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EPOCH

Excellence in Processing Open Cultural Heritage

Network of Excellence

Information Society Technologies

D.3.3.4. First set of open software tools (version month 18)

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Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)		
Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

1 Table of Contents

"There is an inherent affinity between culture and Open Source. A work of culture is open for interpretation by everybody; it is an open source for further developments and other works of culture."

(S. Bürer)

2 Introduction

This deliverable will investigate the possibilities and restrictions of open software in the field of cultural heritage. As EPOCH aims at improving the quality and effectiveness of the use of Information and Communication Technology for cultural heritage, the issue of open software certainly needs to be addressed. This deliverable has been compiled to support the activities in EPOCH's work package 'Jointly Executed Research' (WP 3).

After defining the terminology used in this report, an overview of European research projects dealing with open software is given. The use of open software solutions in the field of cultural heritage is the central theme in this deliverable. When assessing the possibilities of open software in cultural heritage applications, certain advantages arise. However, it immediately becomes clear that the cultural heritage field is not a major target of open software developers.

A survey of open software solutions for cultural heritage forms the core part of this report. It is clear that a lot of generic tools are available on the Internet, which can support cultural heritage professionals. This report primarily focuses on more specific tools, of which a concise overview is given.

In the final chapter of this deliverable EPOCH clarifies its attitude towards open software. Though some advantages of open software are obvious and recognised as such by the network, EPOCH warns for an over-optimistic view on open software. That chapter also lists some of the tools of EPOCH partners which may become open source.

3 Work package 3: Jointly Executed Research

In order to place this deliverable into context, we first sketch the activities within WP3, as formulated in the description of the first JPA. This work package will guide and cross fertilise the research activities of the partners in the Network (and hopefully of others) in order to ensure maximal relevance for the Cultural Heritage domain, high quality, as well as cohesion and complementarities among these activities. A first activity therefore consists of Coordination of the Jointly Executed research (WP3.1).

A second activity aims at Establishing and Maintaining a Common Infrastructure (WP3.3) which will form a substrate upon which to build particular end-user applications and showcases. This activity will define the architecture, components and design guidelines for this common infrastructure. The goal is the creation of a toolbox of inter-operable modules for producing applications involving digital versions of tangible cultural heritage.

This report describes a first set of identified open source tools, specifically designed for Cultural Heritage. The idea is that EPOCH will itself add further such tools and components. As the NoE EPOCH has been explicitly requested by the EC not to develop any technology itself during its first year, the reported tools and components have mainly been the result of work done outside of the network, even for the tools offered by the EPOCH partners.

This report is labelled “version month 18” because of the ambiguity of the delivery date. In JPA18 it must be delivered by month 18 but in the proposed JPA30 it will be delivered at month 30. A future report will see an increase in contributions within EPOCH.

4 Open software

A variety of interpretations exists with regard to the nature of free and open source software, sometimes confusing it with different kinds of gratis software or liberally using the term for the development process, the software product or a particular licensing scheme. Free and open source software is also often mentioned in the same breath as open standards or interoperability, which are distinct issues in their own right.

4.1 What is Free Software (FS)?

The basic characteristic of Free Software[1], as defined by its creator and leading advocate Richard Stallman, is that the user is free to make decisions on the use of the software code.

Free software is software that meets the following "four freedoms" (as defined in the Free Software Definition[2]):

- the freedom to run the program for any purpose;
- the freedom to study how the program works, and adapt it to your needs;
- the freedom to redistribute copies so you can help your neighbour;
- the freedom to improve the program, and release your improvements to the public, so that the whole community benefits.

In the absence of a suitably unambiguous word in the English language, the classic definition of free is "free as in free speech, not as in free beer."

4.2 What is Open Source (OS)?

In the mid 1990s a new movement evolved in reaction to this, seeking to characterize and promote the more 'sellable' aspects of Free Software, while giving much less emphasis to the social, moral and political arguments favoured, and regarded as absolutely fundamental to Stallman and the FSF. This movement was dubbed 'Open Source,' now represented by the Open Source Initiative (OSI) with the programmer and writer Eric S. Raymond at its helm. A quote from the OSI Web site illustrates the shift in emphasis from that of the Free Software Community: "We think the economic self-interest arguments for Open Source are strong enough that nobody needs to go on any moral crusades about it." [3]

Open Source, as defined by Bruce Perens in the Open Source Initiative, is very similar to Free Software. The main underlying concept is that Open Source does not just mean access to and free use of the source code. The distribution terms of Open Source Software must comply with the following criteria:

[1] http://www.fsf.org

[2] http://www.fsf.org/philosophy/free-sw.html

[3] http://www.opensource.org

- Freedom to redistribute
- Source code must be included
- Freedom to create derived works
- Integrity of the author's source code, i.e., amended work must be distinguished from the original version
- No discrimination against persons or groups
- No discrimination against fields of endeavour
- Distribution of license: i.e. redistribution of the software shall include the license and must not add further restrictions (such as non-disclosure agreements)
- The license must not be specific to a product
- The license must not restrict other software
- The license must be technology-neutral

Proponents of open software perceive several advantages and benefits:

- Transparency
- Auditability
- Easy access to the software: download source or binaries
- Tends to be high quality and economical
- Strong communities for support and development: engineering is best when members work together to positively address all constituents' concerns
- Collaborative development

Some prominent success stories:

- Linux
- Apache
- MySQL, PostgreSQL, Firebird
- Php, Perl, Python
- Mozilla
- OpenOffice.org
- GIMP
- Sendmail
- Samba
- Blender
- Gaim
- …

A selection of popular Web sites exists to promote and distribute Open Source software materials (e.g., SourceForge[4] or Freshmeat[5]). For applications that work well, success and prominence usually follow with word spreading around the community. Umbrella resources like the Open Source Developers Network[6] offer a platform for shared ideas and knowledge interchange, and at the same time providing mechanisms for the promotion and distribution of Open Source applications.

Other interesting resources include the International Open Source Network[7] and the UNESCO Free software portal[8].

The OpenScience project[9] is dedicated to writing and releasing free and Open Source scientific software. The project members are a group of scientists, mathematicians and engineers who want to encourage a collaborative environment in which science can be pursued by *anyone* who is inspired to discover something new about the natural world.

4.3 GNU licensing schemes

The most common software license under which Free and Open Source software is distributed is called the GNU General Public License (GNU's Not Unix). Originally conceived to describe the legal status of the GNU operating system, this has become the generic standard Free Software license. It is a Copyleft license, and establishes and seeks to protect the freedom of its associated software quite strictly. However, a number of alternative 'off-the-shelf' licenses are now available for developers and distributors to utilise, and these can be Free, or Open Source, or both[10].

There is a lot of useful information about licensing schemes available on the Internet. Here we mention just a few interesting websites:

- http://www.gnu.org/licenses/ : GNU licenses
- http://www.opensource.org/licenses/index.php : OSI approved licenses
- http://www.museumscopyright.org.uk/question.htm : Questionnaire relating to digital licensing scheme for cultural organisations
- http://cyber.law.harvard.edu/openlaw/gpl.pdf : Open source software licensing
- http://www.abanet.org/intelprop/opensource.html : An overview of open source software licenses

[4] http://sourceforge.net

[5] http://www.freshmeat.net

[6] http://www.osdn.com

[7] http://www.iosn.net

[8] http://portal.unesco.org/ci/en/ev.php-URL_ID=12034&URL_DO=DO_TOPIC&URL_SECTION=201.html

[9] http://www.openscience.org

[10] See http://www.opensource.org/licenses and http://www.fsf.org/licenses for details of approved licenses.

5 European research projects and open software

The European Commission has supported a number of initiatives in the domain of free and open source software since 1998, with initial steps conducted through the creation of the Working group on Libre Software[11]. The working group presented a paper at the IST'99 conference in Helsinki during the special session track on Libre software, and at the workshop on free software held on March 23 2000 in Brussels.

Some 20 research projects directly supporting F/OSS are currently under way, were funded during the EU's 5th Framework Programme (1998-2002). They contributed to the development of essential components of a free software infrastructure, and associated development tools or applications. A catalogue of FOSS related projects funded by the Commission can be downloaded[12].

In preparation of FP6, ISTAG[13] published a report[14] on "Software Technologies, Embedded systems and Distributed Systems" that also has a chapter on the role of open source. The recommendations call for the use of open source in all relevant areas of the IST as well as in specific fields such as e-government. The FP6 IST work programme 2003-2004[15] refers to FOSS in the following way "The development of open standards and open source software will be encouraged when appropriate to ensure interoperability of solutions and to further innovation".

A selection of direct links to projects related to free and open software in various parts of the 5th and 6th Framework Programmes is provided at the Europe's Information Society Thematic Portal[16]:

- CRUMPET (Creation of User-friendly Mobile services Personalised for Tourism)[17]
- E-leGI (European Learning GRID Infrastructure)[18]
- BRICKS (Building Resources for Integrated Cultural Knowledge Service)[19]
- PRESTOSPACE (Preservation towards storage and access. Standardised Practices for Audio-visual Contents in Europe)[20]
- DELOS (Network of Excellence on Digital Libraries)[21]

[11] http://eu.conecta.it

[12] http://europa.eu.int/information_society/activities/opensource/doc/pdf/catalogue.pdf

[13] http://www.cordis.lu/ist/istag.htm

[14] ftp://ftp.cordis.lu/pub/ist/docs/istag-software-wg9final0702.pdf

[15] http://www.cordis.lu/ist/workprogramme/fp6_workprogramme.htm

[16] http://europa.eu.int/information_society/activities/opensource/european_activities/index_en.htm

[17] http://www.ist-crumpet.org

[18] http://www.elegi.org

[19] http://www.brickscommunity.org

[20] http://www.prestospace.org

[21] http://www.delos.info

Some recent EU projects also focussed on open source applications in cultural heritage:

- **ECHO**
  The basic idea of the ECHO[22]-initiative (European Cultural Heritage Online) was to establish an "*open-source culture of the public and scholarly exploitation of cultural heritage on the Internet*". This idea comprises the promotion of content-driven technology in information management. ECHO's aim is to create an Agora, a community of producers and users of culturally relevant information, who are willing to freely exchange this in order to build a joint portal and a common infrastructure.
- **MICHAEL**
  The MICHAEL[23] platform (Multilingual Inventory of Cultural Heritage in Europe) relies on a platform called SDX, which combines the following open-source components:
  - Apache Tomcat java servlet engine, which includes the Apache web server
  - Apache Cocoon publishing engine
  - OAI-PMH compliance and Lucene search engine

[22] http://echo.mpiwg-berlin.mpg.de/home

[23] http://www.michael-culture.org

6 Cultural heritage and open software

The open source approach offers today new possibilities in the field of cultural heritage. A number of factors make the Open Source model particularly suitable for the cultural heritage world (DigiCULT: Technology Watch Report 3):

- financial limitations
- requirements for openness and 'future-proofing' within software
- the often physically distributed nature of organizations and projects

Like public sector institutions, the cultural heritage sector has a vested interest in both the financial cost and the openness and accessibility of the software it uses. Many institutions have discovered that open source solutions offer sufficient advantages to suit all of their requirements.

Given the range of Open Source advantages that are compatible and complementary with the goals and requirements of the heritage sector, it is perhaps surprising that migration to open source solutions has not taken place on a greater scale. A number of factors may account for this (DigiCULT TWR 3: 32):

- lack of information from the Open Source movement directed towards the heritage community
- the heritage sector still regards Open Source as a technological 'bridge too far'
- insufficient expertise is available to fully implement these kinds of solutions

Cultural heritage organizations lacking substantial in-house technical staff should be fully informed about the staff requirements of using open source software products. Although such products offer the latest solutions developed by high-quality technology organizations, they may require considerable time to install, customize, and maintain (Bisshoff & Allen 2004).

Concerning the first factor (lack of information), DigiCULT suggests that "with the primary motive of expanding Open Source's user base, the type of clients most frequently targeted are those in the commercial and government sectors where lucrative contracts are available and interest from other sectors can be more easily generated."

This statement seems to be confirmed, when we look at the readily available open source solutions for cultural heritage professionals. A search on Sourceforge (sf.net), which holds a repository of more than 100.000 open source software projects, yielded less than a dozen projects related to cultural heritage *(see Table 1)*. Although several other open software solutions are – without any doubt – also relevant for CH professionals, it is clear that the field of cultural heritage is not a major target of open source developers.

Although short in its own right, the overlap with EPOCH activities is even smaller. Library storage and access oriented activities are not the focus of our NoE, but of its sister projects PRESTOSPACE, DELOS, and to some extent BRICKS. A first conclusion therefore is that EPOCH's activities in this regard are timely, and that 'market' penetration will not be easy as there is not much of an Open Source community in the CH sector as yet.

Table 1: Software applications found at Sourceforge (July 2005)

Keyword "CULTURAL"	
Spatial Knowledge Base	Spatial Knowledge Base is a web-based document and spatial knowledge system. It allows archiving and indexing of content and spatial data useful in GIS analysis. It can be used for archaeology, cultural resources management, and content management.
myColex	Museum collection documentation, object inventory and cultural event management, using Apache/PHP
Keyword "HERITAGE" : nothing	
Keyword "ARCHAEOLOGY"	
Walldrawer	Alternative to on-site wall drawing for archaeology this software aims at putting together the tools needed to produce scaled, rectified, drawing-like pictures from digital photographs in archaeological excavations
Keyword "MUSEUM"	
Museolog	Museolog is a web-driven software system for cataloguing museum information
Museum Collection Management	Museum Collection Management using MS Access. An MS Office installation is recommended, since this project also utilizes MS Word for merging data into templates.
mapstedi	The University of Colorado Museum (UCM), Denver Museum of Nature and Science (DMNS), and Denver Botanic Gardens (DBG) are collaborating to convert their separate collections into one distributed biodiversity database using Apache, Tomcat, and ArcIMS.
MMS - Museum Management System	The purpose of this project is to develop a web based Museum Management System, which will allow classifying all the museum-related information (i.e., collections, libraries, etc.)
Medlane	The Medlane project is an attempt to create a set of tools that will enable librarians to move from the standard MARC (MAchine Readable Cataloging) format to a new library/museum XML format. This move will ensure traditional library/museum data remains
Virtual Lightbox for Museums	The Virtual Lightbox for Museums and Archives (VLMA) applet allows users to search, browse, collect, compare, and export structured image-metadata clusters from online collections that implement the VLMA rdf format.
Text Encoding Initiative	The TEI is an international and interdisciplinary standard used by libraries, museums, publishers, and academics to represent all kinds of literary and linguistic texts, using an encoding scheme that is maximally expressive and minimally obsolescent.

7 Overview of open source solutions for cultural heritage

Although this deliverable is primarily concerned with open software for cultural heritage applications, it should be clear that a lot of more generic open software tools are available on the World Wide Web. These free software solutions can improve the efficiency of many computer users; including those working in CH. As there is a plethora of information available on these more generic open source software in other resources, we only refer to the OpenCD project, which compiles the most frequently used Open Source, and the content management systems.

The **OpenCD**[24] is a collection of high quality free and open source software. The programs run in Windows and cover the most common tasks such as word processing, presentations, e-mail, web browsing, web design, and image manipulation. Included are only the highest quality programs, which have been carefully tested for stability and which were considered appropriate for a wide audience *(see Appendix A)*.

The website **opensourceCMS.com**[25] lists (and lets you try out) many free and open source CMS (Content Management Systems). Many of these are also used for cultural heritage content. An example is the Swedish museums which use Joomla[26] and Typo3[27].

7.1 General

The success of the session "Open Source and Archaeology" organised during the international conference CAA2004[28], held in Prato (Italy) proved that open software is a promising opportunity for cultural heritage. Several reasons for this can be distinguished: the low cost of the software solution, the great possibility of personalisation of the tools, and the cooperative community towards which this kind of approach leads. Villebrandt et al. (2004) perceived the use of proprietary software to model archaeological objects and sites as an inherently dangerous practice, since such software and its platforms may rapidly become obsolete.

An important web resource is the "**Internet and Open Source in Archaeology**" (IOSA) website[29].

In the same spirit, the **ARC-team**[30] is an Italy-based company founded by five young archaeologists and craftsmen, dedicated to archaeological fieldwork, architectonical documentation and the study and cultivation of our historical and cultural heritage.

Recently a special discussion board (mainly in German and Italian) on archaeology and open source applications was launched at the Austrian Archaeology forum[31]. Currently, the activity level on this forum seems to be rather low however.

[24] http://www.opencd.org

[25] http://www.opensourcecms.com/ (look at the "CMS ratings" menu item for a comparison of CMS implementations)

[26] http://www.joomla.org/

[27] http://typo3.org/

[28] http://www.caa2004.org

[29] http://www.iosa.it

[30] http://www.arc-team.com

The recently (in 2005) started **SIDORA Project** (Sistema Integral de Documentació i Organització del Registre Arqueològic)[32] intends to create and to share with the scientific community an Archaeological Information System, made for archaeological recording in its widest sense. SIDORA has the intention to be open, accessible and free (Tartero Bieto & Vidal Aixala, in press). The current status of this project is unclear however. After the project presentation at the CAA 2005 conference, the SIDORA website has been offline since August 2005.

Alessandro Bezzi *(in press)* summarized his experience in replacing his operating system and most common used archaeological software with Open Source Software. Several considerations influenced the decision to change. The first and most important one was the different ideology behind the Open Source movement: not only software but every kind of knowledge is public property and should be accessible for everyone. By looking for alternatives for proprietary software, Bezzi has found them for almost every archaeological need. As most of this software was not specifically designed for cultural heritage, we give an overview in *Appendix C*.

Bezzi believes that open source solutions have three decisive advantages:

- Software can be modified and optimized by its users
- Software is supported by thousands of programmers around the world
- Software is accessible to everyone

However, Bezzi also identifies some disadvantages:

- Some packages aren't very user friendly (yet).
- Participation from archaeological professionals in the open source community is still restricted. This causes slower development of adapted solutions.
- There is still a psychological barrier for many users (archaeologists) to renounce their usual software packages and try new ways.

7.2 Fieldwork

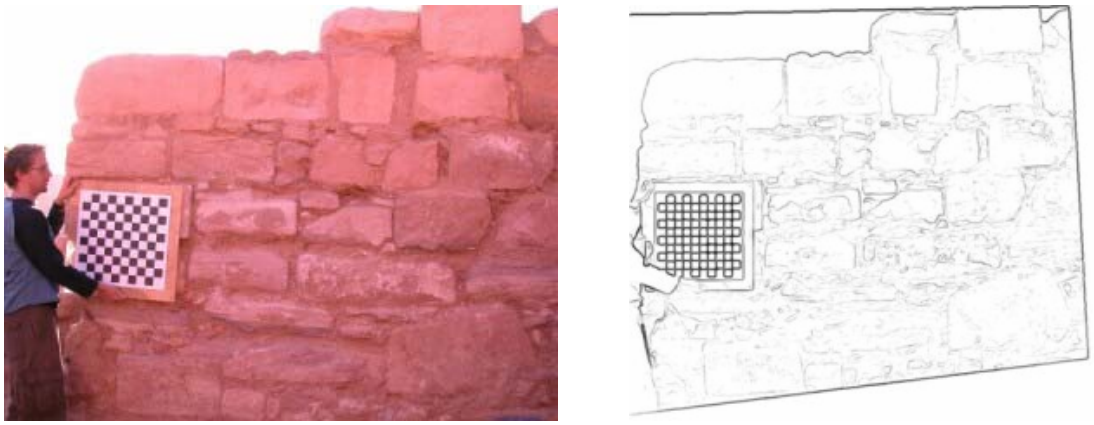
Walldrawer[33] - an easy alternative to on-site wall drawing for archaeology this software aims at putting together the tools needed to produce scaled, rectified, drawing-like pictures from digital photographs in archaeological excavations. It has been successfully employed at the Brown University Excavation of the Petra Great Temple, Jordan. The software seems to have quite some bugs however. Further development seems to have ceased as well, though IOSA announces to publish a Walldrawer manual in the near future (September 28, 2005).

Latest file release: Walldrawer-0.2 May 23, 2004

[31] http://archaeologieforum.at/forum/index.php?showforum=183

[32] http://www.sidora.org (accessed 19 May 2005; website currently offline – 14 august 2005)

[33] http://sourceforge.net/projects/walldrawer/



Wallpaper example from Bazin and Henry 2003[34]

MapTools.org[35] is a resource for users and developers in the open source mapping community, and a home to many open source projects. The projects that are hosted offer essential services including: latest downloads, CVS repositories for source code, bug lists, community mailing lists, and project documentation.

7.3 Visualization

The **3D visualization toolkit**[36] is provided by the Science Museum of Minnesota's Learning Technologies Center for professional museum educators, schools, researchers and science hobbyists who are interested in a community around open source scientific visualizations. On the website one can find areas to learn more about visualization approaches, software that you can freely download, a gallery of images created by the Science Museum of Minnesota and members of this site, pre-made textures, models, and scenes to use as building blocks for your own animations, and more *(see Appendix B)*.

Rawkee[37] is an open source (LGPL) X3D plug-in designed for use with Alias' line of 3D authoring software, Maya Complete and Maya Unlimited. The purpose of RawKee is to export Maya's 3D data as an X3D file with support for scripting through RawKee's interaction editor. Development for RawKee is coordinated by the Archaeology Technologies Laboratory (ATL) of North Dakota State University (NDSU). The ATL conducts research into the use of web-based 3D graphics for use in archaeology, historical and human heritage preservation. The ATL is currently incorporating X3D into several of its projects. These projects include: Virtual Archaeologist, Digital Archive Network for Anthropology and World Heritage (DANA-WH), and Native Dancer (ND). http://groups.yahoo.com/group/RawKeeUsers/ is the RawKee user group.

Latest file release: July 2005

[34] http://medic.rad.jhmi.edu/pbazin/research/publications/bazin-henry-walldrawer-shapelab03.pdf

[35] http://www.maptools.org

[36] http://ltc.smm.org/visualize/toolkit?from=0

[37] http://rawkee.sourceforge.net

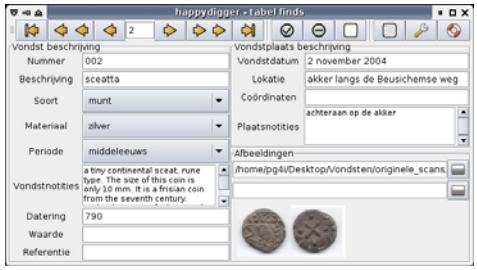
Wings 3D[38] is an open source 3D modeller written in Erlang, similar in design to the now-defunct Nendo. It is rapidly becoming the de facto 3D modelling program, even compared to high-end commercial packages like Maya.

MilkShape 3D[39] is a low-polygon modeller, which was initially designed for Half-Life. During the development, many file formats have been added. It has all basic operations like select, move, rotate, scale, extrude, turn edge, subdivide, just to mention a few. MilkShape 3D also allows low-level editing with the vertex and face tool. Primitives like spheres, boxes and cylinders are also available. It has also skeletal animation capabilities. This allows exporting to morph target animation like the ones in the Quake model formats or to export to skeletal animations like Half-Life or Genesis3d. It currently supports 37 different file formats from 27 different games/engines/programs.

The **Appia Antica Project**[40] is a good example of the growing importance of open software in archaeology. Pescarin et al. (in press) describe the application of tools such as OpenSceneGraph and Virtual Terrain in the Case of the Archaeological Park of Appia Antica (ancient Via Appia, Rome – Italy)[41].

7.4 Data management

Happydigger[42] is a program that can be used for cataloguing archaeological finds. It is intended both for semi-professional use and by amateurs (e.g., metal detectors) who want to keep track of their finds. Data is stored into a database with extensive find and findspot details. If images are available, they will be displayed together with the find information. Currently the program is only available for Linux operating systems. Users need the gtk+-2.0 and sqlite3 development libraries and headers to compile Happydigger. The user interface is available in English, Dutch and French.



Latest file release: 2.0 23-Aug-2005

Spatial Knowledge Base (SKB) server[43] is a web-based document and spatial knowledge system. It allows archiving and indexing of content and spatial data useful in GIS analysis. It can be used for archaeology, cultural resources management, and content management.

[38] http://www.wings3d.com/

[39] http://www.swissquake.ch/chumbalum-soft/

[40] http://www.appia.itabc.cnr.it/index.html

[41] http://www.appia.itabc.cnr.it/OSandCH.htm

[42] http://www.xs4all.nl/~pa4tu/happydigger/happydigger.html

[43] http://sourceforge.net/projects/skb

Staynov & Genov (*in press*) presented an XML based open source solution for online/offline archaeological data storage and processing. The application[44] is a database management system developed by the departments of Informatics and Archaeology of the **NBU**. The existing implementations of the system concern different lithic assemblages from prehistoric sites on the territory of Bulgaria, Greece and Turkey.

Another open source database was used in the **Giza Plateau Mapping Project Excavation Database** (Tonner 2004)**.** To keep costs down, open source software was employed featuring the operating system Linux, the object-relational database PostgreSQL, Apache web server, the scripting languages PHP and JavaScript. Forged together, a flexible and secure web-driven database was developed integrating all archaeological datasets from the Giza Plateau Mapping Project archives.

7.5 Dissemination

Open Archaeology[45] is an XML-based repository of archaeological and related information that can be re-used and redistributed according to the terms of the Creative Commons Attribution License. It is currently very much biased towards the Ancient Mediterranean and within that field towards the study of Late Roman pottery and its distribution throughout the Mediterranean basin. It is a good case of both using open content distribution and open standard encoding for archaeological purposes.

TimeMap[46]: the code will be released at the end of 2005 under the GNU GPL and LGPL licenses, but is available to Consortium members immediately under the *Time*Map Open Source Consortium license. In moving TimeMap to Open Source the authors wish to ensure that it maintains coherence and provides a shared infrastructure, rather than fragmenting into many incompatible implementations through code-mining or poorly coordinated development.

7.6 Museums and libraries

Of particular interest to cultural heritage institutions are several small applications and tools discussed in the DigiCULT.Info newsletter, including Koha and Greenstone (Open Source software for digital libraries). Also of interest are MyColex, EROS image content retrieval system, mcm-f-access[47]. See also “Open Source Tools” in DigiCULT.Info, Issue 7, April 2004, pp. 31, “PLEADE – EAD for the Web” and “NZ Electronic Text Centre” both in DigiCULT.Info[48], Issue 6, December 2003.

Greenstone[49] is a suite of software for building and distributing digital library collections. It provides a new way of organizing information and publishing it on the Internet or on CD-ROM. Greenstone is produced by the New Zealand Digital Library Project at the University

[44] http://www.csisb.org/arcada

[45] http://www.openarchaeology.org

[46] http://www.timemap.org

[47] http://mcm-f-access.sourceforge.net/

[48] http://www.digicult.info/pages/newsletter.php

[49] http://www.greenstone.org

of Waikato, and developed and distributed in cooperation with UNESCO and the Human Info NGO. There is also a user group list[50].

Koha[51] is a full-featured open source ILS. Developed initially in New Zealand by Katipo Communications Ltd and first deployed in January of 2000 for Horowhenua Library Trust, it is currently maintained by a team of software providers and library technology staff from around the globe.

MyColex[52] is a museum collection documentation, object inventory and cultural event management, using Apache/PHP. It supports all important topics of object inventories and cultural events and has interfaces to all major standards. It is a proven application, developed in the Historical Museum Basel, Switzerland, and in use in many Museums.

Latest file release: myColex 1.2.1. June 18, 2004

Museolog[53] is a web-driven software system for cataloguing museum information. Museolog was developed by EUROCLID within the UNESCO HeritageNet, a network of heritage institutions in Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. Russian is the dominating language in documentation and interface. A technical review recommended that the application's basic communal portal be complemented with a facility for virtual exhibits (cf. DigiCULT).

Latest file release: 02-05-2005. Museolog 4.6 for Windows

mcm-f-access[54]: Museum Collection Management using MS Access. An MS Office installation is recommended, since this project also utilizes MS Word for merging data into templates. The fact that the application interfaces with a popular proprietary software package emphasises the fact that using Open Source is by no means an 'all-or-nothing' matter. Software was in the first place implemented for the Charles A. Wustum museum[55].

Latest file release: mcm-f-access-1.1.zip December 8, 2003

MMS - Museum Management System[56]: The purpose of this project is to develop a web based Museum Management System, which will allow classifying all the museum-related information (i.e., collections, libraries, etc.).

Latest file release: 20 may 2001

Virtual Lightbox for Museums[57] (VLMA) applet allows users to search browse, collect, compare, and export structured image-metadata clusters from online collections that implement the VLMA rdf format.

Latest file release: vlma_applet 0.1 April 11, 2005

[50] https://list.scms.waikato.ac.nz/mailman/listinfo/greenstone-users

[51] http://www.koha.org

[52] http://sourceforge.net/projects/mycolex/

[53] http://sourceforge.net/projects/museolog

[54] http://mcm-f-access.sourceforge.net/

[55] http://www.ramart.org/08_wustum_museum/index.php

[56] http://sourceforge.net/projects/mms

[57] http://sourceforge.net/projects/vlma/

GAMERA[58] allows a user, with particular knowledge of the documents to be recognized, to combine image processing and recognition tools in an easy-to-use, interactive, graphical scripting environment.

A recent report[59], published by the Swiss Association of Museums (VMS), ICOM Switzerland and *Kulturinformatik Remigius Wagner* (September 19, 2005), compares several solutions for data management in museums. The report includes both commercially available software and open source solutions. Although a qualitative assessment was not among the aims of the report, it provides some interesting information. The report compares 17 software solutions for museums. Two of them are open source: Greenstone and myColex (cf. supra).

One of the key issues in the choice of software is the total cost of the system. This does not only refer to the mere cost of ownership, but also to costs for installing the system, converting existing data and educating the personnel of the museum. In the Swiss report, figures are given for additional costs for installation (stand-alone or in a network), education, conversion of old databases. In general it appears that the additional costs for the open source systems are not higher than for the commercial systems. Further questions address the existence of user groups, availability of manuals and documentation, technical requirements, the use of standards and the availability of technical support. For all these topics, the open source solutions seem to be on the same level as the commercial solutions.

Of course, one has to keep in mind that the information has been provided by the developers themselves, and that nothing about the quality of the products can be inferred from this information. Moreover, as the report only includes two OS systems in a particular area, these results should not be extrapolated to the whole field of software solutions.

7.7 GIS applications

http://www.opensourcegis.org represents an attempt to build a complete index of Open Source / Free GIS related software projects. The effort has some way to go, especially for projects in languages other than English. The definition of GIS has been kept loose to encompass a broad range of projects which deal with spatial data.

The **FreeGIS Project**[60] provides

- software overview on Free Geographic Information Systems (web site)
- communication on developments, plans, info on Free GIS Software and Free Geo-Data (mailing list)

http://www.maptools.org is a resource for users and developers in the open source mapping community, and a home to many open source projects.

http://www.remotesensing.org hosts and supports various open source software projects related to remote sensing, GIS, mapping and advanced image processing.

GEO Community lists and reviews some free viewers[61]. Some of the viewers or programs can do basic mapping.

[58] : http://dkc.jhu.edu/gamera/papers/jcdl2002.pdf

[59] http://www.e-kultur.ch/softwarevergleich/softwarevergleich.pdf

[60] http://www.freegis.org

WebGIS[62]: can be the future link between this data and the science community. MapLab is a graphical tool for that aim. It's optimized for the creation of web mapping applications based on MapServer.

[61] http://software.geocomm.com/viewers/general/

[62] http://www.webgis.de

8 The contribution of EPOCH

8.1 EPOCH's attitude towards open software

In EPOCH's stakeholder needs report the need to encourage an open source approach is mentioned several times, both for the heritage sector as for the technology sector:

- Needs of heritage sector: "*A policy on the use of ICT that defines best practices, encourages the use of open source technology, and establishes common technological standards.*"
- Needs of technology: "*Need to encourage an open source approach.*"

Although the previous chapters indicate that a genuine interest exists in the field of cultural heritage for open software, one has to carefully consider the choice of software for specific applications. In a non-technical environment, like cultural heritage, the use of open software may not always be the best choice, unless a broad community of developers are working on the technologies. The latter is for example the case for more generic tools, as operating systems, spreadsheets …

Open Source thus seems to work fine in high-interest software areas, where the value of software stability and performance drives the development. On the opposite side Open Source does not seem to work for very specialized areas where people do not agree in general what to develop (Toft 2001). The latter seems to be the case for much dedicated software, specifically developed for cultural heritage purposes.

If only a few research groups worldwide are working on this kind of applications, it's clear that an open source approach doesn't make much sense. Often the members of the research group that developed the tool are the only people having the necessary background to improve the tools. Continuity may hinge on this or that PhD student staying in the lab. Even projects supported by a larger group often cease to exist suddenly (cf. section 7). If CH organizations have to hire software staff to ensure the continuity of their operations, costs may turn out to be far higher than with the use of commercial alternatives with support. For these users open software supplemented by commercial support for it probably bring together the advantages of both.

There are also some further, strategic caveats. Firstly, EPOCH wants to stress that 'free' is a somewhat ambiguous. When researchers are working on open software, their work and the resulting software is indirectly paid by the community.

Secondly, the software industry in Europe currently cannot compete with the United States. Although principles about free and open software have mainly emerged from the USA, ironically this country absolutely dominates the commercial software market, whereas Linux, the prototypical example of successful open source, stems from Europe. One has to realize that it is not always easy to reconcile the aim of creating new jobs and open software in cases where the user base is not really large.

8.2 EPOCH's contributions to the open software toolbox

In the following sections some examples of tools are given, which were developed by EPOCH partners. This is by no means an exhaustive or complete list. NEWTONs and other tools which are still in a preliminary phase are not described here.

This list contains also only software contributions of the partners themselves. The work of integrating existing open source software (e.g., EXIST[63], an open source XML database, with PROTÉGÉ[64], a free open source ontology editor and knowledge-base framework) is not described here.

EPOCH partners have the right to access tools described below for the purpose of work in EPOCH. However, some partners cannot make a commitment to open source access to their software outside the project at this stage, not least because many features are still prototypes. Furthermore most of these tools have been developed (at least partially) within the framework of other projects, so one must take into account the IPR of the other partners in those projects. Nevertheless, many EPOCH partners do expect to make open access to components available for non-commercial use, and already do so.

8.2.1 Mobile, Wearable and Ambient technologies for archaeology

Within EPOCH, the University of Kent (partner 52, UNIKENT) has strengthened existing links with an archaeological field survey team at Rijksuniversiteit Groningen (84 RUG) in order to continue a program of ongoing development and field trials of the UNIKENT software *FieldMap*. This field data collection tool, which normally runs on off-the-shelf PDAs, is primarily configured to match the requirements of archaeological field survey, but has also found use in other field sciences, including botany and zoology. Parts of the tool are being adapted to run on modern smart phones in order to take advantage of their increasing ubiquity and inbuilt multimedia capabilities.

FieldMap is built on top of *MobiComp*, also a UNIKENT development. This is an experimental support infrastructure for storing, managing and sharing contextual information in a distributed environment. The infrastructure has many potential applications in the cultural heritage domain ranging from initial data capture through to public presentation.

The MobiComp infrastructure forms a key part of the collaboration between UNIKENT and ARCES, Università di Bologna (partner 30). ARCES has been working on a possible architecture for the client-side software of MobiComp using the sensor board developed for Whyre (a wearable computer for museums and archaeological sites developed by Ducati Sistemi). The aim of this work is to automatically discover and publish sensor information from multiple clients (e.g. orientation and location). The ARCES contribution has been designed to be generic with respect to the sensor API: it consists of a source-code generation framework that adapts the native API to the java-based technology used in the MobiComp infrastructure. In this way a collection of mobile devices can manage and share their context. ARCES are currently investigating new interaction and usage models based on this infrastructure.

[63] http://exist.sourceforge.net/

[64] http://protege.stanford.edu/

UNIKENT has also developed *jnet*, a tool for visualising, manipulating and editing diagrams of the stratigraphic sequences, or Harris Matrices, derived from archaeological excavations. These are core tasks in the excavation and interpretation of archaeological sites. The jnet tool builds on and extends earlier experience in developing such tools. At its heart is an 'application-configurable' graph browser/editor, which has been enhanced with features that reflect the particular characteristics of the stratigraphic sequence model, and support the specific tasks that archaeologist need to perform in order to interpret the relationships between excavated features and to develop a model of ancient land use across their sites.

Within EPOCH, UNIKENT has also collaborated with Brunel University (55, UBrunel) and Katholieke Universiteit Leuven (4, KULEUVEN) to examine how standards-based data interchange can be established between jnet and other excavation recording and visualisation tools, such as Brunel's STRAT. UNIKENT has also been involved in several aspects of the EPOCH standards programme. This work has concentrated on archaeological documentation standards, and has fed into an ongoing programme to ensure that data collected and used by the FieldMap and jnet software is compliant with the CIDOC CRM and uses established standards including GML (Geographic Markup Language) for describing spatial information.

At present, whilst internal development continues, the source code base for MobiComp, FieldMap and jnet are available to EPOCH partners within the terms of the consortium agreement. At a later date, much of this will also be made more generally available as open source software.

8.2.2 3D-model web service

If open software implies that it be offered for free to all communities, including companies using it as part of commercial services, the return for the European taxpayer could turn out to be lower than bargained for. In order to reconcile existing background knowledge and to keep the possibility to differentiate the condition of usage, EPOCH will start an experiment in the case of the 3D software developed over the years by the partner K.U.Leuven. This will be offered as a free service on the Internet for registered CH users. The service allows users to upload images, which are then automatically turned into 3D models, sent to the party uploading the images. This has several advantages:

- The developers gain experience with the type of objects that are modelled, which enables them to optimise troubleshooting.
- The level of computer expertise at the side of the user can be very low.
- The intensity of use can be quantified, which the sheer number of software downloads is not very telling.
- Commercial use in other domains – which is actually already planned – remains possible.

Plans are in the making to work closely with UNESCO on their repository of World Heritage, which will contain information on all its official World Heritage sites. The EPOCH web service will allow local representatives to produce 3D models, without extensive training or costly equipment.

8.2.3 3D Scanning Tools

ISTI-CNR has designed a suite of software tools, called the 3D Scanning Tools Suite, which manages all phases of the 3D scanning pipeline, except for the acquisition planning phase:

- MESHALIGN allows the registration of multiple range maps; it adopts a classical approach based on a pair wise local and global alignment, implemented with a number of innovations to reduce the user contribution, to improve efficiency and easy of use, and finally to support the management of a large number of range maps (we processed up to six hundreds range maps).
- MESHMERGE allows the reconstruction of a single 3D mesh out of a set of registered range maps. Two different approaches were implemented: a classical volumetric reconstruction approaches based on distance field and a new approach characterized by a lower space complexity, higher efficiency and improved accuracy with respect to the previous, but more sensible to the alignment residual error.
- MESHEDIT allows performing simple editing actions on the mesh (e.g., to fill small holes, to remove non-manifold components of dangling edges/faces, to apply smoothing filters …).
- MESHSIMPLIFY supports the simplification of the (huge) meshes produced by 3D scanning devices, by removing mesh vertices in a controlled manner. The simplification follows the edge collapse approach and has been implemented in an out-of-core fashion to allow the management of meshes that could be larger than the core memory of the computer used.
- WEAVER supports the management of a set of images (either produced by the scanner, or taken with a digital camera) and builds up a texture map wrapped around the 3D model.

In the framework of EPOCH they could release, under an open source license these tools. Currently these tools are available just as Windows executables to EPOCH partners for non-commercial purposes.

8.2.4 The combination of GML and OpenSG

OpenSG is an open source scene graph system with built-in support for (i) multi-threading and (ii) cluster rendering. This feature will be of greatest importance in the near future to assure scalability: Parallel computing on multi-core CPUs is the only option to increase the processing power further when the clock speed comes close to physical barriers, which is the case already today. OpenSG can also digest dynamical changes to the scene graphs: All scene relevant data exist in several aspects that are replicated among the render clients. Changes are logged in a change list that helps to synchronize the data periodically, typically once per frame.

Important features of the *Generative Modelling Language* (GML) are that (i) it can encode procedural modelling tools and (ii) it contains a runtime engine to apply these tools interactively. So the GML bridges the gap between modelling and viewing, it can be seen as a viewer with integrated modelling capabilities. This allows for an extremely concise encoding for the web-based transmission of highly complex models of a procedural kind: Instead of 3D objects transmit only the modelling operations that create these 3D objects.

The combination of GML and OpenSG consists of two parts: exposing the OpenSG API to the GML language, and integrating the GML runtime engine into the (larger) scene graph engine. It combines the strengths of two technologies that were previously unrelated:

- The GML does not have a scene graph, so all models exist in the same coordinate system, and there are no multiple shape instances.
- The OpenSG scene graph engine provides the "hooks" to change all aspects of the scene at runtime, but it has no scripting language. Hitherto, all types of dynamic changes must be programmed in C++, i.e., defined at compile time.

It turns out that both technologies fit surprisingly well together. Their tight integration opens a number of very interesting options for authoring/presentation software for Cultural Heritage content. Domain dependent modelling tools can be defined with respect to a domain, such as medieval castles, as demonstrated in the VAST2005 paper "3D Modelling for Non-Expert Users with the Castle Construction Kit v0.5".

8.2.5 Avatar manipulation

The University of East Anglia plans to make their classes for ARP avatar loading, rendering, and animation in OpenSG available as open source. The precise details of how 'open' the release will be is to be discussed further, but it can be assumed EPOCH partners will receive full access to enable them to use the tools for the work of the Network.

The University of Geneva plans to make their software libraries for virtual human loading, rendering, and simulation in VHD++ available as specified in the NEWTON proposal.

Other software tools from these partners used in EPOCH are

- the ARP Toolkit for skeleton creation, mesh skinning, vertex blending, morph target creation and animation blending;
- the CHARISMATIC Shell Modeller for rapid creation of buildings using a combination of shell primitives and external mesh objects;
- the CHARISMATIC Scene Assembler for the import of multiple object types, the real-time interactive 3D manipulation of objects and the rapid and automatic placement of buildings;
- the VHD++ framework for virtual human simulation (virtual human animation, deformation, cloth simulation, crowd simulation, augmented reality platform, stereoscopic support, facial expressions, speech, motion capture, 3D sound).

9 Conclusion

This report has investigated some possibilities and restrictions of open software in the field of cultural heritage. It does not describe the large amount of generic tools which are available on the Internet and can support cultural heritage professionals. The core part of this report consists of a survey of open source solutions specific to cultural heritage. The survey is complemented by an overview of European research projects dealing with open software and by specific tools provided by EPOCH partners.

As EPOCH has been explicitly requested by the EC not to develop any technology itself during its first year, the reported tools and components have mainly been the result of work done outside of the network, even for the tools offered by the EPOCH partners. Therefore this report should actually be delivered in one year from now, according to the proposed JPA30 update of EPOCH. By that time the EPOCH toolbox will have crystallized into its definitive form and a more extensive list of tools proposed by EPOCH will be available. However to comply with the current JPA18 contract, this interim report has been delivered with the subtitle “version month 18”.

When assessing the possibilities of open software in cultural heritage applications, certain advantages arise. Despite of these advantages, EPOCH warns for an over-optimistic view on open software. An important conclusion of this report is that the cultural heritage field is not a major target of open software developers. Niche applications attract not enough developers to make the open source paradigm work properly. Of course, one can start a one-person project, but this raises questions in the area of liveability and support. Even open source projects depending on several developers are discontinued because developers loose interest or need their time to make a living.

If cultural heritage users don’t (co-)develop the software themselves, support is an important issue. If they can’t buy support from companies, it’s impossible for them to use the software for a longer period of time. Since the different aspects of cultural heritage are niche markets with very few users, very few companies are attracted to it unless these products are an offspring of their other products or they can make enough money of it. This reduces the chance to find an affordable open source solution for non-developers.

Therefore EPOCH thinks that open source is a good way to provide tools to the cultural heritage community, but it should never be regarded as the only way. Furthermore, this survey shows that there are not enough open source solutions for the different cultural heritage aspects. So EPOCH will use open source, but together with more restricted solutions, to contribute tools and services.

10 References

Bazin P.L. and A. Henry. 2003. WallDrawer: a Simple Solution to Traditional Drawing and Photographic Recording of Archaeological Features. *SHAPE Laboratory report, Brown University.*

Bezzi A. (in press) Open Source applications in archaeology. In *Proceedings CAA 2004 Conference, Prato.*

Bishoff L.and N. Allen. 2004. *Business Planning for Cultural Heritage Institutions*. http://www.clir.org/pubs/abstract/pub124abst.html - accessed August 23, 2005.

DigiCULT. 2004. Technology Watch Report 3. http://www.digicult.info/downloads/TWR3-highres.pdf - accessed July 15, 2005.

EPOCH. 2004. *WP 2.1 Stakeholder Needs Interim Report.*

INFONOMICS. 2002. *Free/Libre and Open Source Software: Survey and Study. FLOSS final report*. http://www.infonomics.nl/FLOSS/report/ - accessed May 9, 2005.

Gyftodimos G., D. Rigopoulos and M. Spiliopoulou. 1996 Exploring Archaeological Information through an Open Hypermedia System. In Kamermans, H. & Fennema, K. (eds) 1996. *Interfacing the past: Computer Applications and Quantitative Methods in Archaeology 1995*

Mc Hugh A. 2003. Open Source and Free Software Solutions: Reliable standardised, free. *DigiCULT.Info,* Issue 5, October 2003.

Pescarin S., Calori L. and C. Camporesi (in press) Real Time and 3D Landscape design with OpenSource tools: towards a new and interactive way to reconstruct ancient landscapes. In *Proceedings CAA 2005 Conference, Tomar.*.

Staynov P. and N. Genov (in press) An XML based open source solution for online/offline archaeological data storage and processing. In *Proceedings CAA 2005 Conference, Tomar.*

Tartera Bieto E. and A. Vidal Aixala (in press) SIDORA Project: Once more unto the breach, dear friends, once more. Requirements for an open source Archaeological Information System. In *Proceedings CAA 2005 Conference, Tomar*.

Toft P. 2001. Sharing Digital Information using Open Source. In Conference Proceedings CULT2001 Copenhagen. http://cult.kulturnet.dk/cult2001.pdf - accessed September 12, 2005.

Tonner T.W.W. 2004. The Giza Plateau Mapping Project Excavation Database. In: *Interdisciplinarity or the best of both worlds. Selected papers from VAST 2004*: 21-22

Vilbrandt C.W., J.M. Goodwin, J.R. Goodwin, A. Pasko, G. Pasko and M. Bin Haji Shanat.(in press) Function Representation and Hyperfun: Open Source Tools for Digital Preservation. In *Proceedings CAA 2004 Conference, Prato.*

VMS, ICOM Schweiz und Kulturinformatik Remigius Wagner. 2005. *Softwarevergleich Sammlungsinventare*. http://www.e-kultur.ch/softwarevergleich/softwarevergleich.pdf - accessed September 29, 2005.

Working group on Libre software. 2000. *Free Software / Open Source: Information Society Opportunities for Europe?* http://eu.conecta.it/paper/ - accessed May 9, 2005.

A OpenCD.org

The following applications are included on TheOpenCD 3.0.:

- Productivity
  - OpenOffice 1.1.4
  - AbiWord 2.2.8
  - PDFCreator 0.8
- Design
  - GIMP 2.2.8
  - TuxPaint 0.9.14
  - NVU 1.0
- Internet/Networking
  - FireFox 1.0.4
  - Thunderbird 1.0.2
  - Gaim 1.3.1
- Multimedia
  - Audacity 1.2.3
  - Celestia 1.3.2
  - Really Slick Screensavers
- Utilities
  - 7-zip 4.23
  - Notepad2 1.0.12
- Games
  - Sokoban 1.187
  - Battle for Wesnoth 0.9.3

B Open visualization toolkit

GIMP Image Manipulation Software[65]

Use the GIMP to create textures, modify 3D renders, create red-blue anaglyph 3D images, or any other image modifications you need to make.

Audacity Sound Editor[66]

Use Audacity to mix or record sound files for use in a high-definition or standard definition animation or video project, or for use in a real-time environment created with Blender.

Blender 3D Software[67]

Use blender to create, modify, import or export 3D models. You can also animate and export to video or still images in high-definition. Use Blender to create real-time interactive games or visualizations using the built in game engine.

Inkscape Vector Drawing Application[68]

Inscape is a free, cross-platform SVG (Scalable Vector Graphics) format program that lets you create logos, illustrations and other drawings like commercial packages such as Macromedia Freehand or Adobe Illustrator.

Red-Blue (Anaglyph) glasses[69]

Make your own 3D red-blue viewing glasses.

GoCubic - Windows-based program for building cubic VRs[70]

GoCubic is a free utility for Windows for creating cylindrical QuickTime 4 panoramas as well as cubic QuickTime 5 panoramas.

makeCubic[71]

MakeCubic is a simple OS X-ready application for creating cubic QTVR movies from six faces or from equirectangular images.

[65] http://www.gimp.org

[66] http://audacity.sourceforge.net

[67] http://www.blender.org

[68] http://www.inkscape.org

[69] http://ltc.smm.org/visualize/system/files?file=anaglyph_glasses.pdf

[70] http://www.panoguide.com/howto/display/gocubic.jsp

[71] ftp://ftp.apple.com/developer/Quicktime/Tools/QTVR/MakeCubic_v1.1.6.sit

Expression 3[72]

Creature House Expression 3 is an innovative vector-based illustration and graphics tool that provides exciting creative capabilities for designers working in print, web, video, and interactive mediums.

Terragen[73]

Terragen is a scenery generator, created with the goal of generating photorealistic landscape images and animations. Quickly and easily generate 3D terrains that can be rendered or exported. Terragen is available for Windows and OS X.

Maya Personal Learning Edition[74]

Maya Personal Learning Edition is a special version of Maya® software, which provides free access to Maya for non-commercial use. It will give 3D graphics and animation students, industry professionals, and those interested in breaking into the world of computer graphics (CG) an opportunity to explore all aspects of the award winning Maya Complete™ software in a non-commercial capacity.

Blender QuickTime VR Image Exporter Python Script[75]

Download this script to create a cubic QuickTime VR from Blender and copy it into the folder where Blender looks for scripts.

[72] http://www.microsoft.com/products/expression/

[73] http://www.planetside.co.uk/terragen/

[74] http://www.alias.com/eng/products-services/maya/maya_ple/index.shtml

[75] http://ltc.smm.org/visualize/node/25

C Open source applications in archaeology (A. Bezzi)

- Data acquisition
  - Geophysical prospecting
  - Surveying
  - Archaeological excavation
- Data processing
  - Image processing with GIMP
  - Image rectification and georeferencing with Grass
  - Vectorizing raster data with QCAD & Grass
  - Working with digital terrain data in Grass
  - Orientation of Laserscans with Scanalyze
  - Statistical analysis with R, Weka, Salstat, XGobi, Scilab...
  - Photogrammetrical reconstruction with Stereo
  - 3D Reconstruction with Blender, PovRay, Varkon
- Data management
  - Databases (MySQL, PostgreSQL, ODBC ...)
  - GIS Grass
- Presentation & (Web-)Publishing
  - WebGIS (MapServer, MapLab)

Statistics. Statistical analysis is well supported by several open source applications. Bezzi also used "R" to collect the output information from the resistivity measuring system (RMS). It offers quick possibilities to edit and visualize grids of values, as raster images or as vectors in 2 or 3 dimensions[76]. Results can be exported to Grass GIS for further analysis. Other packages for statistics are software like Weka[77], Salstat[78], Scilab[79], and Xgobi[80]. More free statistical software packages can be found at http://members.aol.com/johnp71/javasta2.html and http://gsociology.icaap.org/methods/soft.html and http://freestatistics.altervista.org/stat.php (accessed May 11, 2005).

GpsDrive: For the communication between notebooks/workstations and GPS receivers open source software exists. One example is GpsDrive[81], which allows importing and georeference topographical maps, to upload tracks and waypoints from different GPS receivers like Garmin or Maghellan, and to navigate with all standard GPS-tools.

[76] http://cran.r-project.org/

[77] http://www.cs.waikato.ac.nz/ml/weka/

[78] http://www.salstat.com/

[79] http://www.scilab.org

[80] http://www.research.att.com/areas/stat/xgobi/

[81] http://www.gpsdrive.cc/

The Gimp: one of the most popular open source software solutions[82]. It offers most of the features like Photoshop or PhotoPaint: retouching, composing and authoring images. Image processing applications like Gimp can be very useful for archaeologists' every day work. It works both on Windows or Linux platforms.

QCAD: Open source currently doesn't offer solutions which can compete with the latest versions of Autodesk's AutoCAD or with Microstation especially what concerns 3D drawing. But for archaeological basic needs QCAD[83] might be sufficient as an open source alternative. QCAD has a very familiar user interface, which shows all principal functions of a normal closed source CAD. In January 2004 a pre-alpha version of BlenderCAD[84] has been released, a toolkit promising to offer fully developed 3D-CAD functions, but development seems to have ceased after this release.

GrassGIS[85]: a very powerful open source software package, which is on the same level as diffused GIS like ArcView or ArcGIS. Without any compatibility problems various kinds of raster data can be imported (e.g. topographical maps or DTM's as ASCII or from ERDAS and ArcInfo). One of the most promising potentialities of Grass is the capacity to communicate with outsourced databases like MySQL and statistical packages like "R".

Scanalyze[86]: an application for viewing, editing, aligning, and merging laser scanner data. It has been developed and continuously improved from the Computer Graphics Laboratory of the Stanford University since the 1990ties. You can process triangle meshes or range images encoded as rectangular arrays of points. Scanalyze is using his own file-format called *.ply, but there exist already data conversion modules for example for Cyberware, 3D Scanners Ltd., and Cyrax Technologies scanners. It has been the primary tool used in the Digital Michelangelo Project to assemble 3D models of Michelangelo's statues from laser range data. It has also been used heavily in the Digital Forma Urbis Romae Project.

Bezzi mentions the use of a program called 'stereo' for photogrammetric reconstruction, but this software has not been maintained since the creator, Paul Sheer, left the project in 1997.

Blender[87]: offers a very familiar graphical user interface (GUI) for 3D-Studio Max users. It is one of the most used open source software and is supported by a large community of programmers. This guarantees a continuous updating and the development of new tools and extensions.

PovRay[88] is a powerful 3D graphic software solution, but its command-based interface may be quite difficult to handle for inexperienced users. The same is true for **Varkon**[89]: a complete 3D CAD software, but not yet so user friendly.

[82] http://www.gimp.org

[83] http://www.qcad.org

[84] http://projects.blender.org/projects/blendercad/

[85] http://grass.itc.it/

[86] http://graphics.stanford.edu/software/scanalyze/

[87] http://www.blender.org

[88] http://www.povray.org

[89] http://www.tech.oru.se/cad/varkon/

Database: MySQL[90] and PostgreSQL[91] are two database servers based on the widespread SQL language. They can manage a big amount of data and this characteristic is very advantageous to serve many clients at the same time. SQL language allows simple and sophisticated queries.

WebGIS[92]: can be the future link between this data and the science community. MapLab is a graphical tool for that aim. It's optimized for the creation of web mapping applications based on MapServer.

[90] http://www.mysql.org

[91] http://www.postgresql.org

[92] http://www.webgis.de