
Marco Silvestri, Giancarlo Tomezzoli

3D FACIAL RECONSTRUCTION OF AN ANCIENT FEMALE SKULL FROM OBERKASSEL BEI BONN (GERMANY)

Abstract

Because our technique of facial reconstruction proved to be successful, we decided to apply it to a skull of an older female subject preserved at the Paläontologisches Museum in Munich (Germany). The skull was found in Oberkassel bei Bonn (Germany), its age is 10,500 years. It appears that the skull is well reconstructed, complete, not much deformed, without traces of severe illnesses. The subject was a woman aged probably 15-25 years. The causes of the death cannot be determined. Because, also in this case, the skull does not appear too dissimilar from the skulls of the present people, and because, as far as can be understood the subject was healthy, it is reasonable to assume that the thickness of the soft tissues on the different portions of the skull was not dissimilar from that of today's young Central European women and/or young American women of Central European origins. For the pigmentation, according to current statistics, we assumed fair skin and light coloured eyebrows, hair, and eyes. The reconstructed female face looks not dissimilar from the faces of today's central European female subjects. However, in the light of the well-reconstructed state of the skull and of our reasonable assumptions on pigmentation, we can say that the reconstructed 3D face model and its artistic representation are good approximations of the facial aspect of a girl who lived at the time of the Würm Ice Age.

Introduction

The techniques of facial reconstruction and the technique we used for face creation for a skull belonging to a Neolithic male of the *Square Mouth Pottery Culture* preserved at the Civico Museo di Storia Naturale in Verona, Italy, had been discussed in a previous paper [1]. The skull-subject of the paper [1], was found near the present-day town of Quinzano (Verona – Veneto, Italy), and is about 6000 years old. The paper provided a comprehensive bibliography concerning the facial reconstructive techniques. Because our approach proved to be so successful, we shall apply it to yet another skull.

The skull we consider here is that of a female subject displayed at the Paläontologisches Museum in Munich (Germany). A small white sign in the showcase near the skull specifies that it be found in Oberkassel bei Bonn (Germany). It belonged to a female and is about 10,500 years old. More accurately, as stated in papers [2,3]: In 1914 prehistoric sites at one of the cliffs above the Rhine at Basaltbau an der Babenley yielded well preserved skeletal remains of an uncommonly robust adult male and of a petite young female. Accurate chronologies of the sites were established by other materials associated with the skeletal remains

and placed it in the Magdalenian period. The discovery was the object of many academic and popular scientific papers. The skeletal remains were subjected to many palaeontological, anatomic-morphological, radiological and stomatological investigations. The 1919 report [2] on the female skull mentions relevant damages to the *infratemporal fossa* and in the coronal sector as well as at the right suborbital yoke, and at the *os sphenoidale*. Other damaged or destroyed portions include the intraorbital sector, and the frontal portions of the mandible and jaw. The *norma basilaris* of the skull shows a postcondylar rupture zone and a bone lacuna. An additional fracture at the right rear principal portion of the skull was reported in 1982 [3]. Significantly, this well reassembled skull represents an ideal candidate for the facial reconstruction of a woman of the Magdalenian period.

This female skull is extremely orthognatic [3] (p. 336). On page 340, it mentions a length–width cranial index (“Längenbreiten-Index”) of 71 or 70.3 characterising the skull also as extremely dolichocephalic and a length–height cranial index (“Längenhöhen-Index”) of 71 or 73,6 characterising the skull as orthocephalic. The results of various other cranial analyses (cf. pp. 361, 362 of [3]) indicate for the skull similarities with the CroMagnonid types from Moita do Sebastião (Portugal) No. 16 and No.19, Arruda (Spain) No. 5 and No. 908 and Cheix (France) No. 1, contrary to the male which can be well considered as a CroMagnon type.

3D Facial Reconstruction – Application & Implementation

As mentioned in the previous paper [1], the main problem in facial reconstruction is related to the flesh thickness to be assigned to each point of the skull, and how to guess a realistic pigmentation for hair, skin and eyes. Our technique uses hybrid *2D – 3D stereo photo-imaging* technique to create a 3D skull model on which the soft tissues are added. For the thickness of the soft tissues we used values derived from Prag and Neave [4,5].

Figs. 1 and 2 show the front view and the side view of the skull. The high-resolution images in Figs. 1 and 2 were produced by a standard digital camera and appear well suited for facial reconstruction. Fig. 1 shows the reconstructed, darker, teeth.

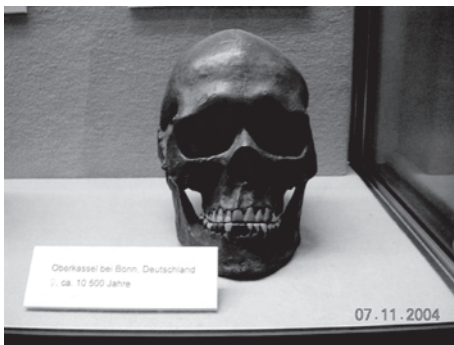


Figure1. Skull, front view.



Figure 2. Skull, side view.

It appears that the skull is surprisingly well reconstructed, all the relevant damages have been corrected, and it is complete, with no further significant deformations or signs of pathology. The female subject was likely 15-25 years old.

As shown in Fig. 4, the skull was isolated from its context. Because the reconstruction was elegant it was unnecessary to reposition the mandible and the jaw, thus, it appears in the normal closed position. However, the aforementioned software was used to generate a nose bridge, which was missing in the find.

As already said in said previous paper [1], the digital images have been processed by means of a 2D stereo imaging technique derived from the works of Chen, Medioni, Zhan [6,7] and D'Apuzzo [8] in order to create a correct 3D skull model by using commercial 3D CAD/CAM software.

Also, because the skull does not appear atypical compared to female skulls of the present-day local population, and since we are led to understand from the images that this young female was petite but apparently healthy, it seems reasonable to assume that the thickness of soft tissues on the different portions of the skull is similar to young Central European women and/or young American women of Central European origins. Therefore, once the 3D model of the skull was finally obtained, we established, according to the technique used in the works of Neave, Prag [5] and Wilkinson [9], a Look Up Table (LUT) containing a set of warping points 1-21 (cf. Fig. 3) having corresponding soft tissue thickness values valid for a normal Central European woman (cf. Table 1).

Additionally, the facial dimensions and proportions in Table 1 of ref. [3] and generated by the frontal view of the skull served well to provide further details and augmented the final 3D facial reconstruction. The absence of any remarkable flaws in the reconstructed skull model presented no ambiguity in our mission to assemble the face.

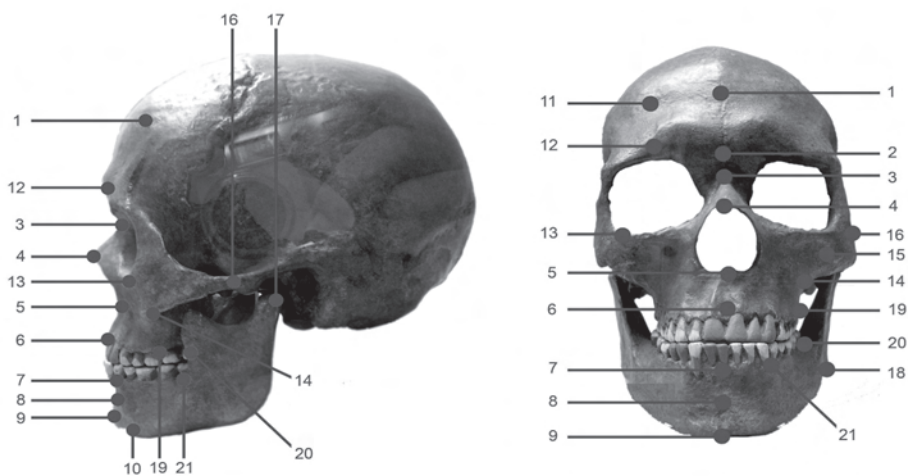


Figure 3. Skull warping point set.

Table 1. Table of measurements for flesh thickness [10].

	Values for average adult female	Position	Size (mm)
1	Supraglabella	Frontal	3.50
2	Glabella	Frontal	4.75
3	Nasion	Frontal	5.50
4	End of Nasals	Frontal	2.75
5	Midphiltrum	Frontal	8.50
6	Upper Lip Margin	Frontal	9.00
7	Lower Lip Margin	Frontal	10.00
8	Chin-lip Fold	Frontal	9.50
9	Mental Eminence	Frontal	10.00
10	Beneath Chin	Frontal	5.75
11	Frontal Eminence	Bilateral	3.50
12	Supraorbital	Bilateral	7.00
13	Suborbital	Bilateral	6.00 </td
14	Inferior Malar	Bilateral	12.75
15	Lateral Orbit	Bilateral	10.75
16	Zygomatic Arch, midway	Bilateral	7.50
17	Supraglenoid	Bilateral	8.00
18	Gonion	Bilateral	12.00
19	Supra M2	Bilateral	19.25
20	Occlusal Line	Bilateral	17.00
21	Sub M2	Bilateral	15.50

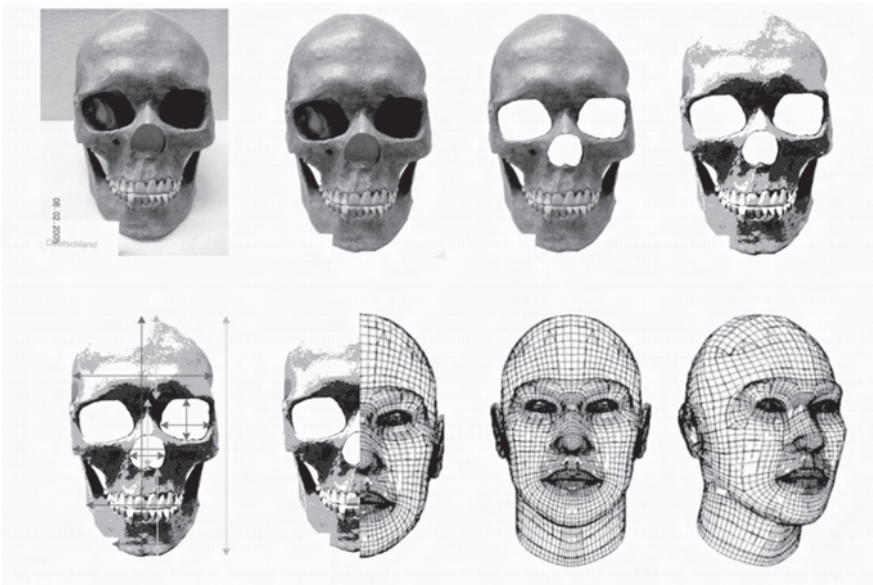


Figure 4. 3D facial reconstruction

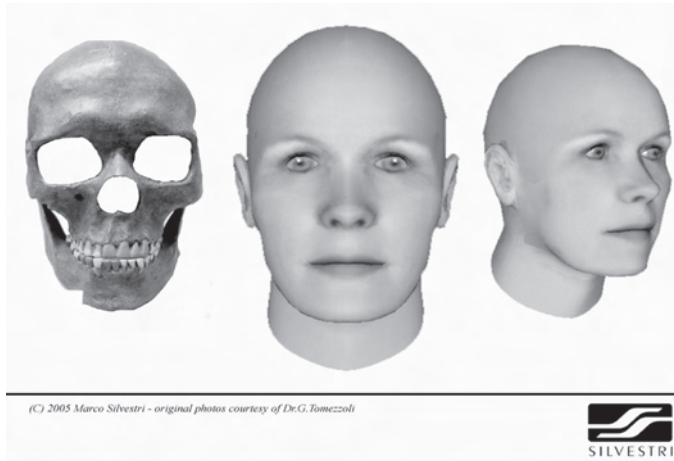


Figure 5. Final 3D facial reconstruction

Fig. 4 shows the steps of the facial reconstruction on the basis the above-mentioned set of warping points and the corresponding soft tissue thicknesses listed in the LUT of Table 1. As stated in the earlier paper [1], because no traces of skin or hair or other indirect indicia are available we cannot have a clear idea of the actual original pigmentation of the eyes, hair and skin of the subject. However, at least concerning the skin, many statistics on the pigmentation of Europeans are in agreement as we consider the Central or Alpine Europeans. The population has no clear dominant pigmentation and ranges from very fair to mid dark. With diminished sunrays associated with the Würm Ice Age it may be safe to speculate that skin pigmentation tended towards the lighter spectrum for more efficient vitamin D production. We therefore, opted for typical fair skin and clear eyebrows and eyes as shown in Fig. 5 in the final 3D facial reconstruction.

The artistic rendition of the “Maiden of Basaltbau” together with geological features of the environment generated the composition in Fig. 6. Artistic license allowed for interpretation of skeletal data, and the observation of the current population suggested the likely facial, skin, eye, and hair colorations. Hair length is suggested by aesthetics and practical utility of long strains fibres. Such pictorial elements were utilised from a public domain on the Internet.

Conclusions

As presented in the previous paper [1], shape and/or thickness of the soft tissues play a crucial role in 3D facial reconstruction. However, the absence, at least at the moment, of precise rules for establishing the real pigmentation and the soft tissues shape and/or thickness for ancient people obligated us to make the reasonable assumptions made above. For this reason, the pictorial representation of the features of the “Maiden of Basaltbau” is not unlike the typical face of contemporary Central European young women. Features



Figure 6. *Artistic facial reconstruction*

and proportions of the skull in Figs. 1 and 2, and the methodology applied and illustrated in Figs. 3 and 4 lead us to the reasonable conclusion that Figs. 5 and 6 represent a good approximation of the facial features of a girl who lived at the time of the Würm Ice Age.

Acknowledgement

We wish to thank the reviewers and Prof. Perdih for valuable suggestions how to improve present paper.

References

1. Silvestri M, Tomezzoli G, 3D Facial Reconstruction from a Skull of a Male Subject of the Neolithic Square Mouth Pottery Culture of Quinzano, *Proceedings of the Third International Topical Conference "Ancient settlers of Europe"*, Jutro, Ljubljana 2005, 159-164
2. Verworn M, Bonnet R, Steinmann G, Der diluviale Menschenfund von Oberkassel bei Bonn, 1919, Wiesbaden. *Die Kulturbeigaben*, 1919, 186-193
3. Henke H, Die magdalénienzeitlichen Menschenfunde von Oberkassel bei Bonn, *Bonner Jahrbücher*, **1986**, 186, 317-366
4. Prag J, R Neave, *Making Faces Using Forensic and Archaeological Evidence*, British Museum Press, London 1997

5. Neave R A H, Prag A J N W, The skull as the armature of the face: reconstructing ancient faces, in Bowman, A. and Brady M. (eds.), *Artefacts and Images of the Ancient World*, British Academy, London 2000
6. Chen Q, Medioni G, Building human face models from two images, *IEEE 2nd Workshop Multimedia Signal Processing*, Dec. 1998, pp. 117-122
7. Zhang Z, Image-based modelling of objects and human faces, *Proc. SPIE*, vol. 4309, *Videometrics and Optical Methods for 3D Shape Measurement*, San Jose, USA, Jan. 2001, pp. 1-15
8. D'Apuzzo N, Measurement and Modelling of Human Faces from Multi Images, *International Archives of Photogrammetry and Remote Sensing*, **2002**, 34(5), 241-246.
9. Wilkinson C, Neave R, The reconstruction of a face showing a healed wound, *J. Archaeol. Sci.* **2003**, 30(10), 1343-1348
10. Rhine J S, Moore C.E., *Forensic Anthropology*, Museum Technical Series, Maxwell 1984 (cited in [4])

Additional Material

The original high-resolution images used for the 3D facial reconstructions and all the produced material are available by the authors: M. Silvestri (marco@marcosilvestri.com), G. Tomezzoli (gtomezzoli@epo.org).

Povzetek

3D rekonstrukcija obraza stare ženske lobanje iz Oberkassla pri Bonnu (Nemčija)

Ker se je najin način rekonstrukcije obraza uspešno izkazal, sva ga uporabila na lobanji ženske, ki jo hranijo v Paläontologisches Museum v Münchnu. Lobanjo so našli v Oberkasslu pri Bonnu in stara je okoli 10.500 let. Videti je dobro obnovljena, popolna in ne veliko spremenjena ter brez sledi resnih bolezni. Ženska je bila stara 15-25 let. Vzroka smrti ne moremo ugotoviti. Ker lobanja ni videti preveč različna od lobanj sedanjih ljudi in ker je bila ženska, kot je videti, zdrava, je smiselno predvidevati, da se debelina tkiv na njej ni dosti razlikovala od debeline tkiv sedanjih mladih Srednjeevropelj oziroma Američank srednjeevropskega izvora. Predvidevava, da je imela svetlo kožo in svetle obrvi, lase in oči. Rekonstruirani ženski obraz ni videti drugačen kot obrazi sedanjih Srednjeevropelj. Zaradi dobre ohranjenosti lobanje in smiselnih predpostavk o videzu lahko rečeva, da je rekonstruirani 3D model obraza in njegov umetniški prikaz dober približek videza dekleta, ki je živelo v würmskem čase zadnje poledenitve.