

NEANDERTAL-3D

Management and valorisation of the digitised Belgian human remains collection

Contract - BR/175/A3/NEANDERTHAL-3D

Summary

Context

Human evolution not only fascinates both the media and the general public, it is also a key topic in Belgian primary and secondary school programs. The Spy Neandertals have been extensively studied by both national and international researchers since they were found in 1886. In 2004, there was a reassessment of the human and faunal material from the Spy cave conducted by RBINS (Spy Cave, Belspo Action 1). Several bones of Spy I and the human collection were reattributed to the Neandertal skeleton Spy II, making it one of the more complete Neandertal skeletons in the fossil record. In 2012-2016, a collaboration between ULB and RBINS (Belspo Action 2) saw the virtual reconstruction of the Spy II Neandertal.

The aim of the Neandertal_3D BRAIN project was to utilise the existing digital collection of Neandertal and modern human fossils housed at RBINS, to showcase the virtual Neandertal Spy II skeleton and to highlight Belgian scientific and cultural heritage, as well the current state of the art research in Belgium. The project joined together teams and skills from the Vrije Universiteit Brussel (VUB) and the Université Libre de Bruxelles (ULB), the Federal Scientific Institution (FSI) of RBINS and a non-profit organisation from the Brussels Capital region Association pour la Diffusion de l'Information Archéologique (ADIA). There was also an International partner from France, Musée de l'Homme (MNHN). Members of the project came from the different disciplines of medicine, biomechanics, palaeontology, engineering, computer science and education.

Objectives (and methodology of the research)

There were several main objectives in the project:

- Highlight the digital collection of Neandertal and modern human fossils
- Develop the lhpFusionBox software
- Create an interactive website on Neandertals.
- Develop a serious game based on the Spy II Neandertal

The Spy II skeleton continued to be developed during the project with additional fossil material added and new fossil reconstructions done with members of the Neandertal_3D partners, the follow up committee and outside experts. A test was performed on different scans of the same object. The reconstructed 3D Spy II Neandertal and other Neandertal fossil specimens housed at RBINS were additionally digitised with photogrammetry, which was found to be the best method for 3D printing. A detailed method was created so that 3D non-contact moulds could easily be made by schools and other museums using low cost 3D printers. This is because cost and the need to budget is an important factor for everyone, especially in public institutions such as schools and museums. The availability of the digitised collection will create more equal opportunities in that anyone with access to a computer

and the internet will be able to gain access to this collection. There were also several studies which examined if the digital bones could be used a substitute for the original bones.

The musculoskeletal software 'IhpFusionBox', which was previously developed by ULB, was the main software used to reconstruct the Spy II skeleton. A literature review was conducted on how paleoanthropology had changed from the use of traditional tools to the use of digital tools and what digital tools would be most useful for paleoanthropologists. Based on this review the VUB worked to improve the software and make it more relevant for paleoanthropologists.

Alongside the digitised collection, an additional aim of the project was to make current knowledge on Neandertals more accessible to the general public by creating a website on Neandertals. Neandertals are often portrayed in the public as cavemen, stupid brutish and more ape like than modern humans. The website sought to use up to date knowledge on Neandertals to redress this balance as well as showing the comparison between them and modern humans.

Finally, serious games (games which have educational/informative purposes) were developed based on Neandertals which could be used by ADIA, ULB and VUB. ADIA currently provides animations to different groups of children and teenagers (generally 8-12 years) and (13-18 years old) who visit the museum. The animations are developed according to the different age groups and are specifically designed to be both educational and fun. VUB and ULB are involved in serious games for patients to assist with rehabilitation.

Conclusions (presentations of the results as well as the main conclusions and recommendations)

The project outcome can also be seen as advantageous in different areas. For the scientific and research community, the freely available bones will be an import resource for (palaeo)anthropology and other disciplines such as forensic science. One of the biggest difficulties in studying Neandertal and other fossil hominin bones is the availability of specimens. Prior to the project, some of the Neandertal data was available from NESPOS or on application to the curator of Anthropology at RBINS in the form of STL models or CT scans. However, public knowledge and valorisation of this data was limited. Digital files of bones and of animated files have been uploaded to the public 3D online platform of Sketchfab (as a viewing platform) and will be freely available for everyone to have under the creative common licence (CC BY NC ND) upon application to the RBINS curator. The format will be in STL or OBJ format and all bones have been made ready for printing. This non-contact 3D reproduction opens up new opportunities for studying, learning about and disseminating Cultural Heritage objects, including human remains. The individual collection of bones will be of most use to museums, schools and scholars. The release of this data will accompany a scientific publication which will serve as a citation document for the fossils. This will ensure that we have the maximum amount of impact to publicise the availability of the fossils. This is an unfortunate delay in the project in that often the publication of scientific work can take a considerable amount of time. However, our aim is that this work will be published in 2022.

The digitised fossils can serve as a replacement for the classical resin cast system which can be up to 2-5% smaller than the original. Plaster casts of the adolescent the Le Moustier 1 Neandertal are housed at both ULB and RBINS. These casts are important as the postcranial skeleton was largely destroyed at the end of the Second World War, with only the skull remaining. The first aspect of the study on Le Moustier examined the differences between the reported measurements on the original bones and the measurements on the casts. The second aspect examined the differences between the casts and the digitisation of the casts. There were no differences between the original, physical and digitised casts. The casts were not smaller than the original as they were in plaster. However, one significant disadvantage of plaster casts is that the details are not preserved. Digitised casts are a much better substitute than either plaster or resin casts and have the advantage that they can be freely shared and are accessible to anyone with a computer. A detailed method has also been created to print large

bones in different parts so that 3D non-contact moulds can easily be made by schools and other museums using low cost small and medium sized 3D printers.

The adaptation of the open source software lhpFusionBox for palaeoanthropological purposes is of significant interest to researchers working in other fields who wish to study and visualise complex 3D structures or hidden features, such as anatomists, forensic scientists, medical professionals, archaeologists (i.e. the study of mummies). The adaptation of lhpFusionBox also gives new valorisation to the digital collection by enabling scientists to perform more analyses on the digital fossils, from taking simple measurements through to complicated 3D analysis of objects and biomechanical analysis. The automated measurements are currently being used in ongoing research projects. A script was set up in lhpFusionBox to automate and analyse measures on the pelvis of Precolumbian mummies to determine sex (DSP measurements) and this was the result of a peer reviewed publication in 2020. The use of digitised specimens was also looked at with the study on the Le Moustier 1 Neandertal and with other studies, one of which looked at the use of geometric morphometrics on digitised specimens. Based on the new tools in lhpFusionBox, project members also have other ongoing studies and publications in submission on the biomechanics of fossil hominins.

The creation of the Neandertal website portrays Neandertals in a new light (<https://neandertal.naturalsciences.be/>). The website is available in French, English and Dutch and seeks to demonstrate that Neandertals are not so different from modern humans. The games on the website also seek to teach children and adults about the current knowledge of Neandertals in a fun and exciting way. The creation of a free website gives access to digital heritage to a broad spectrum of people who may not typically visit museums. Most people have access to a computer and the internet. However, they will not necessarily spend money on transport to or entry fee to visit a museum. Conversely, more visits to the website will also lead to more visits to the Royal Belgian Institute of Natural Sciences as it will show the reconstructed Neandertal skeleton which is currently housed in RBINS.

The use of tablets and the development of games with an educational purpose can also be extended to different cultural heritage collections. Many primary school children seek information online and there is a clear trend towards consulting social media, i.e. vlogs (video blogs) and mobile games. We identify a huge potential in educating children on issues relative to cultural heritage, such as informing them on fossils or extinct species, by means of informative computer games. The so-called serious games also have educational/informative purposes with fun and entertainment. During the project a series of publications were also produced on serious gaming.

The Neandertal and AMH fossil collections are an important digital collection. However, the project could also serve as an example of what to do with other 3D digital heritage collections. The use of tools to accompany the fossils and perform both traditional measurements and new avenues of research is a smart and exciting realisation of cultural heritage. The project further demonstrates the need for a 3D digital collection in conjunction with a physical collection at the Federal institutions by the following:

1. 3D digitisation creates a permanent record of the object,
2. helps preserve the object,
3. help in the curation and restoration of the object,
4. help to improve the valorisation of the object both from the scientific point of view but also the viewpoint from education and the broader public.

The creation and the valorisation of a 3D digital collection can also play a role in difficulties involved in repatriation as they provide an alternative by giving access to the scientific information to scientists from the countries of origin. The 3D printing of physical replica also allows Museums from the countries of origin to display high resolution replicas based on this non-contact digitisation.

Project website: <http://collections.naturalsciences.be/ssh-projects/projects/neanderthal-3d>

Website on Neandertals: <https://neandertal.naturalsciences.be/>

Key publications

1. Boucherie, A., Chapman, T., García-Martínez, D., Polet, C., Vercauteren, M., Exploring sexual dimorphism of human occipital and temporal bones through geometric morphometrics in an identified Western-European sample. *American Journal of Biological Anthropology* (Early view : 2022) (Peer reviewed).
2. Dumas, M., Chapman, T., Louryan, S. 2021. The discovery of two new sets of casts, 3D reconstruction and comparison with original fossils. *Digital Applications in Archaeology and Cultural Heritage* 23, e00204 (Peer reviewed).
3. Chapman T., Tilleux C., Polet C., Hastir J-P., Coche E., and Lemaitre S. 2020. Validating the probabilistic sex diagnosis (DSP) method with a special test case on Pre-Columbian mummies (including the famous Rascar Capac). *Journal of Archaeological Science: Reports* 30:102250. doi.org/10.1016/j.jasrep.2020.102250 (Peer reviewed).

Key words

Neanderthal, Virtual, Fossils. Reconstruction, lhpFusionBox