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TNT – The Neanderthal Tools:

Providing an Online Database and Collaboration Platform for Neanderthal Research

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TNT – THE NEANDERTHAL TOOLS is a combined research and demonstration project, which is funded within the DigiCULT programme of the European Commission. The project aims to improve the access to the cultural heritage of Neanderthals for researchers and the broad public. The scientific core of TNT is the creation of NESPOS, an interactive online database containing, in the long run, all available anthropological and archaeological data related to Neanderthals, e.g. computed tomography (CT) and 3D surface scans of Neanderthal fossils and artefacts as well as additional data like scanned literature, images or tables. Using Wiki-functionality, the NESPOS users themselves are able to upload data or add their comments to their colleagues' entries. A metadata search provides an efficient tool for content retrieval. In addition, software for 3D and 2D visualisation of digitised finds as well as geographic information about excavation sites is an integrated part of the system. Since March 2006 NESPOS is open to the scientific community.

Introduction

TNT is a combined research and demonstration project that has been funded within the DigiCult initiative of the 6th Framework Programme of the European Commission. The project started in March 2004 and will end in February 2006. Its main objective is to improve the access to the cultural heritage of Neanderthals for researchers and the broad public using latest technologies (SEMAL et al. 2004, WENIGER et al. *in press*). The consortium consists of eight partners from five European countries: the project manager ART+COM in Berlin, a company for media technology and design, the Hasso-Plattner-Institute in Potsdam, PXP Austria in Vienna and National Geographic Germany in Hamburg as well as the Royal Belgian Institute of Natural Sciences in Brussels, the Croatian National History Museum in Zagreb, the University of Poitiers and the Neanderthal Museum in Mettmann, which was the scientific initiator of the project.

The main task of the partners has been the creation of NESPOS (the ***Ne***anderthal ***S***tudies ***P***rofessional ***O***nline ***S***ervice), an interactive online database and collaboration platform for Neanderthal researchers. Data collection of the scientific partners includes the digitisation of Neanderthal fossils and artefacts by techniques like CT and 3D surface scanning as well as the accumulation of additional data like scanned literature or images and the entry of meta-data. An integrated part of NESPOS is the newly developed visualisation engine VISICORE, a suite of software tools for 3D exploration of digitised finds and excavation sites. Moreover, a popular science web site, the National Geographic ArchChannel (http://www.archchannel.de), has been set up, in order to present the collected data in an intelligible and appealing way to the broad public.

Current Challenges in Neanderthal Research

Neanderthals are the best documented fossil humans. More than 300 Neanderthal individuals from about 130 sites in Europe and Asia are known. In addition, several thousand sites yielded archaeological finds that can be linked to Neanderthals and offer important evidence for the reconstruction of their lifeway. Due to major advances in excavation and analysis techniques as well as the increasing interdisciplinarity of Neanderthal research, combining as diverse fields as archaeology, palaeoanthropology, geology, climatology, genetics, botany or zoology, the data on Neanderthals have become highly abundant, but also difficult to be handled by the means of conventional data management.

In addition, the accessibility of information is a problem. Many Neanderthal sites have been dug before the 1950ies. Therefore, the first detailed descriptions of the sites might have been published in journals that do not exist any longer or in early volumes that have been preserved only in very few places. However, especially for the understanding of the archaeological context of the finds, these original descriptions are essential. On the other hand, Neanderthal sites and finds that have been studied very recently are often not yet published, so that it is not possible to get detailed information. Sometimes it takes several years until the first detailed descriptions are published. Unfortunately, some sites are then only described in journals with very limited regional distribution or published as so called grey literature only (M.A. thesis, PhD thesis etc.), which is also not easily available and only known to a small group of scientists.

In the field of palaeoanthropology the application of CT and computer-assisted 3D reconstruction have become more and more important, as these techniques have proven to be highly useful for the study of fossil hominids. Often hominid fossils are embedded in stony matrix that cannot be removed manually without risking to damage the precious fossil. By the means of computer-assisted reconstruction a virtual removal of sediment is possible, which is a completely non-invasive approach (e.g. GRÖNING 2003). In addition, it allows the refitting of fragmentary fossils, the correction of taphonomic deformation or the study of internal features like the bony canals of the inner ear (e.g. PONCE DE LÉON, ZOLLIKOFER 1999, SPOOR et al. 2003). For these purposes various software packages, mainly adopted from medical applications, have been used by palaeoanthropologists.

However, the necessary software is rather expensive and requires a lot of technical knowledge so that only very few anthropological institutes are able to work on high quality 3D reconstructions, especially as underfunding of universities is a common problem in several European countries. Furthermore, there is only little collaboration between the teams of different institutes at this stage.

At present, most of the anthropological and archaeological research is still based on the study of the original artefacts or fossils. By now, relatively few fossils have been scanned with CT. Hardly any 3D scans exist of archaeological finds associated with Neanderthals. If CT scans of fossils already exist, they are often of insufficient quality or only suitable for the study of certain anatomical features.

In order to study the original fossils the permission of the curators is required. In some cases this is rather difficult to obtain. As hominid fossils as well as archaeological finds can often only be studied within the museum, where they are kept, travel costs of archaeologists and anthropologists are in general very high. This is especially the case if studies comprise the comparison of finds from several sites. In addition, finds of the same site can be distributed among museums in different countries.

The originals themselves suffer from repeated examinations. Even if they are handled with care, minor damages cannot be avoided e.g. that edges are worn off or scratches on the surface occur. This is for example a severe problem for the famous Krapina collection, which has already been noticeably damaged

by the repeated examinations of anthropologists from all over the world. In order to preserve the fossils for future generations, it is necessary to reduce the treatment of the originals to a minimum.
Although Neanderthal research has, therefore, benefited during the last decades from new exploration and analysis techniques as well as greater interdisciplinarity, the scientific progress is slowed down by limited access to information, originals and software and the low degree of inter-group-collaboration. In addition, a tool for structuring the diverse data and allowing a quick content retrieval is urgently needed.

The Opportunities of NESPOS and VISICORE

The online platform NESPOS is unique in combining advanced content management, collaboration and visualisation features. The system is the result of adapting the software Confluence® from Atlassian Software Systems to the special needs of Neanderthal researchers. Confluence® was chosen as it is an open source software and since it offered a set of key features that were required for NESPOS, e.g. Wiki-functionality for collaborative content editing and sophisticated tools for the management of access rights.
NESPOS is based on an elaborated data model and tus able to comprise diverse data from various disciplines. This includes e.g. CT and 3D surface scans of Neanderthal fossils and artefacts as well as additional data like scanned literature, images or tables.
Specialised input forms support the structured entry of meta-data and provide multiple linking possibilities between different objects in the database, like e.g. archaeological sites, excavation campaigns or single finds. These links reduce time-consuming data entry and mirror the complexity of archaeological data. Thus, an efficient content retrieval is not only provided by a full text search, but also by a sophisticated meta-data search that allows the combination of various attributes. Search queries like “Search for all supposed burials of juvenile Neanderthals attributed to the Mousterian” are therefore possible.
In addition to predefined entry fields, each NESPOS object represents a Wiki-page so that the NESPOS users themselves are able to enter additional information or add their comments to their colleagues’ entries quickly and without knowledge of html. The distinction between public and private spaces in NESPOS allows to keep data either private or to share it with colleagues. Next to these core features, NESPOS includes various other content management and collaboration tools like a notification service about recent changes, a discussion forum as well as an XML-import and export of content, including a direct import of bibliographic references from PubMed, the online platform of the US-American National Library of Medicine and the National Institutes of Health.

Fig. 1 – NESPOS-Logo

With the integrated visual simulation engine VISICORE, NESPOS offers a suite of software tools for real-time 3D exploration of finds and excavation sites. The VISICORE suite comprises two components: ArteCore, the 3D visualisation tool for fossils and artefacts, and GeoCore, a GIS and exploration tool for 3D terrain models and virtual excavation sites. Although various applications already exist for such purposes, VISICORE is unique for its integration in an online database and collaboration platform (Fig. 2).

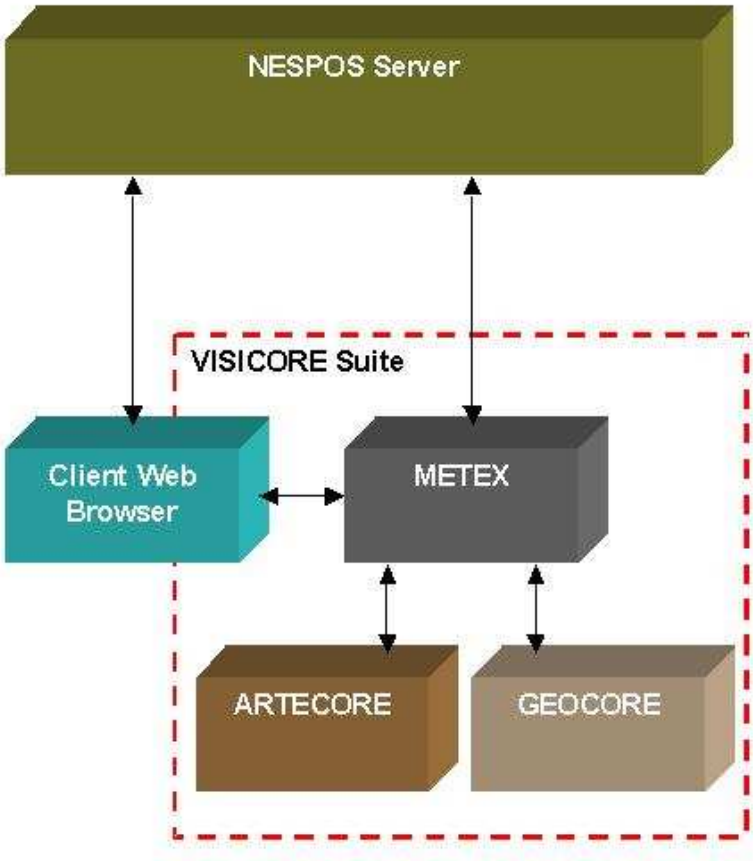

Fig. 2 – Interaction between NESPOS and VISICORE via METEX, the download manager of the VISICORE suite

ArteCore is able to import CT image stacks, polygonal models, single images as well as pseudo 3D models based on six views of an object (Fig. 3). In addition to standard exploration tools like real-time rotation, zooming and panning, it offers sophisticated 3D reconstruction tools. Based on CT volume data, polygonisation can be carried out by simply defining a density range or by using a manual segmentation tool, which allows the application of various thresholds at the same time. This is especially useful for the virtual removal of sediment from fossilised bone. Morphometric tools include distance, area and volume measurements as well as the setting of landmarks. The results and coordinates of the measurement points and landmarks can be exported for further statistical analyses. By saving and exchanging the landmark positions via NESPOS users can jointly work on a specimen.

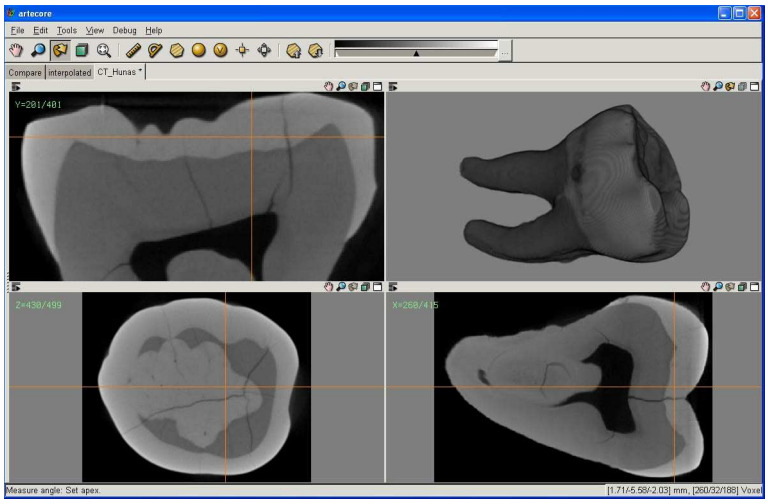

Fig. 3 – Screenshot of ArteCore

The visualisation features of GeoCore can be characterised by three different levels: a 2D mapping of sites, 3D models of site locations and 3D virtual excavation sites. The 2D mapping of archaeological sites is a crucial part of the advanced search as it provides a direct spatial distribution of sites listed in the search results and thus facilitates the archaeological interpretation. A large database of digitised maps allows to customise the resulting maps and e.g. to zoom to a region of interest. In addition, the included hyperlinks provide a useful tool for navigation through NESPOS. 3D terrain models offer a new perspective on the location of archaeological sites within the landscape and 3D models of excavated sites provide an easier understanding of the relative position and orientation of 2D documentations like profiles and excavation maps (Fig. 4). If 3D coordinates of finds are available, also the 3D distribution of single fossils and artefacts can be visualised.

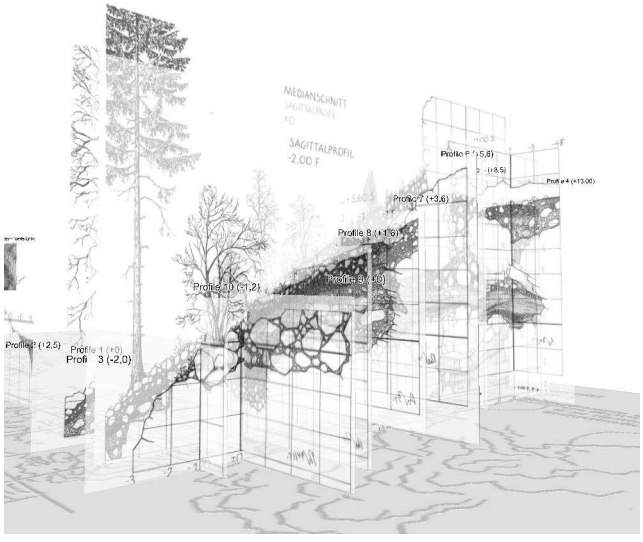

Fig. 4 – Screenshot of GeoCore showing the 3D arrangement of the profiles of the Middle Palaeolithic site Bockstein, Germany.

The usage of all functionalities of NESPOS including the licence for VISICORE is limited to registered users, scientists in the fields of anthropology and archaeology and in adjacent disciplines. The literature database as well as introductory information about all the sites that are represented in NESPOS is, however, open to all interested internet users.

Prospective Benefits of NESPOS and Outlook

One major advantage of a large database for digitised Neanderthal fossils and artefacts is that research becomes more independent from the originals. Observations and measurements on virtual objects have proven to be reliable and highly informative (WEBER 2001). As high quality scans are available through NESPOS, many studies will not require to include the examination of the original finds any more. By this, the orignals are prevented from unnecessary damage by repeated analyses.

In addition, the travel costs of scientists can be reduced if they do not have to study the original fossil or artefact any more. As a consequence, good scientific results will depend less on funding opportunities than today. This will especially benefit young scientists, for whom raising funds is more difficult then for the established researchers.

By the development of VISICORE the number of researchers working with computer-based reconstruction will be highly increased. As there are no additional licence costs for NESPOS users, even researchers of institutes with a small budget will be able to use these new techniques.

Furthermore, using the same software and the same data formats will facilitate the exchange of data and, consequently, the collaboration between scientists. Increased communication between scientists as well as the opportunity to save the 3D position of landmarks used for measurements of the 3D models and images will result in a much higher reproducibility of results.

In general, the collaborative tools of the NESPOS system like comments attached to objects and discussion forums will enhance international cooperation between scientists. Prehistoric data can be regarded as highly imprecise or soft data that can be interpreted in various ways. Discussions and comments on the different interpretations are, therefore, important means of the data analysis.

Next to the digitised fossils and artefacts, 3D scans of modern humans as well as extant non-human primates will be available. For comparative studies, large modern samples, preferably representing different regions of the world, are essential for the correct interpretation of results, but not all anthropological institutes possess such a large modern reference sample. By providing this data, not only Neanderthal research but anthropological studies in general will benefit from NESPOS.

Finally, the collection of all the additional data on fossils, sites and artefacts like digitised literature, isolated images and tables will be of great advantage for Neanderthal research. Articles in old journal volumes or exhausted books will be available online. Time-consuming search in different libraries can be avoided and costs for travel or interlendings can be reduced. As NESPOS gives the opportunity to upload any kind of information, researchers will be able to provide preliminary data on sites, which have not been published yet. Through the continuous updating of the NESPOS database by the scientists themselves, it will significantly speed up the distribution of new results among the scientific community and, therefore, the progress of Neanderthal research in general.

In December 2005 the NESPOS Society e.V. was founded, which is responsible for maintaining the NESPOS system since March 2006. Full access to NESPOS is gained by becoming a member of this society and paying an annual membership fee that is necessary to cover the costs. Students are able to obtain a restricted access at a lower price. The NESPOS system offers a high level of flexibility so that it can be easily adopted for the handling of new types of content. It is planned that, in the long run, the platform will also include data from other periods like the Lower and Upper Palaeolithic.

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http://www.the-neanderthal-tools.org

https://www.nespos.org