# Multimedia information systems for East African archaeology (*paper submitted to Archeologia e Calcolatori*)

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# 1 Introduction

The last decade or so has produced many changes in the way we approach archaeological data, due not least to the impact of information technology upon the human sciences. Archaeology, as a data intensive discipline, has been open to many influences, and we now face the challenge of how to 'publish' in the electronic media. At the same time we are seeing a revolution in general attitudes to archaeology, and an increasing realisation of its place in world politics; the impact of the controversy over the 1986 World Archaeological Congress ((Ucko, 1987)) is still being felt outside Europe and America. This paper covers an area where these two themes meet, i.e. the use of information technology in electronic publishing in an area where the political status of archaeology is open for discusssion — the *Urban Origins in Eastern Africa* project.

We describe the use of the *Microcosm* open hypermedia system in an archaeological context, providing an environment in which a variety of archaeological information sources can be accessed, ranging from databases, through digitized site plans and survey data, to synthetic text and GIS images from high-level analysis.

We show how the integration provided by multimedia is a vital part of research work, as well as publicity, and propose the structure of a genuine regional resource.

This paper arises from a continuing association by Sebastian Rahtz with the computing needs of the *Urban Origins in Eastern Africa* project which developed, after contacts at the Second World Archaeological Congress in 1990, to more in-depth teaching and investigation at Uppsala in 1991 and 1992. Thanks are due to all the participants on the project 1991 teaching session at Uppsala who stimulated the work described here.

# 2 The *Urban Origins in Eastern Africa project*

The *Urban Origins in Eastern Africa project* (referred to hereinafter as 'the project') ran from from 1987 to 1993, under the sponsorship of the Swedish development agency, SAREC and the overall scientific coordination of Paul Sinclair at Uppsala. The project began with a meeting at the Swedish Central Board of National Antiquities in Stockholm in 1986, where representatives from institutions from seven East African countries were invited to meet their Swedish counterparts to discuss urban origins. For the first time colleagues from East Africa were asked to define their research priorities in a field which had been much misunderstood and little provided for in Eastern Africa. For many years Africa had been conceptualised as an inert source of raw materials and not as a creative participant in the global processes of urbanisation. Towns where they were admitted to occur were usually conceptualised as foreign in origin. It was this bias, a legacy of colonial prejudice which denied the creativity not only of the Bantu speakers of the African continent but also the peoples of Madagascar, which was of central concern to many participants in the formulation of the project. Recognition of urbanism as a complex and widespread phenomenon in Eastern Africa which required a regional research approach to comprehend it adequately was an important result of those first initial contacts.

When the project formally begin in 1987 (the countries eventually involved were the Comoros, Botswana, Kenya, Madagascar, Moçambique, Namibia, Somalia, Tanzania mainland, Zanzibar, and Zimbabwe), an important consideration was to question and redefine the nature of foreign funding in African archaeology. Were foreign sponsored projects extractive or contributory in nature? What practical i.e. material benefits

in addition to new scientific knowledge were there for the participating institutions? How could these research activities be used to raise the educational level of professional archaeology locally? The project was accordingly organised in a novel way, based fundamentally on consensus with project control being clearly located in a joint executive committee of African and Swedish archaeologists. Control was divided between the African project leaders and the regional coordination was reflected directly in the budget. The Africans were responsible for all project activities in Africa, and Swedish personnel had a coordinating and advisory role only, with participation in fieldwork only by invitation.

One of the strategic decisions was to emphasize the needs of the younger east African researchers in order to raise their productivity. Resources were shared amongst over 25 students, many registered in Europe or America for research degrees. It was also decided to a regular series of workshops and specialist meetings in East Africa; meetings in Nairobi, Madagascar, Zimbabwe, Moçambique and Zanzibar culminated in the final international meeting held in Mombasa, Kenya in January 1993 (a World Archaeological Congress inter-congress meeting on urbanism). This activity has resulted in a vibrant network of contacts spanning the whole region and increasingly attracting the interest in participation of other countries such as Uganda, Malawi, Zambia and Nigeria.

Four research themes were jointly defined ((Sinclair, 1989)). Briefly these focussed on processes of urban origins from the point of view of a) chronology b) between-site spatial relations c) internal organisation within sites and d) ethnohistorical and archaeological interpretive frameworks. The aim first of all was to know where and when town complexes arose in eastern Africa. It was also important to obtain a broad view of the processes of urban development avoiding both the colonial fixation with stone buildings and the more subtle bias of viewing town centres in isolation from the surrounding settlements.

Four years of field research in each of the themes has generated a large body of new data, new questions, and new analytical perspectives resulting from the incorporation of the African interior, the coast and the off shore islands in the same frame of reference.

It is not the intention of this paper to present the archaeological results of the project; the reader is referred to a general view of the project in (Sinclair, 1989), the One World Archaeology volume on Africa ((Shaw et al., 1993)), and the project publications (eg (Sinclair, 1988; Sinclair and Wandibba, 1988; Sinclair and Rakotoarisoa, 1990) and (Sinclair and Juma, 1992))

## 2.1 Information technology in the Urban Origins project

With the project stress on the training of young professionals, an important emphasis was always laid on the *appropriate* use of information technology. All field and resarch projects were encouraged to use computers, but there was no technology training *per se* or provision of general computing facilities; computers were used on an *archaeological need* basis. Because project participants came from all levels, computing has become a *habit* in East African archaeology, based on personal machines; it was gratifying to read the surprised reaction of an English academic to the casual use of computers in Zimbabwe (Peter Ucko, in (Reilly and Rahtz, 1992), p. viii). Extensive use of desktop-publishing systems for conference proceedings and theses has helped this to develop.

The use of computers of African archaeology has an interesting history (see (Sinclair et al., 1992; Sinclair, 1992a) and (Kokonya, 1992) for perspectives, and (Karega-Munene, 1992) for a rather less optimistic assessment). Early IT applications in eastern

and southern Africa involved both the development of museum-based site recording systems and also academic interest in statistical analysis and comparison of archaeological assemblages. By the 1970s certain countries of the region e.g. Zimbabwe and Kenya possessed well curated archaeological site indexes. The first computer-based archaeological site index in eastern or southern Africa seems to have been that of the Zambian Antiquities service which was operational in the mid 1970s.

The current situation in the East African project countries is that IBM compatible micro computer systems with at least a 286 level processor are established in each country, with Macintosh systems also in Kenya and Madagascar. Financial constraints pose severe limits on the rate of development of systems. Software in use for data management includes Microsoft Works, dBase III+ and IV, Minark and Autocad; GIS systems (Idrisi and Arc/Info) are now coming into use. Following the nature of the project archaeology (much large-scale survey), sophisticated use is made of the geological survey analysis system *Rockware*; we may also note the use of matrix programs (from the Bonn Seriation Package), including for the analysis of standing buildings in Zimbabwe (K. T. Chipunza *pers. comm.*). Use of statistical analysis has been quite widespread in research work.

The urban origins project has depended on information technology since its start, and is a good example of democratisation of technical knowledge through the widespread use of portable computers. It is to be hoped that it will serve as a model for future projects of this type.

# 3 The Urban Origins electronic data

As the main project came to an end, it was clearly necessary to reassess the information infrastructure of the project. The new range of data now available for synthesis and publication included:

1. Raw survey and excavation data;
2. Detailed analyses;
3. New synthetic collections, such as a greatly expanded set of radio-carbon dates;
4. Working papers circulated at meetings;
5. Completed academic theses;
6. Project administrative information (database of project elements and personnel).

Much of this was already stored on computer, but it was not easily accessible, or linked together in a systematic way. At the same time, there was increasing awareness of the potential of geographic information systems for regional synthesis, and the exploration of shared interests with geographers. Specifically, it was realized that quite detailed topographical, soil, land-use and crop data could be obtained for the region (and indeed the whole of Africa) from the UN Food and Agriculture Organisation (an example of this data, showing Madagascar, appears in the background of Fig. 10), which made it important to start building up computerized versions of regional archaeological maps.

A project initiative started in 1991 was the use of hypermedia and multimedia to share research data between archaeologists, and to display cultural data to the general public. For an exhibition at Uppsala in 1991, a rolling demonstration of GIS was created using IBM's AVC (*Audio Visual Connection*) software, and images from an

Idrisi analysis of archaeological sites and modern land-use on one of the Comoros islands (see Fig. 9). This involved the digitizing of a set of maps of the Comoros islands, and inputting the archaeological data collected by the Comoran archaeologists. Also at this time an electronic database was started of project photographs, and pictures of project students, using a Canon Ion still-video camera, digitized through an IBM Video Capture Adapter/A.

By the end of 1992, a substantial amount of electronic data had been collected, including the machine-readable versions of nearly all the project publications, and it was decided to build a hypertext demonstration to show how the synthetic materials could be accessed in a simple, low-cost, system. Experiments in 1991 with Toolbook (cf. (Rahtz et al., 1992)) had proved unsatisfactory, and the AVC product was too limited in its hypertext features to be of any real use. Neither Unix X Window systems, nor the Macintosh authoring systems such as Hypercard, successfully used in other projects (most notably in archaeology, the Perseus system — (Smith, 1992); see also parts of (Rahtz et al., 1989)), were not an option due to the almost total dominance of DOS machines in the project. Although many of the machines in the field were not yet of a standard to easily run Microsoft Windows, they were likely to be upgraded in the near future, and the Archaeology Department at Uppsala was standardising on OS/2, so a Windows or OS/2 setup was adopted. Following an academic link with the University of Southampton, the experimental hypertext system *Microcosm* was available from the Department of Electronics and Computer Science, and this was the basis of the experiment reported here. We are very grateful to Dr Wendy Hall, Hugh Davis, and their Microcosm development team, for giving us access to the software, and helping with its use.

# 4 Principles of Microcosm

Microcosm is an open hypermedia system developed at the University of Southampton, running under Microsoft Windows 3.1 (and also under OS/2). Its development is outlined in (Fountain et al., 1990), and the current version is described in (Davis et al., 1993). The principles of hypertext itself have been frequently rehearsed; the reader is referred to references in (Rahtz et al., 1992). Microcosm is an innovative concept, which is primarily an *architecture* which manages *documents*; these can be of any type — read-only, images, video, sound, animations, or even actions (such as the running of another program, or some network message). The structure of its operation is shown in Fig. 1.

The system does not have its own format for documents, but can be extended to pick up almost any type of file. To add a document of a previously unknown type, the user needs to provide a *viewer* and register it with the system. The viewer may simply be the commercial application which created the document; thus documents written with Microsoft Word use that package as their viewer, and it is Microcosm's job to call Word on demand, and to manage messages to and from it. Similarly an archaeological drawing created with Autocad might appear in the system, and Microcosm might invoke either the complete Autocad to display or, or the Autocad 'slide' viewer. This means that the user can at any time undertake normal work with the software (such as viewing the Autocad drawing in different ways) before returning to Microcosm to explore further directions.

A *document management system* is used to track details of all documents; this provides meta-information (authorship, history, etc), and classifies documents according

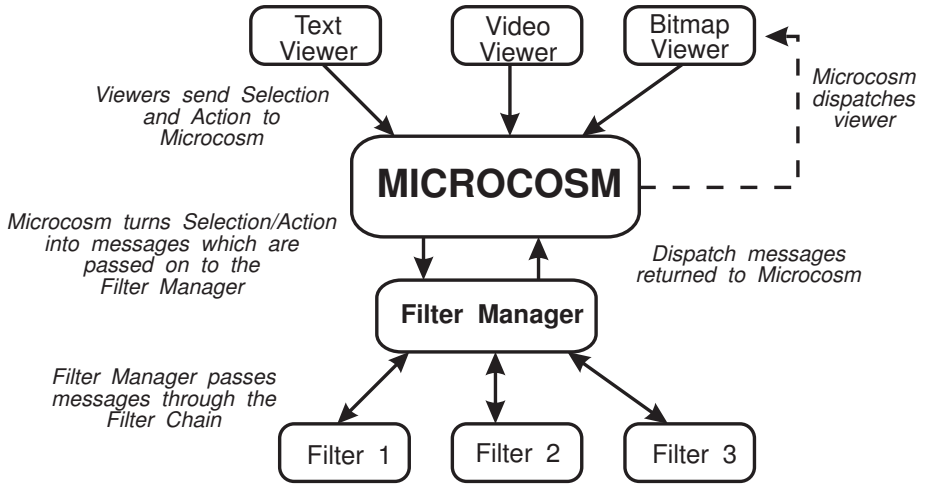


Figure 1: Structure of Microcosm operation, from user manual ((Davis et al., 1993))

to their viewers.

*Links* between documents can be point to point links (from a specific place in document to a specific place in another), general links within a document (selection of a key phrase or pattern anywhere with a document produces the same link), or generic within the whole system (the selection anywhere in a registered document produces the link). They can also (in database terminology) be many-to-many links; a point in a document may act as a starting point for many links, and have many links pointing to it. Links can be presented as visible 'buttons'.

Microcosm maintains links *separately* from documents, at multiple levels; if a link from a picture to a text document is desired, the information is stored in a central database rather than being attached to the documents themselves. This is a crucial feature, allowing read-only documents (such as those on a CD-ROM) to be used.

*Filters* act on messages (usually *selections* from a document) and (usually) produce new documents for the manager to present. The concept of these filters is interesting, as they are used to provide some apparently diverse functions. Some filters provided with the system are:

**Show Links:** given a text selection, the system will look up the available links in its database, and display a list for the user to choose from;

**Compute Links:** this accesses a pre-computed index of similarity for a set of documents; given a set of words, it locates documents which have a similar content vocabulary;

**History:** every time a document is displayed, its name is put on a history list; when a subsequent selection is made which returns the name of the same document, the history filter displays an informative message;

**Mimics:** since Microcosm is designed simply to manage and display documents, allowing users to move between them, it does not allow a conventional linear movement *per se*, but this is catered for by meta-documents which are an authored set of suggested links. These *Mimic* documents superimpose a structure,

by providing a *Next document* and *Previous document* facility on top of the usual linking.

**Link database:** the basic database of links; given the name of a document, it returns the document itself to Microcosm to display.

It is important to realize that messages are passed through a *filter chain*; a choice from a list displayed by *Show Links* is passed along the set of filters, perhaps activating the *History* filter, perhaps ending in the *Link Database*. The selection from a document is commonly accompanied by an 'action', which affects which filters are activated; thus a word selection may specifically be sent as a link request, or passed to the *Computed Links* filter to obtain a closely-related document.

Microcosm is implemented as a series of autonomous processes which communicate by means of the Windows DDE message-passing protocols. This means that new processes can be added, if they respond to the appropriate messages.

# 5 The urban origins project application

## 5.1 Description of implementation

The basis of the sample Microcosm application was:

1. Nearly 100 papers from project annual conferences were converted to a common format of Microsoft Word from a variety of word-processor files (using Rich Text Format as an interchange format); a limitation of the *Computed Links* facility meant that they also had to be converted to plain ASCII and indexed for similarity;

2. Photographs of the majority of project participants were available, with some colour slides of archaeology on the Comoros islands; these were stored as Windows Bitmap (`.bmp`) files;

3. The project administration database of people and projects was converted to a *Paradox for Windows* database;

4. the complete archaeology, topography and soil data for the Comoros islands was held in a series of Idrisi images, with the original maps in Autocad format;

5. an Arc/Info coverage for all of Africa of FAO soil and crop data was available, but only accessed in Microcosm through Idrisi images.

This comprised about 270 elements in the document management database. The primary starting point is this list of documents, presented by category, as shown in Fig. 2. This screen-dump shows the Microcosm filters sitting as Windows icons on the desktop waiting to be activated. An example entry in the DMS is shown in Table 1.

When a document is selected, an appropriate viewer is launched. Fig. 3 shows a Word document about a site in Madagascar; using the Word macro language, a set of actions has been added to the Word menus, which permit the user to communicate (using DDE) back to the Microcosm manager. The figure shows the word `Radimilahy` (the author's name) highlighted, and the action *Follow link* chosen. This has been processed by the filter chain, resulting in a list of documents which will respond to this message (on the right-hand side of screen); two documents and a photograph of Chantal

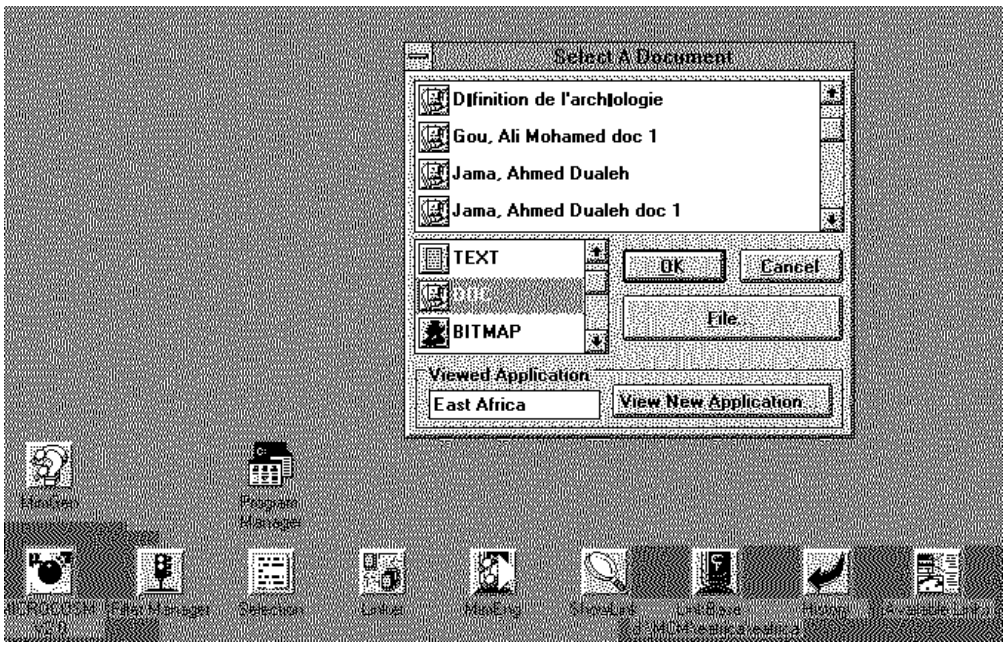


Figure 2: Microcosm Documentation Management System

| *Field* | *Value* | *Meaning* |
|---|---|---|
| `\Type` | BITMAP | Type of document; this dictates which viewer program will be used to display it |
| `\Description` | Jama, Ahmed Dualeh (photo) | Used-defined description of document |
| `\UniqueID` | 100.03.06.93.40.53.15 | Reference number in Document Management System (DMS) |
| `\Application1` | East Africa | Microcosm application to which the document belongs |
| `\FileName` | `D:\\MCM\\EAFRICA\\PICTURES\\AHMED.BMP` | Disk file name |

Table 1: An example of the ASCII representation of an entry in the Document Management System

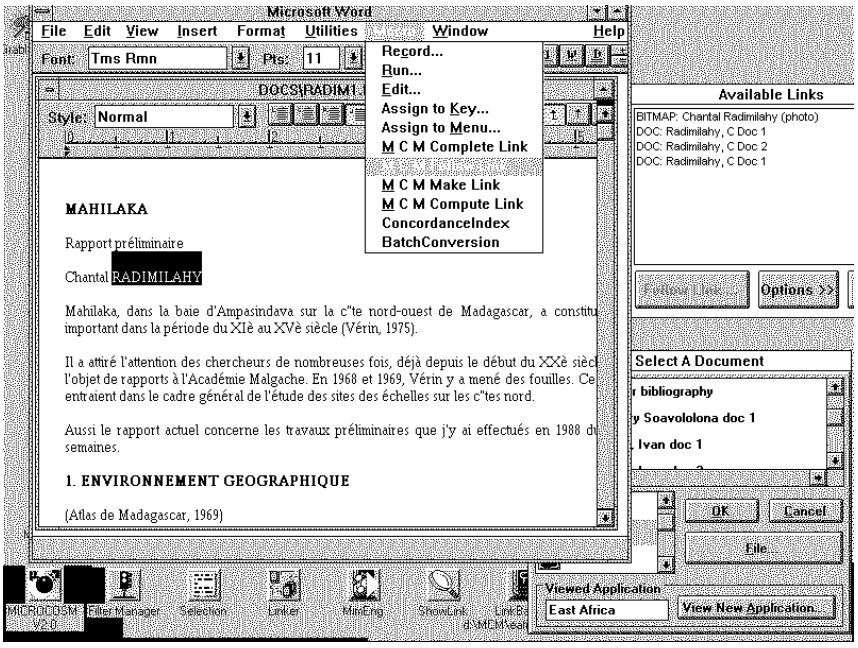


Figure 3: Text document opened with links to follow

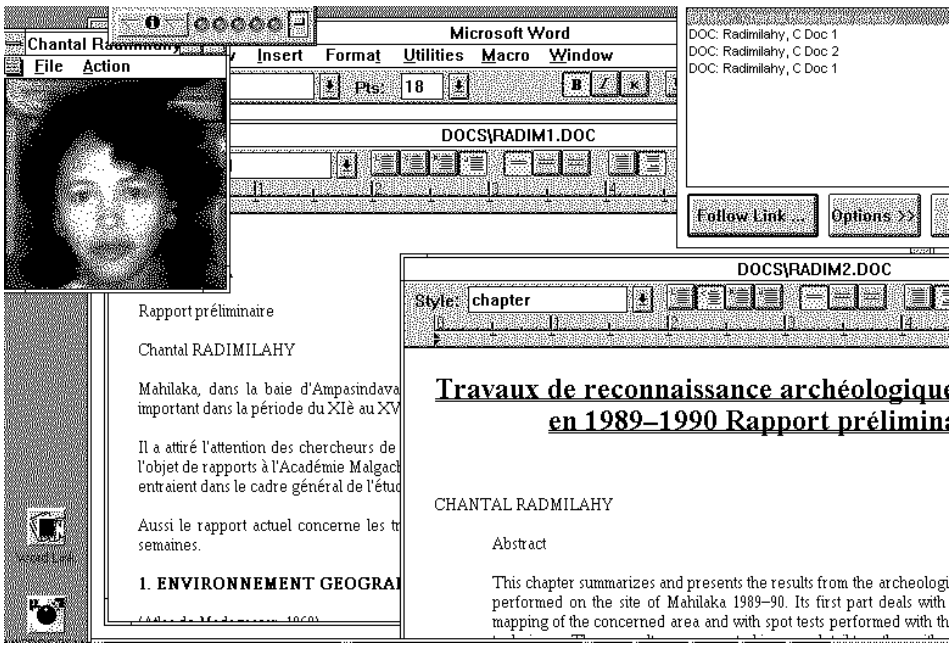


Figure 4: After linking, two documents and a photograph

| *Field* | *Value* | *Meaning* |
|---|---|---|
| \UniqueDocID | 1 | (unused) |
| \SourceFile | 100.03.06.93.40.53.25 | Catalogue number in DMS of source |
| \SourceSelection | 321,51,436,194 | Point in source document which is the start of the link (in this case an area of a map, so the value is two pairs of x/y coordinates defining a rectangle which the reader will see as a 'button') |
| \SourceOffset | 0 | (unused) |
| \SourceDocType | BITMAP | Document type of source document |
| \Action | CREATE.LINK | Message originally used to create link |
| \DestFile | 100.03.06.93.40.53.15 | Catalogue number in DMS of destination |
| \DestSelection | | (optional) Point in destination to which link points; the start, by default |
| \DestOffset | 0 | (unused) |
| \DestDocType | BITMAP | Document type of destination document |
| \Description | Ahmed Dualeh Jama (photo) | Description of link |
| \ButtonAction | FOLLOW.LINK | Message defining link |

Table 2: An example of the ASCII representation of a Microcosm link

Radimilahy are offered. When the photograph is selected, a bitmap viewer is activated to display it, with the result shown in Fig. 4

This linking of the author's name to related documents and photographs is given in the Microcosm database. These can be created by hand (see below, Fig. 8), but for this application we have built a large number of links automatically, resulting in nearly 9000 entries. These generic links are derived from the project participant database, and link:

1. all documents to country of author;
2. all authors' names to all other documents by the same author;
3. all authors to photographs;
4. countries in a map of East Africa (see Fig. 6) to papers by authors from that country;
5. all documents by automatic keywords; these are words greater than four letters in length which occurr in the first 20 lines of the document.

These are provided as a basic skeleton on top of which readers may impose more archaeologically meaningful links (note that individual readers may have their own private databases of links). The link database is built from an ASCII file; a typical entry is shown in Table 2, describing the beginning and end of the link, and some information about the link itself.

The creation of a Microcosm 'application' consists in essence of little more than registering a set of 'documents' and letting the reader explore them, making or following links. Additional functionality can be added to existing applications by making them talk to Microcosm, and expand the user's choice. Thus Fig. 3 showed how functions had been added to Microsoft Word to allow following and creation of links. In the same way, the administrative database, implemented in Paradox for Windows, was linked to Microcosm by adding methods to various fields; thus the 'Country' field has the following code attached:

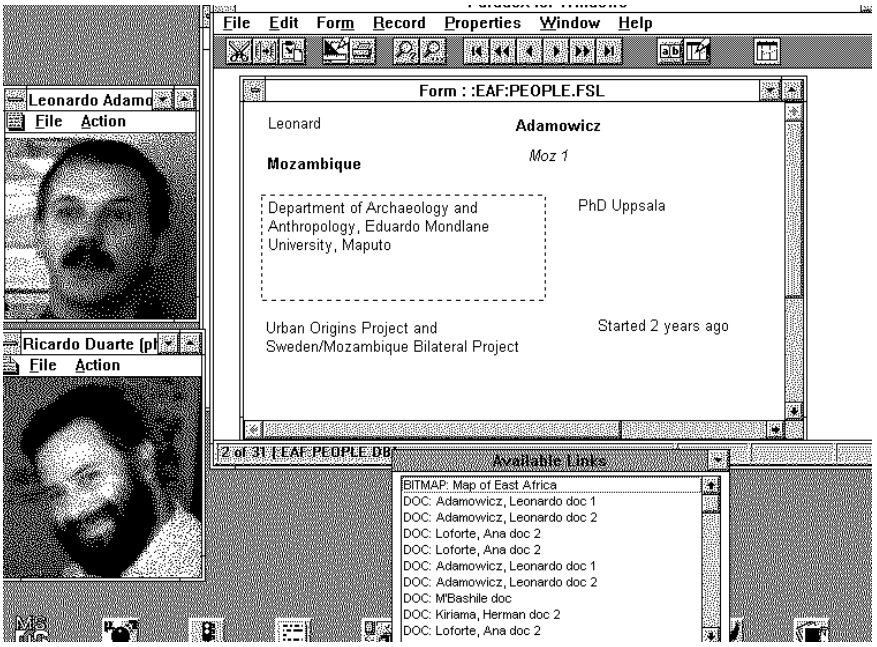


Figure 5: Paradox table accessing Microcosm through DDE

```
method mouseClick(var eventInfo MouseEvent)
 var
   stuff DDE
   name anytype
endvar
if stuff.open("MICRCOSM","LinkServer") then
  stuff.execute("[FOLLOW.LINK]["+country+"][0][people.db][DOC]")
  stuff.close()
else
 msginfo("Microcosm link","cannot open Microcosm")
endif
endmethod
```

When the field is clicked with the mouse, this tells Paradox to start a DDE conversation with Microcosm, and send the contents of the field, with a request to follow it as a link. In the example shown in Fig. 5, Microcosm has received 'Mozambique' from the record for Leonard Adamowicz, and offers (at the bottom of the screen) a list of available links (various documents, photographs and maps).

It is also possible to allow Microcosm to display 'documents' from non-Windows applications, and to receive messages from them. The latter is implemented using the Windows clipboard facility; Microcosm can be asked to monitor the clipboard for messages, and will act as if it had been sent them in the same way as, say, a text selection from Word. For the East Africa application, we needed access to a large number of images from the Idrisi GIS package; this was implemented by defining two new document types ('IMAGE' and 'VECTOR' for the Idrisi raster images and vector files), and providing a DOS batch file as a viewer, which is called by Microcosm and then invokes Idrisi in full-screen mode. This is a temporary solution, and we await a full-featured Windows application which can display Idrisi images, but it shows how easily new 'foreign' programs can be used. Fig. 9 is a typical Idrisi image from the

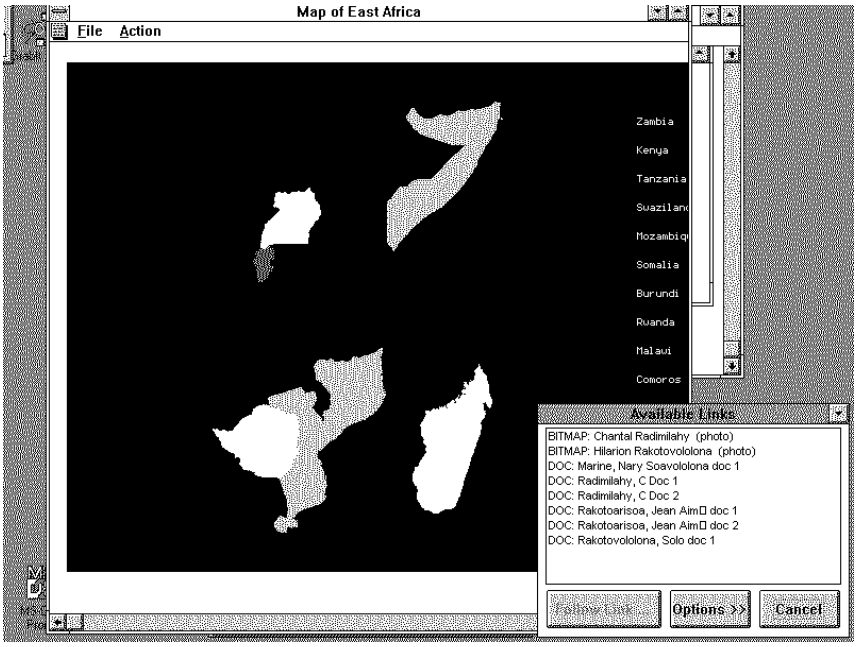


Figure 6: Bitmap image with links from Madagascar area

East Africa application.

## 5.2 User interaction

When Microcosm is started, it prompts the user for a username (and password); the username is needed to allow for different user 'views' of the application. If the reader makes an interesting link from one document to another, it is stored (if desired) in a private database. The initial interaction is almost always with the Document Management System (Fig. 2); a typical starting point might be a map of East Africa. This has links which offer a list of documents relating to each country as it is clicked on with the mouse; Fig. 6 shows the result of selecting Madagascar. From here the user might select one of the documents by Radimilahy, and follow links from there to the author's other works (Figs. 3 and 4). The same result might be arrived at if we had not started Microcosm at all, but worked with Paradox, and then asked for a link. This would automatically load Microcosm, and let us explore documents there, while leaving us free to work in the normal way with Paradox.

A keyworded link is shown in Fig. 7. Here, the reader has selected a phrase from a document ('ceramic assemblages') and has asked for the *Show Links* filter to be activated. This finds other documents which know about the separate words in the phrase, and lists them (in top right-hand corner of the screen). Contrast this with the effect of the *Computed Links* process, which would have looked for documents which matched the words *as a group*, and listed the 'hits' in order of proposed relevance.

If the reader wants to add a link to the database, any 'selection' can be made (a piece of text, an area of a picture), and a 'create link' action followed. This offers successive panels where the start of the link, the end, and its type can be defined. In Fig. 8 the word 'Kilwa' (a famous archaeological site) has been selected, and the

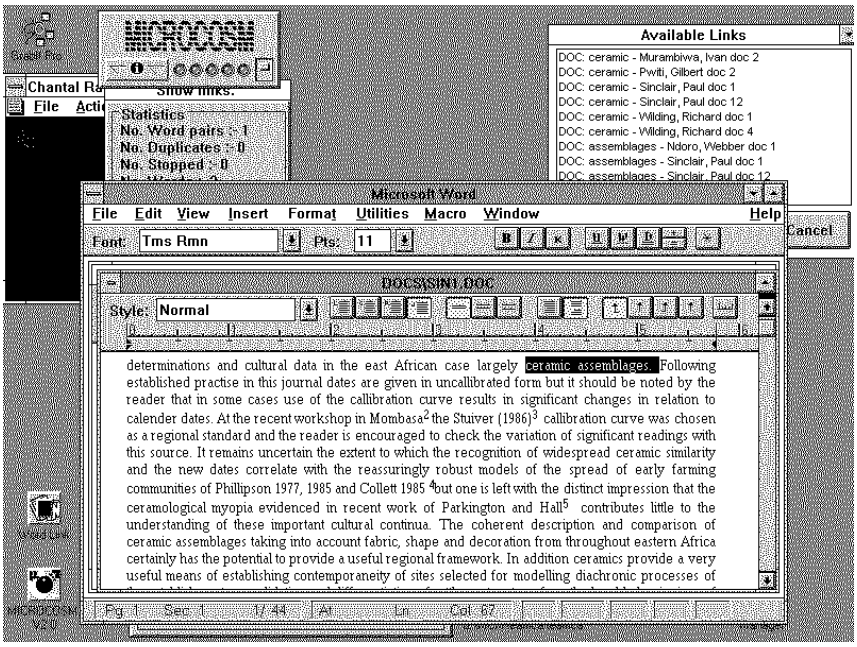


Figure 7: Text document showing output from Show Links

reader is making a link from there to a document by another writer. The lowest panel (titled 'Linker') allows the link to be 'Specific' (from *this* point in the document only), 'Local' (the word 'Kilwa' can be selected anywhere in the current document to activate the link) or 'Generic' (the word 'Kilwa' in *any* document will activate the link).

Many functions of Microcosm remain unused in this application; we have not, for instance, had any video documents (a system for video summaries, 'micons', is available), nor have we yet made extensive use of the *Mimic* facility to superimpose structure. The application has not yet had any use beyond demonstration, and *Mimic* sequences will be used to make available different parts of it to different groups.

# 6 Conclusions

The East Africa project needs highly visible, integrated, results from its work. This is partly for 'political' reasons (to attract further funding), but also because the project needs a transition from individual research to useable regional data. A program of research into urban origins does not necessarily produce a regional database. There is a danger of the final result being no more (or less!) than a pile of PhD theses, with no single point of access to the results. If all the work can be placed into a loose system like Microcosm, it can be used flexibly in the traditional way, but also be amenable to structuring and exploration. The use of hyper links is sometimes *unexpected* for the reader; it can stimulate new research questions.

Given the decreasing library resources in all parts of the world, information technology might start being cost-effective if we can move from individual publication to contribution into a growing resource. The Microcosm open architecture allows for any new technologies, and caters for different software bases throughout the region. It must

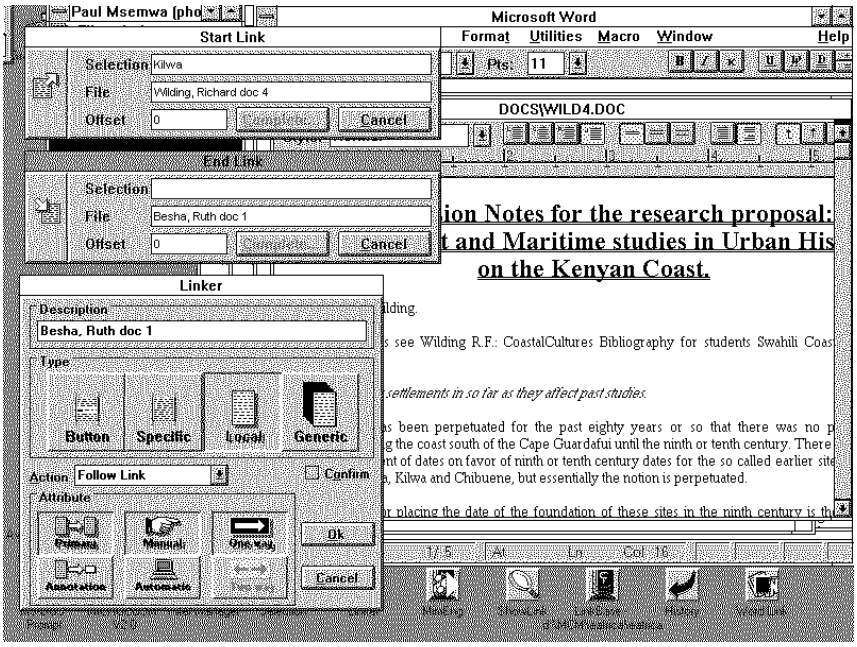


Figure 8: Making a link: start, end and complete panels

also be stressed that it is politically important for the project participants to be at the leading edge of information technology.

There are some obvious problems with the system as it stands:

- Most obviously, the system has not been used for anything archaeologically *interesting*; its prebuilt links are essentially 'administrative'.
- It is easy to generate bitmap images of plans for display, but a 'clean' database of (eg) Autocad vector images under control of Microcosm involves a lot more work, and even greater processing power to run the large CAD packages under Windows. Experiments with Microcosm and Autocad (Hugh Davis, *pers. comm.*) show that it is easy to set up communication, and allow links from 3D models to supporting textual data, for instance.
- Colour images are poor quality at present; we can assume use of something like Kodak Photo CD in due course to store the large number of colour slides which all archaeologists accumulate.
- We do not yet have any detailed archaeological databases from excavations or survey in the application; while some will fit quickly (eg the up to date catalogue of radiocarbon dates), the very detailed pottery collections and so on will need more careful thought on how to link to and from them.

Perhaps most importantly, GIS *linking* is not yet thought out, though this is our greatest resource. (Hall and Simmons, 1992) and (Simmons et al., 1992) have already discusssed the relationship between hypermedia (Microcosm in particular) and GIS, and it is easy to see how educational multimedia systems can be built which use GIS systems as one of their delivery tools. But this system is still closer to a synthetic

book than a genuine integrated research tool. We need some experience of having GIS tools as an analytical tool to be accessed during the reading processing. Thus if we are reading about an interpretation of the site of Kilwa, we want to be able to trivially ask 'what was the catchment area for iron-ore sources in the 16th century' or 'what other sites were producing this sort of pottery within 2 days sail of Kilwa', and expect to use our GIS databases to get the answer. We may in due course be able to use this type of interaction build a new electronic atlas of African archaeology, but so far we are limited to either 'canned' analytic images (such as Fig. 9), or shifting entirely to the GIS to do our analysis.

On the more general level of information technology penetration in East African archaeology, the use of computers in the SAREC project is widespread — is it too wide? Is knowledge spread too thin, to the extent that everyone can use the few programs they originally needed, but there is no deep expertise to develop applications further. On the other hand, if there had been a policy of a small number of pure computer science experts, would archaeology have benefited at all? Some level of computer sophistication is required to make effective use of hypermedia systems, and it is predicated upon *casual* availability and use of machines, and physical networking, which cannot currently be guarenteed.

Because the project participants come from a wide spectrum of the archaeological hierarchy in the participating countries, there is no one 'level' of archaeologist familiar with computerisation. In some cases academics are using machines, in others it is museum directors, and in others it is technical staff. This can produce a situation where there is a mismatch between power and expertise, and the leadership does not feel able to question daily work. This may hamper development of 'public' facilities, and this damages one potential use of the Microcosm system, for the educated public. There is a more insidious danger that we in fact lack any severe statistical understanding of the data that are being collected, so the 'analytical hypertext' will be a dangerous tool. Some would argue that the science of data visualisation makes traditional number-crunching unnecessary, but we must be careful to ensure that multi-media systems do not make archaeology look *too* easy and *too* well understood.

Whatever our *caveats*, East African archaeoology has reached a level of computerisation where regional databases are both practical and necessary. We hope that the current experiment will allow them to be built with greater confidence.

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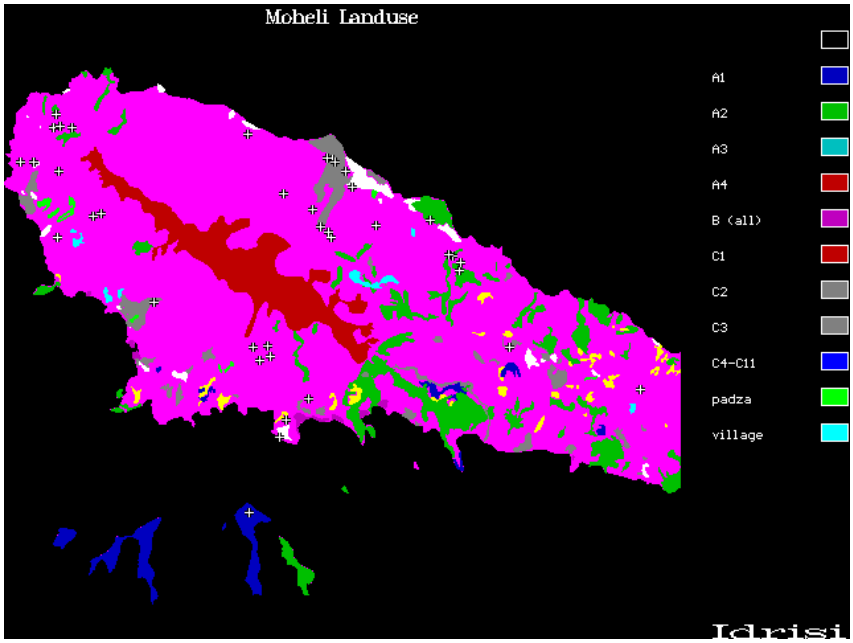


Figure 9: Idrisi image of Moheli (Comoros Islands) showing modern land use and distribution of sites

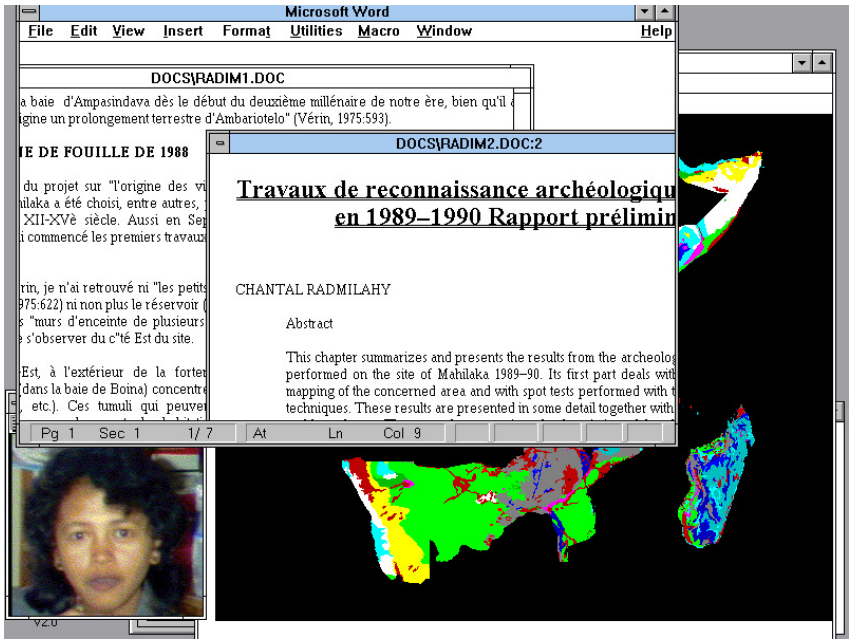


Figure 10: Two open documents, linked to landuse map of East Africa and photograph of author