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Identifying technologies used in Cultural Heritage

Ruth Owen [a], Dimitrios Buhalis [a], and Daniël Pletinckx [b]

[a] School of Management, University of Surrey, UK

[b] ENAME Center for Public Archaeology and Heritage Presentation, Belgium

Abstract

There are a growing number of Information Communication Technology (ICT) applications in cultural heritage. However despite funding constraints, projects often involve similar or even duplicate work carried out at the same site. This emphasizes the need for an enterprise whose purpose is to coordinate research projects in this field. The EPOCH programme has been established to address this requirement. This paper focuses on the development of a diagram depicting the technologies used in cultural heritage research from papers presented at VAST 2003. The aim of this paper is to draw together technologies currently being used by researchers in the cultural heritage sector in order to direct future research in this field.

1. Introduction

Although numerous ICT applications are used by the cultural heritage sector, to date there has been no study on the range of applications available and hence cultural heritage and IT professionals often work in isolation, when they could be harnessing opportunities derived from techniques, tools and methodologies used by other researchers.

This paper presents a systematic study that identifies the technologies used in research presented at VAST 2003. This was undertaken by adopting an information systems theory approach [LL00] classifying procedures into three activities: input, process or output.

The paper adopts the proposition that cultural heritage comprises a series of three stages. It begins with the Discovery of artefacts; followed by Scientific Process which involves documentation, digital reconstruction and cataloguing. The final stage is Dissemination to both professionals and the general public.

This study has set out to generate a comprehensive flow diagram or 'inventory map' that depicts the range of technologies and techniques used within cultural heritage. An information systems approach was adopted because it offered a comprehensive framework for analysis. A further diagram summarises the technology currently being used in the cultural heritage field.

The objective of this research is to identify trends in technologies used within cultural heritage, in order to support scientific exchange between relevant parties. The resulting inventory map identifies techniques, as well as hardware and software used. The summary diagram depicts a synopsis of technologies being used by VAST 2003 researchers.

2. Cultural Heritage and ICTs

An Information System can be defined as "*a set of interrelated components that collect (or retrieve), process, store and distribute information to support decision making and control in an organisation. In addition ... information systems may also help managers and workers ... visualize complex subjects*" [LL00 pp 7].

Typically an Information System contains three activities:
Input: captures or collects the raw data
Processing: converts this raw input into a more meaningful form
Output: transfers the processed information to people who will use it or to the activities for which it will be used [LL00, pp 7].

Applying this to cultural heritage, input can be termed as "Discovery". This includes field research such as excavations, scientific discoveries and all the technologies and processes used within the field. This provides data that is used in the Scientific Process phase (process) where information about artefacts is collected and combined with other related items, documented and prepared for the output or Dissemination phase. In this phase processed information, images and artefacts can be used by cultural heritage professionals through databases and digital displays for further research, as well as by the general public visiting museums and cultural heritage sites.

2.1. Stages of the cultural heritage process and ICT applications

2.1.1. Discovery Phase - Documentation

During an excavation, the site and artefacts found are recorded for documentation purposes. Lopez [2003] observes a strong resistance amongst archaeologists to adopting new technology because they do not see that they have any real advantages over traditional methods of recording a site using photography and illustration.

Lopez believes that there are situations where technology benefits archaeologists: Digital cameras allow the archaeologist to take a more exhaustive record of the subject, as costs of processing images are less than when using an ordinary camera. Furthermore the instant processing capability of a digital camera allows the archaeologist to confirm in situ that the subject is documented, whereas previously they may have developed the photos at home, only to discover that they are unusable. Access to images of artefacts can be obtained in the field through using portable electronic devices such as laptop or palmtop computers, using databases to compare images with the artefact found. This assists the documentation process. Moreover images are quicker to access in a database, than searching through archive boxes.

2.1.2. Scientific Process - Reconstruction

Technology addresses the problems arising from manual reconstruction. These include the fact that it can be time consuming [MTL03], prone to error, for example one artist may illustrate a subject slightly differently to another [KM03], expensive and labour intensive [ST03]. Technology aims to minimise these drawbacks.

Reconstruction technology enables 3D models of artefacts to be generated from fragments found at the excavation site. This speeds up the process of documentation and classification [KM03; MTL03].

Monuments can be reconstructed to depict their original appearance. This can provide a source of added value. For instance the reconstruction of the Parthenon research project aimed to reassemble its sculptures, which are currently distributed in museums throughout the world. This resulted in a 3D model of the Parthenon. The researchers found that the viewer was able to appreciate the structure more, because by placing the sculptures in their correct locations, the relationships between them became more apparent [ST03].

2.1.3. Dissemination

2.1.3.1. Professionals

Many projects presented in VAST 2003 concentrated on advancing technology and used an artefact or sculpture as their test subject. Some resulting papers included a URL where their results could be obtained over the web [ST03]. Other projects involved designing web interfaces to databases thus making collections accessible over the Internet [Lop03; CIG*03; SSE03]. This increases the amount of information available to researchers and also enables the general public to access images from museum collections for their own purposes.

2.1.3.2. General public

In 1991 Merriman [in Ric96] predicted that cultural heritage sites would make a greater use of visual display, which would replace text based formats of interpretation. Today there are many technologies that can assist in presenting information for example virtual reality, augmented reality and interactivity.

Caulton [1999] observes that traditionally the curator of a museum was appointed due to their specialist knowledge on the subject matter of the collection. The safeguarding of the collection was paramount and visitor needs were regarded as being less important, especially as most of the funding received was derived from public sources. Nevertheless there were some museums that decided to invest in interactive technologies and this is thought to have raised expectations and pressure from visitors which resulted in many other heritage establishments facing static or decreasing visitor numbers, along with a reduction in funding by the public sector. [Dav95, in Cau99] This gave rise to new initiatives including exhibition redesign, to increase educational effectiveness [Cau99].

In contrast to falls in funding levels, visitors are becoming increasingly discerning in their evaluations of attractions and are more demanding. The growth of international travel has resulted in the customer comparing the attraction with the best in the world [Ano01]. Moreover people are comparing across sectors and judge the attraction in the context of the best hotels, cinemas and shopping centres they have experienced [Ano01].

Museums and galleries in the UK (and throughout Europe) are being pressurised by governments and local authorities to widen audiences and make their collections culturally and intellectually accessible to everyone [Dav01]. Visitors may differ in their requirements for depth of understanding on the subject matter of the museum [Sil95; Mun96; MdC02] and it is also believed that the depth of information required may differ according to the exhibit. Technology can now accommodate different information requirements. In some mobile applications such as pen tablet PCs, the commentary can be dynamically adjusted to user's walking speed and time spent at the exhibit [TC03; VPD*03].

Such is the competition involved in attracting visitors [Cau99] that there is a need to make the visitor experience as pleasurable as possible and one way to do this would be to 'entertain' the visitor [Ben99]. This trend of entertaining the visitor, whilst at the same time providing education, is called 'edutainment' [Buh03]. Virtual reconstructions allow the visitor to "effortlessly learn whilst being entertained" [PGC03 pp 193]. Avatars and virtual electronic tour guides enable the provision of multimedia representations and reconstructions that make the exhibits livelier [LS03] and provide a sense of personalisation bringing a more human feel to the technology.

3. Methods / Procedures

The aim of this study is to construct an inventory of technologies currently utilised within cultural heritage and determine the technologies most frequently being used. The purpose of this research is that it can support scientific exchange between relevant parties and cultivate innovations throughout the process

This research constitutes exploratory research because not much is known about the subject [Sek00] at this present time. The research procedure began by investigating secondary data sources to acquire instances of technologies and techniques used to transform data. However at the present time, the secondary data sources used were limited to papers presented at VAST 2003. These were examined to produce a comprehensive diagram, based on information systems theory. Thus the techniques implemented were classified using input, process and output theory. The resulting diagram is depicted in figures 1 and 2.

During the construction of this diagram it was found that there was an input, process and output stage for the project overall and also for each procedure. Regarding the project overall, this is represented by dividing the diagram into three columns separated by dotted lines. The input, process and output for each procedure was depicted on the diagram by using different coloured boxes. Also arrows underneath these boxes represent processes that can be repeated. For example multiple scans need to be taken of a subject to enable full, comprehensive coverage.

The analysis of VAST 2003 papers clearly demonstrated a Discovery Phase where data and artefacts are being transformed, a Scientific Phase which involves processing, cataloguing and image development and the Dissemination process, where information was prepared and presented in a form suitable to be consumed by both cultural heritage professionals and the general public.

The numbers in boxes on the left hand side of the diagram correspond to the project number, or in other words the order in which they appeared in the VAST 2003 conference notes. At the bottom of each project are HW and SW boxes. This stands for hardware and software and the respective tools were reported where they were specified in the literature. These were also linked to show which projects were using the same hardware and software.

Once the activities of the project had been sorted, it then became clear that there were projects using the same technologies. This is depicted on figures 1 and 2 by dotted lines which connect two or more boxes together (one connector per project). The relevant technology is shown in capital letters in each box.

Figure 3 condenses the projects into technologies used. It adheres to the three stage archaeological process defined in this paper of discovery, scientific process and dissemination. Therefore a summary of technologies currently used in cultural heritage and how they are interrelated is presented.

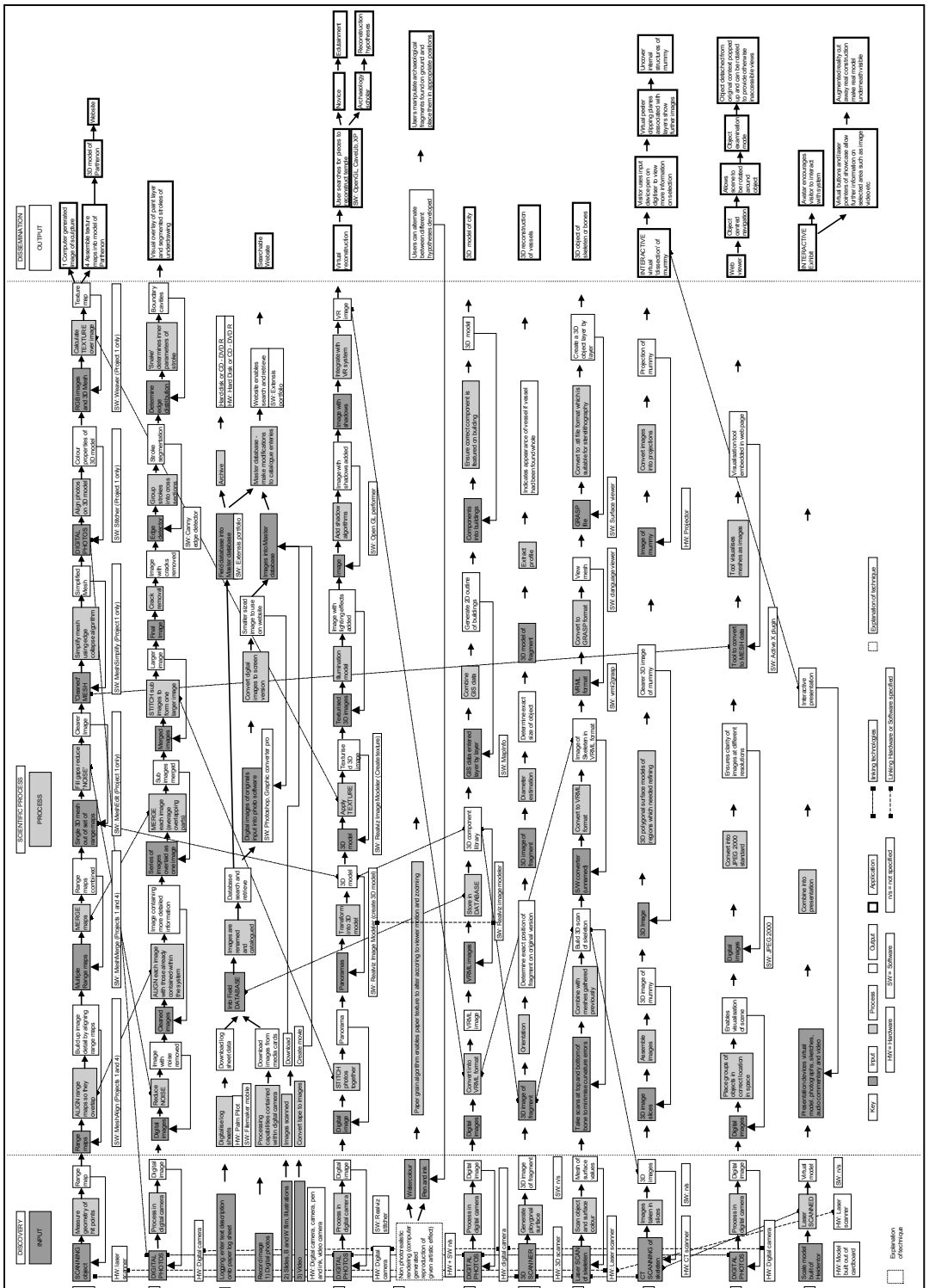

Figure 1: *Inventory of cultural heritage technologies page 1*

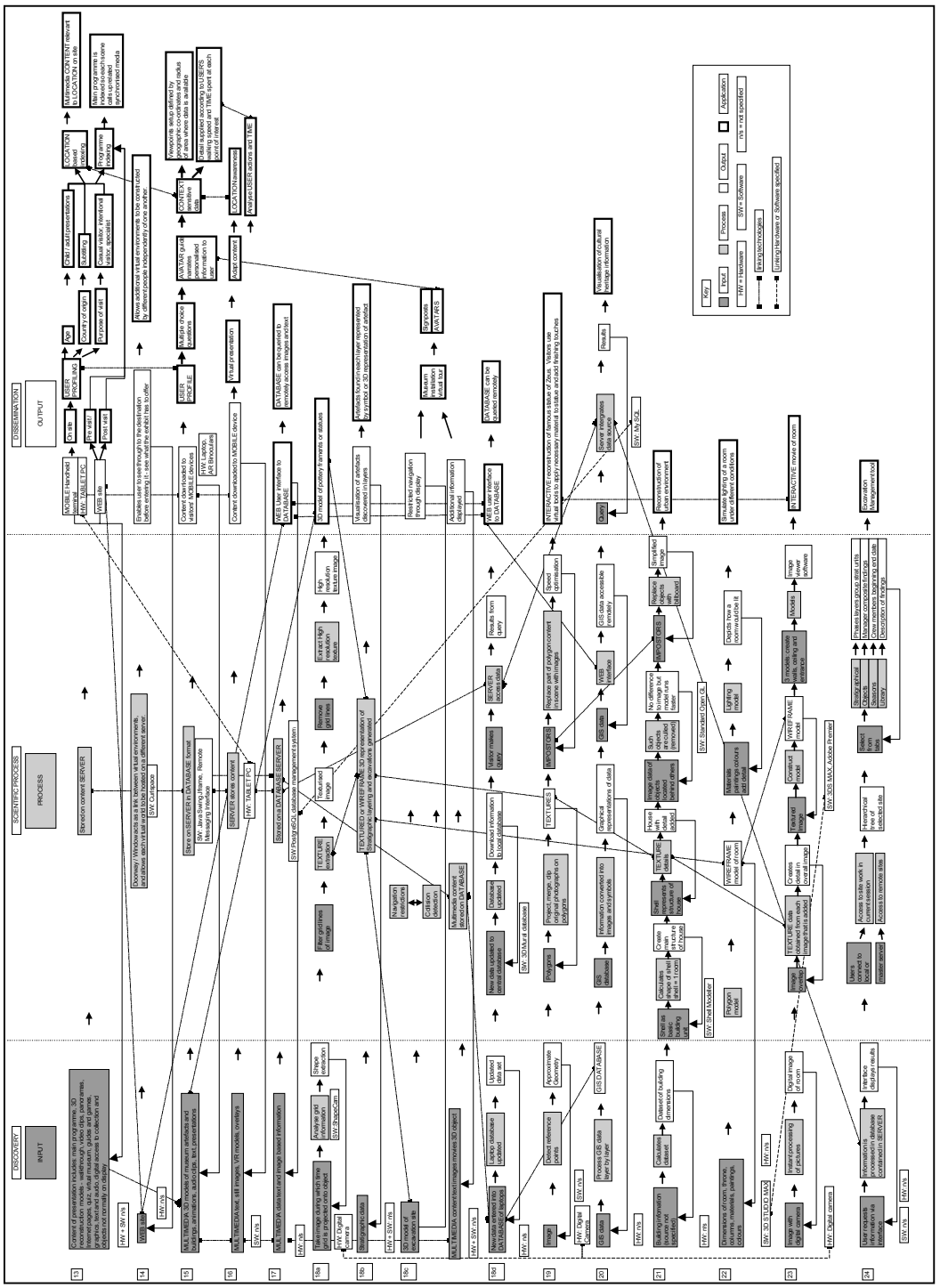

Figure 2: *Inventory of cultural heritage technologies page 2*

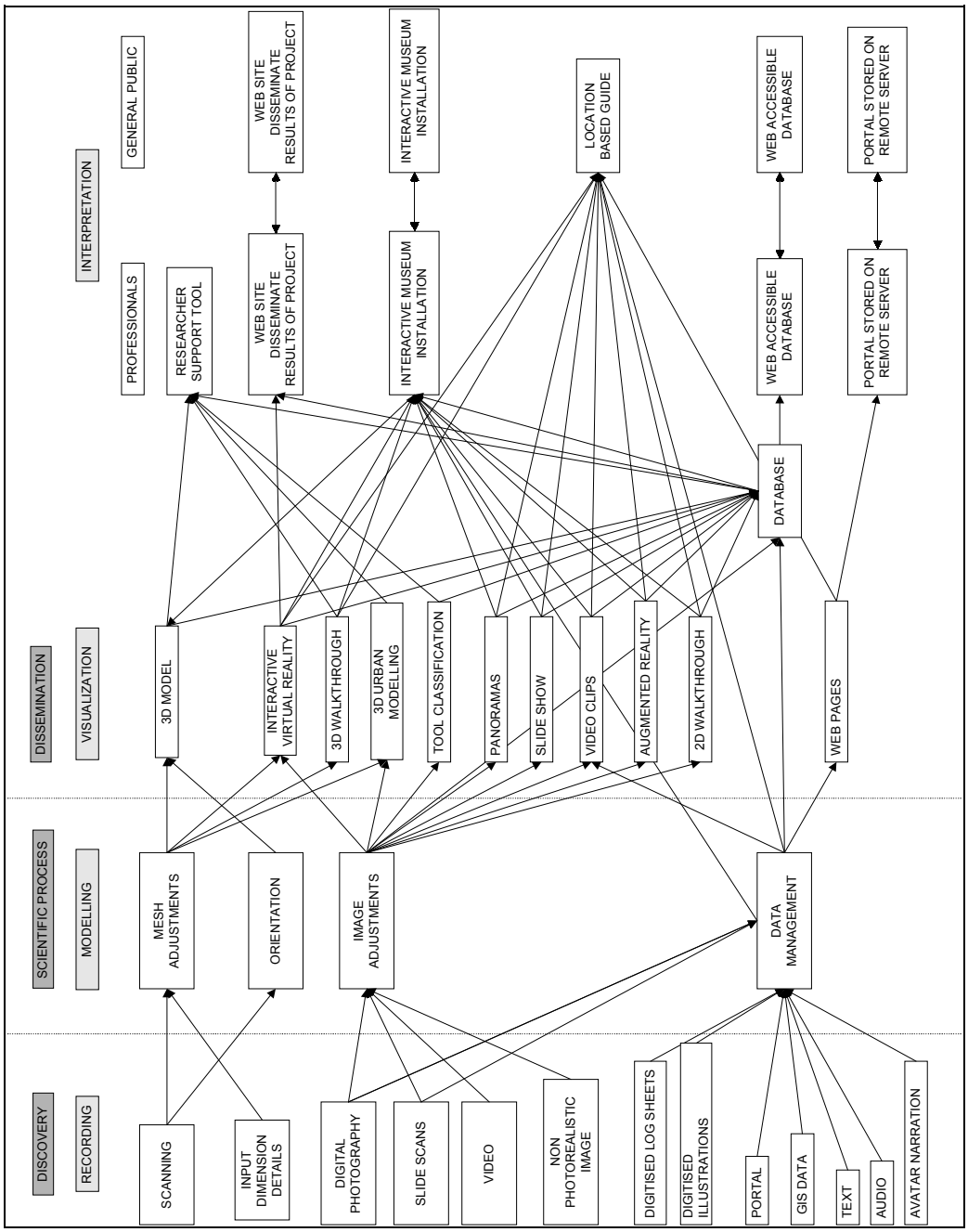

Figure 3: *Summary of cultural heritage technologies*

4. Results

Figures 1 and 2 show that there were instances where the same technologies were being used by different projects and also that some hardware such as scanners and digital cameras were repeatedly utilised for data acquisition. Researchers most frequently used their own proprietary software.

4.1. Discovery – documentation

Images, text and other multimedia were converted into a digital format and then stored in a repository, usually a database. It is becoming increasingly important to develop a common electronic repository to store text, images and multimedia (http://www.ssl.co.uk/) due to an increase in applications. Databases had a dual functionality of storage and search capabilities. Research projects utilized the web to enable access to study findings and often museum collections remotely.

4.2. Scientific process – Reconstruction

Multiple images were taken of the same subject to ensure that as much detail was collected as possible. Images overlaid one another using geometric co-ordinates. However superfluous data was often removed to reduce the file size of the model and to speed up its operations.

4.3. Dissemination

4.3.1. Professionals

There was a general trend towards increasing the amount of information that researchers had access to, particularly disseminating results over the web in terms of presenting findings, or producing searchable databases. In a museum context, often the installations would cater for both the general public and researchers who could test out hypotheses at their leisure.

4.3.2. General Public

The projects focused on interactivity enabled visitors to learn by doing. Users could select the subject they wish to receive further information on. Therefore they could concentrate on subjects they are particularly interested in, instead of having to watch an entire linear presentation.

Wireless technological applications focused on developing electronic tour guides. These harnessed the context specific capabilities of a mobile device, by presenting information which directly related to the exhibit viewed. Information was also sent to visitors in accordance with time spent viewing the exhibit.

4.4. Summary diagram of technologies used

Figure 3 demonstrates that the techniques used within cultural heritage projects presented at VAST 2003 can be summarised into recording, modelling, visualization and interpretation.

Recording could be viewed as 'data acquisition' technologies. Part of this process may involve converting one technology (such as slides) into another, so that it can be used in computer applications. For example producing a digital image of a slide.

Modelling can be described as putting data into a specific order. Mesh adjustments encompassed positioning and aligning different meshes to increase the detail about an overall image. Orientation involves positioning fragments to estimate size and therefore determine the vessel's appearance. Image adjustments involve ordering images, for example stitching images into panoramas for output in a new application. Data management involves putting data into a structure.

Visualization is where information is sorted into a format for the purpose of making it more accessible. Accessibility can be in two ways. Firstly a 3D model of a sculpture enables the visitor to view its image remotely, rather than being physically present at the exhibit. Accessibility can also be in terms of promoting understanding. For example presenting the subject in a visual way such as a walkthrough, or augmented reality helps to explain the subject. Databases visually depict the relationships between one subject and another. This can be seen when the user inputs their search criteria and the results are displayed. In the diagram databases are placed away from other visualization techniques. This is to reflect the fact that databases may be used to store other visualisation technologies such as 3D models, augmented reality images etc. Placing databases to the right of other visualisation technologies emphasises there may be another stage between visualization and interpretation. For example a 3D model is developed first and then is stored on a database. Digital photographs may be stored directly on the database and the diagram reflects this fact.

Interpretation is divided into interpretation for: professionals and the general public. Sometimes technologies can be used for both categories. For example professionals and the general public can use web accessible databases for their own purposes. This is reflected on the diagram by showing the same text box in both categories. For brevity and to avoid confusion, the arrows from visualization technologies are only linked to either professional or general public examples (not both). The horizontal arrows in

between the boxes show that the visualization technologies apply to both categories.

Figures 1 – 2 show that scanning and digital photography are the most frequently used forms of data acquisition technologies used in recording. Scientific process focused on image development and data management. Dissemination involved up to a three step process: enhancing information about a subject, perhaps storing on a database (or at least in computer files) and interpretation for professionals and / or the general public.

5. Conclusions

The research process has proved that is possible to depict an inventory of technologies used in cultural heritage, although at this present time it has been limited to the technologies presented at the VAST 2003 conference. Therefore it does not give full coverage of the archaeological process, but provides a useful starting point.

The research found that each project consisted of a Discovery, Scientific Process and Dissemination stage and that within each stage there involved input, process and output activities. Furthermore procedures were often repeated (such as scanning different parts of a sculpture) until all the necessary data was transformed.

This paper enables the reader to identify technologies applied within cultural heritage and found that technology was used in four main ways: recording, modelling, visualization and interpretation.

It is envisaged that further work will involve an examination of additional publications concerning technological developments in cultural heritage. Primary research involving representatives from cultural heritage organisations will also be carried out. This will consist of questions to identify the technologies currently being used within cultural heritage sites and to obtain information about future initiatives involving technological applications within their establishments. Furthermore their opinions of cost and benefits of technology will be gathered.

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