keep all records available at all times.*
4d	*It would be helpful if it were possible to ask for say "Amphora" & get all records of all types ie object, sample, etc. at once, instead of looking at different blocks of files and asking the same question several times.*
4e	*A4 format desirable.*
4f	*No.*
4g	*Stored in binders.*
4h	*It would be helpful if, when the screen scrolls up during printing, the page divisions could be shown.*
5	General remarks -

Conservation records

1 Procedures -

2 Numbering, Location Recording, Labelling and Storage

2a *Satisfactory.*

2b *Room numbers for the whole of the museum. (This has been implemented).*

2c *Satisfactory.*

2d *Satisfactory.*

2e -

3 Paper records

3a *Satisfactory.*

3b *Satisfactory.*

3c *Waterproof paper is useful for on-site work.*

3d *Stored in binders.*

3e *A4 format of paper desirable to facilitate xeroxing.*

4 Computer record

4a *Satisfactory. No fields never used.*

4b *OK.*

4c *Bigger memory desirable on hard disk so as to keep all records available at all times.*

4d *It would be helpful if it were possible to ask for say "Amphora" & get all records of all types ie object, sample, etc. at once, instead of looking at different blocks of files and asking the same question several times.*

4e *A4 format desirable.*

4f *No.*

4g *Stored in binders.*

4h *It would be helpful if, when the screen scrolls up during printing, the page divisions could be shown.*

5 General remarks -

Contexts

1 Procedures

Satisfactory.

2 Numbering, Location Recording, Labelling and Storage

2a *Satisfactory.*

2b *N/A*

2c *N/A*

2d *N/A*

2e -

3 Paper records

3a *Yes, very good form.*

3b *Satisfactory.*

3c *Satisfactory, waterproof paper useful.*

3d *Kept in ring binders relating to excavation. Satisfactory.*

3e -

4 Computer record

4a-h -

5 General remarks

In practice no excavation has produced a large enough number of contexts for computer manipulation to be helpful.

Photographic negatives

1 Procedures

Satisfactory.

2 Numbering, Location Recording, Labelling and Storage

2a *Satisfactory*

2b *Rarely updated.*

2c *Satisfactory.*

2d *Items stored in relevant research files. An attempt was made to keep a master set of prints or contact prints in negative number order but this has not proved very useful.*

2e -

3 Paper records

3a-d -

3e *Not used in practice.*

4 Computer record

4a-g -

4h *Not used in practice.*

5 General remarks -

Bibliographic records

1 Procedures -

2 Numbering, Location Recording, Labelling and Storage

2a-e -

3 Paper records

3a-e -

4 Computer record

4a-h -

5 General remarks

Record system not used in practice.

Radiocarbon dates

1 Procedures -

2 Numbering, Location Recording, Labelling and Storage

2a-d -

2e *Not used in practice.*

3 Paper records

3a-d -

3e *Card index only used.*

4 Computer record

4a-g -

4h *Not used in practice.*

5 General remarks

Original manual system continues in use.

MAXARC User Survey

1 Frequency of use

Please indicate on average how often you use each facility, using the following terms:

1 Never
2 More than once a year
3 More than once a month
4 More than once a week
5 More than once a day

1.1 Write data to file

1.2 Edit (Standard)

1.3 Edit (automatic of selected fields)

1.4 Edit (manual of selected fields)

1.5 Print (standard to printer)

1.6 Print (programmable to printer)

1.7 Print (standard to file on disk)

1.8 Setup new Volume

1.9 Erase Records

1.10 Cancel erasure

1.11 Print numbers of void records

1.12 Retrieve records

1.13 Count and enumerate

1.14 Write to sequential file

1.15 Read from sequential file

1.16 Write to mailmerge file

1.17 Restructure file

1.18 Sort and output in sorted order

1.19 Other (Please specify)

2 Data Structure and Setup Facilities

2a Setup Programmes

Do you use the setup facilities for setting up new files, and altering file and word list definitions ? Do you have any comments on the usefulness of these facilities ?

2b Record Structure

Do you have any comments on the size of record which may be accommodated, or the number of fields per record ?

2c Fields

Do you require the same field to be repeated within a single record ? Is this dealt with adequately by Maxarc ? Are the data types (text, integer, real and coded text) sufficient, or are other types required ? Is there enough room for individual fields, or is there a need for more space for data ?

2d Data Structure - General remarks

Do you have any other comments on the structure of the records and files which are supported. Are they adequate for your needs, and are different facilities desirable ?

3 Input

Are the facilities for data input adequate ? How could they be improved ?

4 Editing

Are the facilities for editing records adequate ? How could they be improved ?

5 Outputs

How useful are the facilities for outputting data ? How could they be improved ? What outputs do you regularly produce ? What outputs would you like to produce which cannot be produced at the moment ?

6 Present facilities - General

Please comment on the usefulness of the facilities which are currently available, and their ease of use. What do you find useful, and how could it be improved ?

7 Additional facilities

please describe additional facilities which you would like MAXARC to have.

Thank you for completing this questionnaire. Please return it by 1st June 1989 to Ben Booth, Science Museum, Exhibition Rd., South Kensington, London SW7 2DD 01-938-8210

Section 1 (Frequency of use)

FACILITY	USER:	1	2	3	4	5
1.	Write data to file	5	5	5	2	5
2.	Edit (standard)	5	3	4	5	4/5
3.	Edit (automatic of selected fields)	2	2	2	4	1
4.	Edit (manual of selected fields)	2	1	2	4	1
5.	Print (standard to printer)	3	4	4	4	3/4
6.	Print (programmable to printer)	1	1	1	4	1
7.	Print (standard to file on disk)	1	1	1	4	1
8.	Setup new volume	2	2	3	2	2
9.	Erase records	2	1	1	2	1
10.	Cancel erasure	2	1	1	2	1
11.	Print numbers of void records	3	2	2	1	2
12.	Retrieve records	3	3	5	1	3
13.	Count and enumerate	3	2	1	1	3
14.	Write to sequential file	2	2	1	2	3
15.	Read from sequential file	2	2	1	2	1
16.	Write to mailmerge file	4/5	1	3	1	3
17.	Restructure file	1	1	1	1	1
18.	Sort and output in sorted order	2	3	2	1	3
19.	Other	-	-	-	-	-

Sections 2-7

User 1

2 Data Structure and Setup Facilities

2a *Might be helpful to be able to alter selected fields rather than the whole lot.*

2b *Fine*

2c *Fine*

2d *Fine*

3 Input

How about a facility to enable files of different formats (1-2-3, Dbase etc.) to be imported either into existing or new records ?

4 Editing

How about a "view" facility. ie viewing without the choice of editing.

5 Outputs

A feature to allow selected fields of selected records to be printed. eg print lengths and flint number of all complete waste flakes. ie print without selecting first.

6 Present Facilities - General

Constant recycling of programme in IBM PC version a bit annoying sometimes. Also I have a batch file to delete the log every time I enter MAXARC - it takes too long if you don't.

7 Additional facilities

-

User 2

2 Data Structure and Setup Facilities

2a *Yes. Very useful and flexible.*

2b *About the right length as they are. Output to variable length files - eg wood joints when old files fill up.*

2c *No. No - cumbersome. Yes, but what about graphics ? Space is OK, but not too liberal.*

2d *Would be nice if statgraphics or Lotus could be grafted on.*

3 Input

Yes. No.

4 Editing

They are OK, but could be less cumbersome.

5 Outputs

Graphics etc. easier interfacing of MAXARC with (eg Lotus), via menus, would help.

6 Present Facilities - General

The interfacing with other standard software is important.

7 Additional Facilities

Statistics

User 3

2 Data Structure and Setup Facilities

2a *No*

2b *It's fine*

2c *Everything OK*

2d *No problems*

3 Input

I find inputting perfectly straightforward - no problems.

4 Editing

Editing is the weakest part of MAXARC - for me anyway. I have to do a lot of editing, as info comes in in batches - I tend to delay editing as its very slow - I seem to make more errors when I edit than with any other facility.

5 Outputs

Output: regular printouts.

6 Present Facilities - General

All facilities easy to use - I have to show a lot of people how to use MAXARC & there are never any problems.

7 Additional Facilities

Graphics interface

User 4

2 Data Structure and Setup Facilities

2a *No - but someone else in our unit does this for me.*

2b *I find that we are generally slimming down on the number of fields used per record.*

2c *Yes; Yes; Yes; No; Yes.*

2d *Generally adequate, but sorting larger number of fields per record seems difficult.*

3 Input

Yes; I don't know.

4 Editing

Yes

5 Outputs

rarely use it; mainly finds/feature records - now use brief/bare essential data input to produce lists for reference & basic data file.

6 Present Facilities - General

For writing of reports, easy to use for me.

7 Additional Facilities

-

User 5

2 Data Structure and Setup Facilities

2a *Occasional use of SETUP. Poor knowledge of computing restrained my use of this facility at first, but it is useful. Seems a programme is never perfect first off, so its good to have this facility whilst working through it.*

2b *No - except I suppose for record size which could be longer in certain text fields. esp. for descriptions.*

2c *For descriptive use for artefact studies text data types are too short. Would be good in some cases not to repeat fields (in my case), but to activate them by key questions, which later aid in sorting programmes.*

2d *OK for my needs.*

3 Input

Yes, facilities are adequate. If asking key questions to activate thesauri other data could be squeezed in, then this would save time having to bang through blank fields to the next relevant question. Key questions for eg "Is sherd decorated - Yes/No" if "yes", then 5 fields of position of decoration are activated, if "no" then these five fields are automatically skipped.

4 Editing

Yes. Fine.

5 Outputs

For my verbose pot studies, & because of my limited computing skills, have needed output of many general notes fields - alongside other contextual data. Could probably get round this next time round, by making more use of set up & not needing general notes fields so much.

6 Present Facilities - General

Most useful are the fields pertaining to sorts/retrieves/counts etc. ..... & mailmerge.

7 Additional facilities

Basic graphics ?

THESIS CONTAINS MICROFICHE