

# FROM SACRED RELICS TO BYZANTINE HAGIOGRAPHY. A METHOD OF FORENSIC RECREATION AND VISUAL REPRESENTATION

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## 1. ABSTRACT

Although in the Byzantine tradition illustrations the holy figures of the Christian faith are presented, the true faces of Saints remain silent and unknown. So there is always the big issue of the relationship between the original (ie real person) and the figure illustrated in the icons. The holy relics are Church artefacts, which complicates their disposal for scientific research. The reconstruction of the Saints face, though quite popular as anthropological method, has not so far been used in the case of ecclesiastical tradition.

This work presents the stages for the facial reconstruction of St Eftichios who lived between the 9<sup>th</sup>-10<sup>th</sup> century. His holy relics are kept in an Orthodox monastery called Holy Monastery of Odigitria.

By using CT scan technology a copy of the Saint's skull was created employing three-dimensional reconstitution and reverse engineering methods. The reconstruction of the mandible

and the missing left cheekbone was implemented employing the Sassouni method. Then soft tissue was remodelled with appropriate thickness clay deposition on the surface of the skull model, followed by addition of the eyes, nose and lips based on the dimensions of the underlying bone structures. Finally, hair and beard were added, according to the classic Byzantine tradition pattern for the ascetics of the time.

The final bust developed was then digitized, using a 3d non contact laser scanner, in order to maintain its shape in a digital file in the computer. The 3d geometry produced with this method was employed to produce a mould with vacuum casting reverse engineering techniques. This mould was used to produce clay copies of the bust for the people involved in this project.

This work is the first case of Saint facial reconstruction in the Orthodox Church. After 1000 years the ability to reconstruct the shape of the face of a hermit and Saint who lived in a little known period of the Cretan history and the local Church is given.

## 2. INTRODUCTION

Icons are not just creations of the painter. They maintain through time the figure of Saints, which is always similar, can not be radically changed or be produced by the imagination of the painter. For this reason, after the iconoclasm, Church tends to keep the Saints' figures unchanged and that was the case until the 19<sup>th</sup> century.

In this century the iconographic types were changed, because of the influences of westernized paintings, Russian culture and especially the so-called "Nazarene" art.

This artistic trend was spread across the Balkans, supplanted the post-Byzantine Orthodox Art and the particular characteristics of the two great painting schools, the Cretan School and the respective Northwestern Greece School. It used models for the Saints representation that were altered and forged compared to the usual Saints forms. In the 20<sup>th</sup> century the Orthodox Church realigned with the correct course of its tradition for the iconography forms, mainly because of the efforts of specific people, such as Photios Kontoglou.

The physiognomic facial features of each Saint are encoded in the famous "Interpretation of the Art of Painting", by Dionysius of Fourna of Agrafa (18<sup>th</sup> c.). Theodore Stouditis (8<sup>th</sup> c.) writes that the form in principle expresses the outer gifts. The painter not only represents in colour the shape and the form of the presented person, but also interprets his inner mood, mental state, spiritual depth, inner qualities, stability of faith and the stirrings of the soul. According to St. Photios the painter hand belongs to the artist, but moves by the breath of God.

The Saints figures shown in the icons are monuments not only for the religion but also for the art. These icons follow the style and techniques of the great Byzantine School masters of painting. The ascetics are usually presented disembodied and deprived of material pleasures.

Few data exist nowadays for the real facial characteristics of Saints, especially for those the lived in the older periods of time. The actual face morphology remains unclear to this day and is usually moulded in the believers' imagination.

To date only few attempts have been implemented for the facial reconstruction of Greek history persons. King Fillipos of Macedonia [1] and the representation of an 11 years old girl from ancient Greece [2] (Figure 1) are the examples know so far. No scientific method has been applied for the facial reconstruction of a Greek Church holy figure.

Saint Eftichios lived on Mount Raxos, current Asterousia, in the southern region of Heraklion, Crete, Greece (Figure 2), possibly in the years of Arab occupation (824 – 961 ad) and was elected bishop of Gortyna. The earliest evidence available for the Saint comes from the Testament of St. John the Hermit who lived in the 10<sup>th</sup>-11<sup>th</sup> century. He says he discovered his grave along with the grave of his brother Eftichianos in an Asterousia mountains cave in a miraculous way. According to tradition, their skulls were stored in the temple which he founded and they were transferred later to the Monastery of Odigitria (Figure 3), where they are kept ever since.

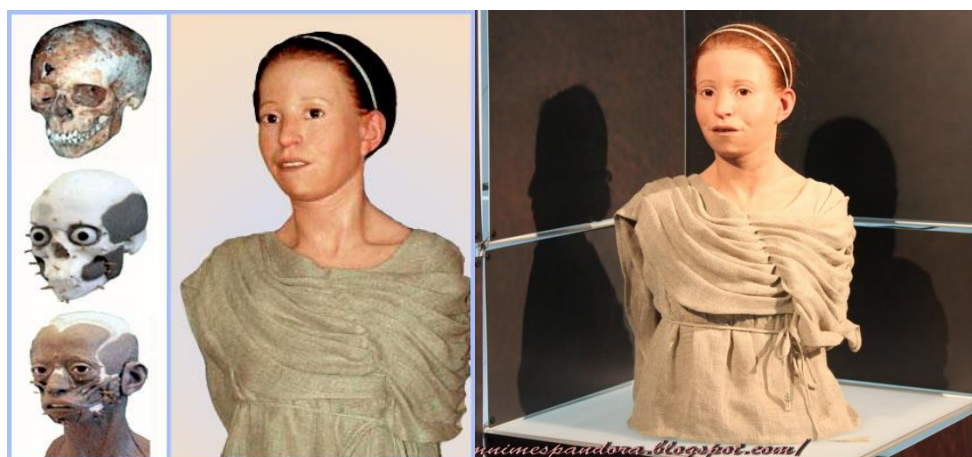


Figure 1.  
Representation of an 11 years old girl from ancient Greece (Courtesy of the Myrtis project team).

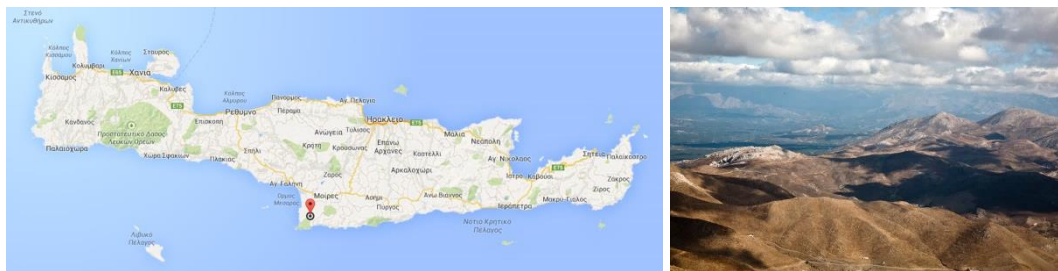


Figure 2.  
Asterousia mountains in the Southern part of Crete, Greece  
(left picture courtesy of Google maps and right picture courtesy of ioanniscrete.blogspot.gr).



Figure 3.  
Monastery of Odigitria (Courtesy of www.crete2day.gr).

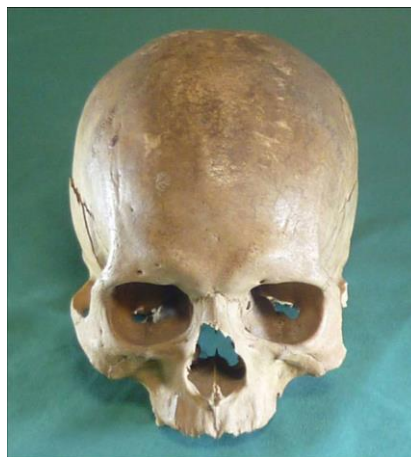


Figure 4.  
Saint Eftichios skull.

The condition of Saint Eftichios skull is quite good, with absent mandible (Figure 4). According to the forensic study implemented during this project, the skull belonged to a man aged 60-65 years.

The increase interest from the scientific and religious community of Crete to reveal the Saint Eftichios form led to the implementation of this project for the facial reconstruction of the Saint. This work describes the stages followed in the Saint Eftichios facial reconstruction process.

### 3. CASE REPORT

The use of the actual Saints' bones in a reconstruction process is not indicated, since it is not allowed to cause any damage to the holy relics. To prevent this, a copy of the Saint Eftichios skull was created with reverse engineering and additive manufacturing techniques.

Cranial copies are usually manufactured using a mould. This is an invasive method and in order to maintain the original condition of the Saint Eftichios skull, the use of reverse engineering techniques was chosen. CT scan was chosen over 3d laser scanning, since the whole bony structure of the skull will be acquired and digitized in this way, producing a more complete model, while laser 3d scanning captures only the outer shape of the scanned model geometry.

The skull of the Saint underwent computed tomography using three-dimensional reconstruction protocol.

Due to the high resolution of the CT scan sections, the data obtained contained significant amount of information for the cranial morphological structures. These data were employed to produce a digitized model of the skull in the computer, with the use of CT scan sections reconstruction techniques (Figure 5).

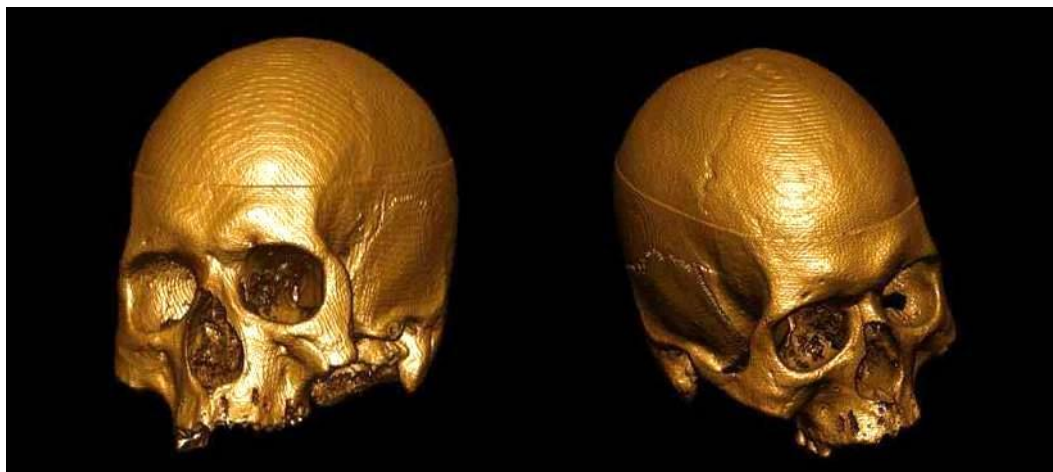


Figure 5.

3d model of the skull in the computer, produced by the CT scan sections.

By using suitable software tools, the geometry of the skull was improved and it was converted from CT scans to cloud of points, with a software developed by one of the authors and then to a 3d solid watertight model, suitable for 3d printing. With the 3d printing technology employed in the study, ABS plastic models can be manufactured from a 3d geometric model stored in the computer, which is the input to this process.

3d printing technology belongs to the Additive Manufacturing family of technologies and it manufactures parts by adding material in layers, in contrast to the traditional manufacturing methods, in which the final shape is produced by removing material from a workpiece.

In order to produce parts with this technology, the initial shape is sectioned into horizontal layers. The thickness of each section varies, depending on the machine specs. The machine starts to produce the part by producing the lowest section of the geometry. The next section is manufactured on the top of the previous section and it is fixed to that with an automated process. The process is fully automated and no user intervention is required during the build of the part. This process provides the ability to construct parts with any complexity.

TEI of Crete Mechanical Engineering Department Dimension Elite 3d printer was used (Figure 6). First a 1:5 scale model of the Saint skull was constructed to evaluate the model and the process accuracy and feasibility (Figure 7).

Then, a full scale 1:1 model of the skull was constructed (Figure 8). The volume of the skull was 400cm<sup>3</sup> (requirement in 3d printing ABS material) and it required 105 hours for the printing process to complete. By the end of the procedure an exact copy of the skull was available to use as the basis for the Saint Eftichios facial reconstruction process.

Following the mandible was constructed. Lack of mandible is a common problem in incomplete skulls [3]. For the creation of the mandible, a method proposed in 1957 by Viken Sassouni, known as Sassouni method or analysis [3, 4] was employed. The mandible was created with clay material and the design was to be harmonious with the upper face.

The Sassouni method requires that the person is orthognathic. Given the lack of information on the Saint face characteristics, this can be assumed. This method provides a quite acceptable copy of the mandible in cases in which it is missing, making this method a useful suitable tool for the facial reconstruction process.

For the soft tissues reconstruction, the American method was employed [5], which is based in the measurement of the skin thickness in specific positions on the skull. The measurements are used as guidance for the soft tissues reconstruction on the face. The prerequisite of the method is the knowledge of the age and the gender of the individual, in order to provide soft tissues thickness values for specific positions in the face.



Figure 6.  
TEI of Crete Mechanical Engineering Department  
Dimension Elite 3d printer.



Figure 7.  
1:5 scale model of the Saint skull, build to evaluate  
the model and the process accuracy and feasibility.



Figure 8.  
Full scale 1:1 3d printed model of Saint Eftichios skull.



Figure 9.  
Tissues thickness indices at 21 predetermined points  
of the skull, based on the American method.

The reconstruction of the skull facial bones is a combination of art and science [3]. It is accomplished in two phases: the technological phase, in which the soft tissue data are applied in the skull and the general shape of the face is constructed and the artistic phase in which personal characteristics in the face transition regions are developed.

The skull was placed in the Frankfurt reference plane, which is the anthropological position that best approximates the physical position of the head in vivo. Tissues thickness indices were placed in 21 predetermined points of the skull (Figure 9).

These points correspond to anthropological skull points. Tissues thickness considers muscle, fat and connective tissue thickness in each specific morphological point.

First the eyes bulbs were added in the orbit. The eyes were created taking into account the origin and the age of the Saint. The depth of the eyes was determined from the shape and depth of the orbit. The study of the orbit shape also showed orbital shape and direction of the eyebrows. Then tissue thickness indicators were connected with clay, to create the facial contour. This approach provides the general shape of the face, based on the shape of the skull.

Then, the oral design was implemented, taking into account the origin and the age. The height of the lips was determined by the height of the teeth, while the width of the oral was determined by the size of the six front teeth.

The nose was designed according to the skull shape characteristics and is considered the

most accurate part in the face reconstruction process. For its construction, the Krogman [6] method was employed. This method is based on skull bones points' measurements and is also taking into account the origin of the person.

Also, cheekbones were constructed, taking into account the bony parts, the origin, the gender and the age of the Saint.

The ears because of their cartilaginous construction could not be rescued during the years. The size and the shape were determined by the proportions on the face and the age. Their slope is affected by the slope of the jaw. Their design ensures alignment with the rest of the face. By adding the ears the facial characteristics became apparent (Figure 10).

Then in the artistic phase of the study, the artist Ms. Aspasia Papadopferaki sculptured the hair

and the beard of the Saint. She also improved the texture of the face (Figure 11).

Taking this as an input, the icon of Saint Eftichios was created, following the Byzantine style and assigning Byzantine form while retaining the original features and proportions (Figure 12).

The final bust developed, shown in figure 11 was given to the Odigitrias Monastery, to be shown to its visitors. Because this is a unique effort involving different scientific work and people, it was critical to maintain its result through time. The best way to achieve that is to create a digital copy of the bust shape that can be stored in the computer for future use. So, before handing over the bust to the Monastery, it was scanned with the Konica Minolta VI910 3d non contact laser scanner of the Mechanical Engineering Department of the TEI of Crete, to produce a digital copy of the bust three dimensional geometry.



Figure 10.  
Facial reconstruction technological phase result.

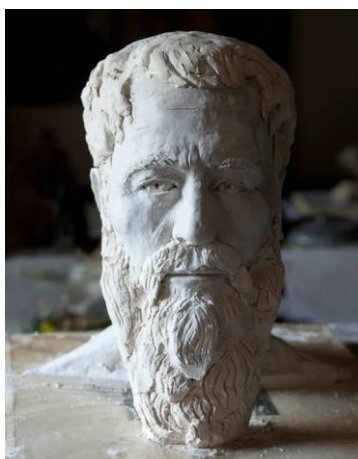


Figure 11.  
Facial reconstruction artist phase result,  
final Saint Eftichios bust.

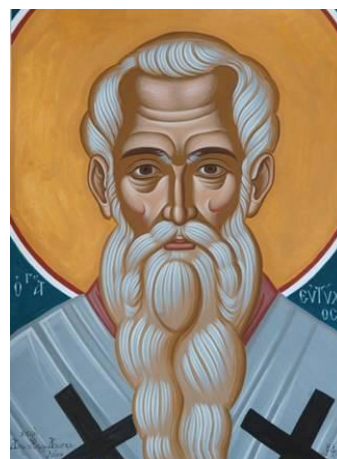


Figure 12.  
Saint Eftichios icon created,  
based on the outcome of this study.

A 3d geometric model of the bust was developed in the computer from the 3d scanning data. A 1:2 scale model was 3d printed, based on this computer 3d geometric model. This model was employed to produce a silicon rubber mould with vacuum casting reverse engineering techniques. This mould was used to produce clay copies of the bust for the people involved in this project. Finally one of the clay copies of the bust was painted by one of the project members to produce a more realistic representation of the Saint's face. The steps for this process are shown in Figure 13.

#### 4. DISCUSSION

In this study the face of St Eftichios that lived at an unknown time, probably in the 9<sup>th</sup>-10<sup>th</sup> century in the southern regions of the Heraklion prefecture, in the island of Crete in Greece, was constructed.

The testimony for the Saint holy relics was confirmed by historical sources of the 11<sup>th</sup> century.

The exact representation of the Saint Eftichios characteristics can be set as a matter of scientific debate. The form followed the characteristics of the underlying bony skeleton and is considered relatively accurate. Some parts of the face which are cartilaginous is impossible to be precisely represented.

The hair and beard of Saint Eftichios were selected following the existing tradition for their ascetics of the time.

Doubts can be expressed for the tissues thickness in various skull regions. They were constructed based on the existing rules for the Caucasian race, since the published scientific data on Greeks are scarce.



(a) 3d scanning of the bust.



(b) 3d printed model of the bust.



(c) Silicon rubber mould developed with the vacuum casting process.



(d) Clay copies of the bust produced with the silicon rubber mould.



(e) Painted bust for more realistic representation of the Saint's face.

Figure 13.

The face of the Saint should not be compared with his Byzantine icons. However, there are no older icons illustrating Saint Eftichios. The only ones known are from the last decades of the 19<sup>th</sup> century, which is relatively recent compared with the period the Saint lived. With the scientific approach followed, it was possible to design a Byzantine icon, based on the face characteristics as they were revealed by the facial reconstruction process.

The facial reconstruction process was possible to be implemented entirely on the computer following equivalent digital face reconstruction techniques. It was preferred to employ 3d printing technology to develop a physical bust of the Saint, as this approach is more accessible for viewing to the general public, while yields and a sense of immediacy.

The facial reconstruction was entirely implemented in Greece creating the basis for similar work in the future.

## 5. REFERENCES

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