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WWW.BEAZLEY.OX.AC.UK

1. Introduction

To celebrate the fifteenth anniversary of «Archeologia e Calcolatori» Oxford University's Beazley Archive of Classical Archaeology and Art offers a summary of its work since 1999[1]. For the period 1988 to 1999 please see the tenth-anniversary volume of the journal (Kurtz 1999).

The single most important development of the past five years has been the migration of all of the Archive's databases and educational programmes on to the web. The second has been diversification of materials studied and methods of presentation. The third – the amalgamation of more than twenty databases into one searchable master dataset – will be completed before the publication of this article.

www.beazley.ox.ac.uk (Fig. 1) has more than 150.000 images in multimedia databases, many thousands more in educational programmes and in an illustrated Dictionary with many hundreds of entries. All of this material is held in database form and updated daily. The Beazley Archive data store exceeds 3000GB and is expected to grow by as much as a terabyte every two years. The web site receives on average about 50.000 visits per day and even the most advanced scholarly database (Athenian black- and red-figure pottery of the 6th, 5th and 4th centuries BC) receives more than 5000 queries per day.

2. Sir John Beazley's archive

The transformation of the personal archive of Oxford University's Lincoln Professor of Classical Archaeology and Art (1925-1956) into the Beazley Archive from 1970, the date of Sir John Beazley's death (Fig. 2), has been the subject of many articles over the past two decades. The extent of this "paper archive" is also described on www.beazley.ox.ac.uk/archive. Almost all parts of the original archive have been steadily enlarged since 1970 through benefactions and, less often, purchases. Sir John Boardman, Lincoln Professor between 1979 and 1994, deserves special mention for generously giving books, off-

[1] The first part of this five-year summary relates to content and presentation (§ 1-5); it is written by the Beazley Archivist and Professor of Classical Art, Donna Kurtz. Her active involvement with undergraduate and graduate teaching has ensured that information on the web site is accurate, useful to students and readily accessible to them. The second part (Appendix 1) relates to the technical structure of the datasets, storage and back up facilities; it is written by Greg Parker, Technical Director of the Beazley Archive. The third part (Appendix 2) relates to the nature and extent of the Archive's electronic assets and their relation to others in the University of Oxford; it is written by Adrian Parks, Network Systems Management Service of the Oxford University Computing Services (OUCS).

Fig. 1 – Beazley Archive Home Page.

prints, negatives, and gem impressions, and, most importantly, much time and thought to the preparation of electronic resources on the web site. One of the many distinctive features of the site has been the active participation of senior teaching academics; they have also written lengthy essays (the "educational programs" referred to in this article) specifically for students.

The relationship between Beazley's original "paper archive" and the electronic resources, that have developed since 1979, needs to be explained. The latter is not a computerised version of the former. The "paper archive" had very large numbers of photographs, notes, drawings and gem impressions of different types of classical art, mostly Greek, but some Roman. The material related to all major art forms, but Greek painted pottery, sculpture and engraved gems accounted for about 75%, the remaining 25% was largely Roman. Of the Greek about 60% related to painted pottery, with the remainder being divided fairly evenly between sculpture and engraved gems.

On the web site these three great strengths of Beazley's original archive are maintained in the three principal fields of Pottery, Gems, and Sculpture. The part of the "paper archive" that relates most closely to the electronic resources is painted pottery – the subject for which Sir John Beazley is best known. Some of his publications inspired the Beazley Archive's first use of computers.

The lists of Athenian black- and red-figure pottery published in various editions of *Athenian Red-figure Vase-painters* (1925, 1941, 1964, 1970) and

Athenian Black-figure Vase-painters (1956, 1970) provided "records" of an estimated 60.000 vases and fields (e.g., town, collection, inventory number, provenance, subject, inscriptions, etc.) for computer programmers. Although Beazley's personal archive had more than 200.000 photographs of these vases the Beazley Archive could not begin to digitise them until 1992, when scanners became less expensive and broadband communications were sufficiently well developed to make transmission of images viable for students and senior scholars.

3. The Pottery Database

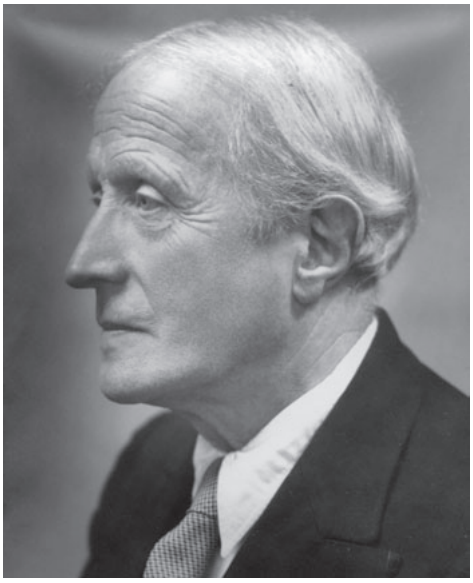
In 1979 programmers in the Oxford University Computing Services (OUCS) began to work with the Beazley Archive. Data were held on the university's central computer and communication with the Ashmolean Museum, where the Beazley Archive has been housed since 1970, was through a large, cumbersome and very slow device known then as Gandalf. Since OUCS was used almost exclusively by scientists, rapid advances in their researches resulted in frequent migrations of data. Although we grumbled about this at the time we learned quickly, swept along by scientists. As a result we were the second university user of international online access in 1991; the Cairns Science Library was the first.

The Pottery Database has been directed by Dr Thomas Mannack since 1986. He records illustrations of Athenian black- and red-figure vases in publications received in Oxford libraries, up-dates references to vases already in the database, and adds new ones. He also receives information from scholars and museum curators. Today the database records more than 70.000 vases and has 35.000 images. The images, from vases in more than one hundred collections in fifty countries, are protected by invisible watermarking developed by Datamark UK in association with IBM Europe. Images also have a visible watermark, forbidding publication and registering copyright with the museum and they are compressed for swift transmission. This database has been the model for the development of other Beazley Archive databases.

For those who are unfamiliar with the material the importance of the database may not be apparent. The painted pottery of Athens, made between c. 625 and 325 BC, is the single richest source of visual information about classical antiquity. In addition to scenes from daily life there are mythical stories that have survived in western culture to this day. The material is critically important to archaeologists, historians, art historians and many other disciplines.

3.1 *Inscriptions on vases*

One aspect of the pottery has special importance and that is the inscriptions painted or incised on a relatively large number. These take a variety of



Figs. 2-3 – 2. Sir John Beazley (1855-1970); 3. Edmond Pottier (1855-1934).

forms – names of painters or potters, names of figures in narrative scenes, rarely captions, names of things or places, rarely names of historical figures, exclamations and trademarks. The Pottery Database has recorded inscriptions on Athenian black- and red-figure vases. The study of Athenian vase inscriptions has been the life work of Henry Immerwahr. He has given the Beazley Archive the eight volumes of his *Corpus of Attic Vase Inscriptions* with more than 8000 inscriptions. These are being added to the Pottery Database. Rudolf Wachter has studied the non-attic vase-inscriptions (WACHTER 2001) and offered this material to the database, as has Alan Johnston, who has studied trademarks (JOHNSTON 1979).

3.2 *Corpus Vasorum Antiquorum*

Corpus Vasorum Antiquorum is the oldest research project of the Union Académique Internationale, begun in Paris after the Great War as an international initiative in the cultural sector. From 1922 to 2004 more than 300 volumes have been published with an estimated 100.000 examples of ancient pottery from more than 100 museums and collections in twenty-six countries. Early volumes had a wide range of examples, as its founder-scholar, Edmond Pottier (Fig. 3), had envisaged, but by around 1950 the figured-decorated Greek and related were dominant.

Between 1999 and 2001 the International Committee of CVA discussed the possibility of digitising volumes. The Beazley Archive, well known for the

success and accessibility of its Pottery Database, was asked to propose a feasibility study. In 2000 this was accepted by the Committee and by the Union Académique Internationale. The president of the UAI asked the Beazley Archivist to prepare a project proposal for the J. Paul Getty Trust. In 2001 the Trust awarded the UAI £75.000 (about $125.000) for a three-year project to digitise out-of-print volumes of CVA for the web. The UAI, based in Brussels, passed the grant to the Beazley Archive in the summer of 2002. The completion of the project, in the summer of 2004, will coincide roughly with the publication of this account (Figs. 4-5; Tav. XIII, a-b).

In real terms the three-year project will cost an estimated £250.000 ($400.000). The British Academy gave £20.000 for digitisation of British volumes, the Bavarian Academy £15.000 for German, the French Academy £11.000 for French museums, the Austrian and Swiss academies £1000 each. The large shortfall in funding has been met by the Beazley Archive involving all members of its staff in the project. The Archive has also been obliged to purchase a robust server and tape-drive back-up system that cost £30.000; its existing electronic assets plus new assets generated by the CVA project were so large that they could not be made secure by the university.

The CVA project digitises the volumes so that they can be browsed as the originals; the International Committee of CVA specifically requested this. It also creates a record number for each text entry and attaches images to it. This means that the CVA project has not only created an on-line searchable CVA, it has also created a master database of ancient pottery produced over a period of more than 700 years. Records of Athenian black- and red-figure are attached to existing records in the Pottery Database, bringing to the CVA project more than twenty years of research in Oxford. The Beazley Archive hopes scholars of other types of pottery will wish to add their data and images to the CVA Database.

The process of digitising volumes, creating text records and adding images is complicated.

Preparation of each CVA volume for on-line publication is lengthy and complex. Approximately 16 to 38 hours of staff time and 16 to 18 hours of computer-processing time are spent on each volume, depending on the consistency and accuracy of the terminology used in the text, and number of entries, images, and fabrics. Eight people work on various stages of the procedure described below, including a co-ordinator who monitors progress and ensures that the system is running smoothly.

Each page of each CVA volume is scanned on a A3 flatbed scanner and saved in TIFF format. Scanning the text pages of a single volume takes on average about two hours. Scanning photographs takes about three hours. Plates may contain a single photograph or as many as forty, on average between four and eight. Each photograph is cropped (extracted) from the elec-

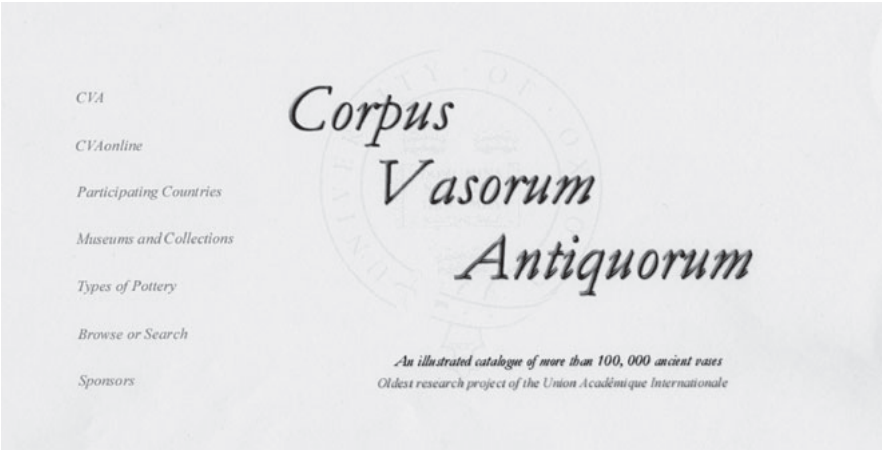


Fig. 4 – The CVAonline project: the current Home Page.

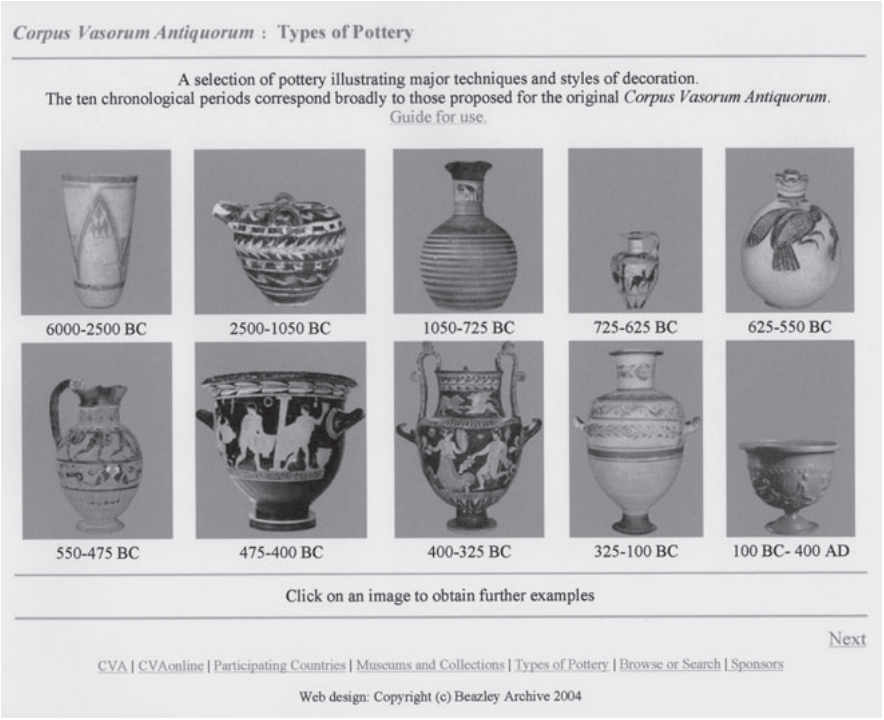


Fig. 5 – *Corpus Vasorum Antiquorum*: types of pottery.

tronic image of the plate, and saved as a separate file, also in TIFF. Cropping and saving can take up to one working day (eight hours). Backup and archive copies of files are kept in different locations.

Details about each vase are entered into a database; this takes a half to one full working day. The information entered is rudimentary (in comparison with the Pottery Database) and includes: fabric, technique, shape, collection name, inventory number, and CVA reference.

After scanning and data-entry have been completed, another program is run to enable scanned images from each volume to be indexed, registered, and linked to their correct database records. The program lists any images that cannot be matched to a record – a problem usually arising from typing errors made during data-entry; these must be addressed before linking can proceed. The program is re-started and corrections are made until no errors are listed. Corrections may take up to half a day, and processing up to a whole day. When images have been successfully processed, a similar program is run for about an hour to index and register text pages.

Each record is checked manually – for academic accuracy and for data or system errors not recognised during automatic checking. Academic corrections are made immediately. If data or system errors are discovered, backup files must be retrieved and errors corrected manually. Corrected records are then re-processed. This final stage may take up to a day.

When the CVA project has been completed a dedicated web site www.cvaonline.org will be launched. It will have a five-language search facility. The 8000 terms of the Pottery Database will be translated into German, French, Italian and Spanish. The text records will be in English as will the other components of the site. There will be links to museums and collections that have their own web sites, and links to national academies. Membership of the international and national committees will be listed.

Greg Parker will write a computer program that will enable each country to access its own data and images. Protected by password access, this facility will enable museum curators to edit and update text and image; it will also give them a ready-made database of their collections. This means that www.cvaonline.org is a dynamic interactive research tool with benefits for museum curators. It is also a public service; few libraries have the complete series of 300 volumes of CVA. Those fortunate enough to have the complete series usually find that many of the loose plates have been lost.

The Beazley Archive's programming of protected password access, creation of active links with museums, watermarking and registering of their images, management of the network and responsibility for its security is a very major commitment that deserves support from national academies. The service creates a model that can be applied to other types of art. The Beazley Archive has already extended it to engraved gems and sculpture.

4. Sculpture

Beazley's mounted photographs of Greek and Roman sculpture, largely from Bernard Ashmole's negatives, are today in twelve four-drawer metal filing cabinets. His many thousands of notes about them are in cardboard boxes. His notes on pottery are stored in the same way, but these photographs have been kept in box files since the 1970s. They were in constant use by students and senior scholars and this type of storage was better suited to simultaneous multiple users. During the 1970s the decision was taken not to enlarge the "paper archive" relating to classical sculpture because there were large and well-established photo-archives of Greek and Roman sculpture on the continent, for example in the German Archaeological Institute in Rome. The Beazley Archive and the *Forschungsarchiv für antike Plastik* in the University of Cologne are exploring the best technical means of searching across their respective datasets. As soon as the Beazley Archive databases are amalgamated this system can be made compatible with Cologne's.

The Beazley Archive's electronic assets on sculpture were developed between 1992 and 2000. The Archive has been housed in the Ashmolean Museum's gallery of plaster casts of Greek and Roman sculpture since 1970. We saw visitors to the gallery on a daily basis as we went about our work. An interest in museum-based initiatives, such as those being promoted by the EU at this time, was a natural result of location and resources. Between 1992 and 1996, in an EU project to test broadband systems with IBM, British Telecom, Nokia and others, the Archive catalogued the roughly 900 plaster casts in the Ashmolean, photographed them, and put the collection on the web.

During the years of the EU telecommunications project the Beazley Archivist began research into the history of Oxford's collection of plaster casts. In 2000 she published *The Reception of Classical Art in Britain, an Oxford story of plaster casts from the antique* (Kurtz 2000). To demonstrate the potential of electronic publishing she designed the page format and cover of the series *Studies in the History of Collections*, published with the Oxford-based Archaeopress, who also publish *British Archaeological Reports. Reception* was the first volume in this series. The *Catalogue of Casts* from the book was placed on the web site with colour images as an example of how traditional and electronic publishing can be combined.

5. Gems

Sir John Beazley published *The Lewes House Collection of Ancient Gems* in 1922. In 2002 Sir John Boardman published a revised edition in a second series produced by the Beazley Archive with Archaeopress (Boardman

2002). Beazley's scholarship of classical engraved gems tends to be overlooked today. For that reason his extensive collection (several hundred thousand) of impressions ("casts") of engraved gems, which the University of Oxford acquired with the Beazley Archive, are now being used for programs on www.beazley.ox.ac.uk. The impressions, Beazley's library of gem books, and the availability of experts such as Sir John Boardman, Dr Martin Henig, Dr Jeffrey Spier, and Gertrud Seidmann, made the development of programs about engraved gems as natural as the Archive's work on plaster casts.

For the past three years Dr Claudia Wagner has been working closely with Sir John Boardman on the gem programs. He has written essays for students and prepared two catalogues which are now on the web with images – *Corpus of Classical Phoenician Scarabs* and the *Danicourt Collection*. She has digitised Erich Raspe's *Descriptive Catalogue of a General Collection of Ancient and Modern Gems* (1791) with 15.000 impressions of engraved gems made by the Scot James Tassie, using photographs (by R.L. Wilkins) of the collection of impressions in the Victoria and Albert Museum. The Tassie Catalogue can be browsed as the original publication; it can also be searched. One of the added benefits of computer technology for the study of the tiny engraved gem stones is that they can be enlarged and viewed easily.

Dr Wagner and Gertrud Seidmann are currently engaged in research on Prince Poniatowski's nineteenth-century collection of classical and neoclassical gems. The collection of 2500 gems was dispersed after the death of the Prince and Dr Wagner is tracing originals in collections and sales catalogues throughout the world.

6. Mixed media programs

One of the many advantages of the Beazley Archive's amalgamated datasets is that different types of objects can be studied together easily. Information is extracted as required to create new programs. An excellent example of how the data can be extracted and made to serve another purpose is *Signatures of Greek Artists* a three-year research project (2002-2004) with the Université Libre de Bruxelles and supported by the Wiener Anspach Foundation. The Brussels team, under the direction of Professor Didier Vivier, will document inscriptions on sculpture, effectively bringing up to date Jean Marcadé's *Receuil des signatures de sculpteurs grecs* (Paris, 1957-1958). The Beazley Archive will extract signatures of artists from the pottery and the gems databases for this program. Brief biographical sketches of artists will be provided using sources such as R. Vollkommer's *Künstlerlexikon der Antike* (2001) and its predecessor Thieme-Becker's *Allgemeines Lexikon der bildenden Künstler der Antike bis zu Gegenwart* (Leipzig, 1907-1950). Examples of their work will be taken from existing Archive databases.

7. Antiquarian books

Digitising the text from Raspe's 18th century catalogue of James Tassie's gem impressions marked the beginning of the Beazley Archive's digitisation of antiquarian books. Like some of its other projects this developed naturally from the resources available in the Archive and in Oxford libraries. Unlike other library digitisation projects this links images of objects illustrated to records in existing Archive databases of pottery, gems, and sculpture. This gives the researcher much added information. The Beazley Archive has, for example, digitised the plates from A. Furtwängler and K. Reichhold *Griechischer Vasenmalerei* (1904-1932) and the 18th catalogues of Sir William Hamilton's vase collection published by P.F.H. d'Hancarville and W. Tischbein. The images can be viewed as the original publication, plate by plate, or they can be viewed as additional illustrations to records in the Pottery Database.

The process of digitisation depends on the type of publication. Some volumes can be put on an A3 flat-bed scanner, some are captured more easily with a digital camera. The quality of image on the web site is adequate for research purposes, and indeed can be enlarged. Like other images on the web site these are not suitable for reproduction.

Since the number of antiquarian books in Oxford with classical pottery, gems and sculpture is large the Antiquarian Book project will be ongoing. The Beazley Archive hopes to be able to coordinate this work with centres in other countries interested in digitising antiquarian books, e.g., France for Bernard de Montfaucon's *L'antiquité expliquée*… (from 1719) the Comte de Caylus' *Receuil d'antiquités*… (from 1752).

Donna Kurtz
Beazley Archive
Ashmolean Museum – Oxford

APPENDIX 1

Technical Structure of the Beazley Archive's electronic assets

The Beazley Archive maintains 22 distinct databases which have evolved over the years. There are 63 distinct interfaces to these databases, giving researchers, scholars, web users etc. different methods of accessing the data. The large number of databases and interfaces has become increasing difficult to maintain. A single coherent structure is under development. The difficulty is that a uniform structure, set of fields, and data entry system cannot be enforced on all users as scholars have developed their own idiosyncrasies in their own specialised fields. Therefore, the Beazley Archive is developing a structure that will allow each database user to have a system tailored to his own specification and acting entirely independently of all the other databases, but there is only one physical underlying database. This allows all development and maintenance work to be carried out on a single system instead of performing the same update 63 times every time a change is made. It also allows cross searching of datasets and compilation of thesauri across all datasets.

The database uses Microsoft's SQL Server database engine. It runs on a Windows 2000 Web Server, using Active Server Pages as the programming system. All interfaces to the database are through standard web browsers so access for display and data entry can run on any type of computer world wide. Security is in place to prevent unauthorized users altering data. This allows the Archive to work closely with researchers in other organizations.

Images are scanned at high resolution, then copyright registration information is embedded into the image, then it is converted to a pyramidal format which allows it to be displayed through a web browser. www.beazley.ox.ac.uk/BeazleyAdmin/Script2/Copyright.htm and www.beazley.ox.ac.uk/BeazleyAdmin/Script2/Copyright.htm provide details. Users can zoom into the image with a Java program automatically loaded by the web page. Only the minimum information is transmitted over the Internet allowing high-resolution images to be accessed over slow modem connections. High-resolution images are kept in an archive tape store maintained by the University of Oxford while the compressed images are stored on the Archive's server to be accessed by users.

GREG PARKER
Beazley Archive
Ashmolean Museum – Oxford

APPENDIX 2

The Beazley Archive datasets and the University of Oxford

The Beazley Archive runs a Windows 2000 domain on the University's Ethernet network, providing World Wide Web access to the Archive's databases as well as file and print services to the staff. The domain was implemented jointly by the Technical Director of the Beazley Archive and the Network Systems Management Services (NSMS) team of Oxford University Computing Services (OUCS).

NSMS provides a wide range of chargeable IT support services to University departments, colleges and associated institutions that either have no existing formal IT arrangements, or that require them to be supplemented in some way. NSMS emphasises security, resilience and continuity of service:

– Security is the first priority; all services are maintained to the latest stable patch levels, configured to the maximum security level commensurate with required functionality, and backed up on a daily basis.
– Resilience is provided through overlapping staff skills, suitable hardware specification standards that NSMS attempts to encourage amongst all its customers, and an effective, rigorous security policy.
– Continuity of service is the consequence of a sound security and resilience policy.

Because of the data storage requirements (the Beazley Archive's electronic resources comprise over 3 terabytes of data – one terabyte being equivalent to 1024 GB), special consideration was given to the specification of the primary fileserver in the domain, especially in terms of hardware redundancy and storage capacity. Much of the Archive's data consists of high resolution uncompressed images. These are stored on the University's Hierarchical File Server at OUCS, a centrally funded service providing backup and long-term archive services to members of the University. Data sent to the HFS server is archived on magnetic tape in an automated (robotic) tape library. Currently the Beazley Archive's uncompressed image material accounts for 25% of the total amount of data archived to the HFS by units within the University – a significant portion.

However there is a requirement for at least some of the data to be locally stored – primarily the same images, but compressed for viewing via the web site. At present there is approximately 750GB of data on the Archive's primary fileserver, and this is increasing at the rate of 150 GB/year (a yearly increase of 15GB on the server, with 135GB being archived to

the HFS). As such consideration was also given to the ease of adding extra storage capacity to the server.

Most server systems within the University use the HFS as a means of backing up their data on a daily basis, rather than as a long-term archive (it should be noted that the archive and backup functions of the HFS are very different services). However, owing to the fact that the image data stored on the server (compressed images) is in essence duplication of the data stored on the HFS archive (uncompressed images) it is currently not feasible to implement the HFS backup service for this fileserver. Furthermore, even excluding the archived material, the server holds over ten times the amount of data of any other servers in units that NSMS is involved with. In light of this a separate tape library was specified for the server and local backups to tape are performed on a daily basis.

The specifications of the primary fileserver are as follows:

– Xeon 2.5Ghz/512K processor, 2GB RAM, 1 TB storage (expandable to approx 2.5 TB) in a RAID-0 (system drive) and RAID-5 (data drive) configuration, using hot-swappable SCSI drives.
– Redundant power supplies/network card.
– LTO tape library, supporting up to 24 100GB LTO tapes.

Adrian Parks
Oxford University Computing Services

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ABSTRACT

This article offers a summary of the Oxford University's Beazley Archive of Classical Archaeology and Art work since 1999 (for the period 1988 to 1999 see the tenth volume of this journal). The most important developments have been the migration of all of the Archive's databases and educational programmes on to the web (*www.beazley.ox.ac.uk*); the diversification of materials studied and methods of presentation; the imminent amalgamation of more than twenty databases into one searchable master dataset.

This five-year summary is divided into three parts: the first part relates to the content and presentation of the Beazley Archive, with particular reference to the Pottery Database and the recent three-year project to digitise the CVA volumes for the web, which was granted to the Beazley Archive by the *Union Académique Internationale*; the second part relates to the technical structure of the datasets, storage and back up facilities and the third part relates to the nature and extent of the Archive's electronic assets and their relation to others in the University of Oxford.