

TECHNICAL NOTE**PHYSICAL ANTHROPOLOGY**

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On Gerasimov's Plastic Facial Reconstruction Technique: New Insights to Facilitate Repeatability*

ABSTRACT: Gerasimov's plastic facial reconstruction method is notoriously difficult to repeat from the published literature. Primarily, this is because of the method's underlying qualitative basis but other factors contribute including: misreports in the secondary literature of Gerasimov's method essence; a lack of published details concerning Gerasimov's modeling mastic; Gerasimov's deviation from his own published nose projection prediction guidelines; and continued refinement of the methods in the 15 years following their foremost publication. As Gerasimov cannot be consulted to resolve these issues, we provide solutions via one of his five former principal students. This includes clarification of Gerasimov's method and use of soft tissue depths; the constitution of his modeling mastic; methods used for nose projection prediction; and refinements made to his methods following their primary publication.

KEYWORDS: forensic science, facial approximation, facial reproduction, forensic anthropology

No facial approximation practitioner holds more global acclaim than Gerasimov (see, e.g., [1–4]). He is famous for claiming close to 100% accuracy (5,6), and his techniques form the basis for many contemporary protocols (see, e.g., [1,4,7,8]). However, Gerasimov's method is beset by its unrepeatability—an issue which Gerasimov himself recognized and was plagued by (5,6).

Several factors give rise to this unrepeatability. First, no full written account of the method exists because of its qualitative nature (9,10). For example, the eyeball is said to be more deeply placed within orbits of the “closed type” but exactly how deeply the eyeball should be placed goes unreported (11). Further complicating repeatability is: an absence of published detail on the modeling substrate that Gerasimov formulated and used; only vaguely accurate published directions for determining nose projection; little comment on his more contemporary soft tissue prediction methods produced in the 15 years following his 1955 (11) publication; and frequent errors in the secondary English literature concerning the method's underlying principles.

Because of his death in 1971 (12), it is clearly impossible for Gerasimov to clarify and reaffirm his methods. However,

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confirmations can be equally provided by Gerasimov's former students. In this paper, we present such details to help resolve some of the aforementioned issues. This is possible because the first author trained and worked with Gerasimov during five 2- to-3-week visits to the former USSR between 1959 and 1969 (for mention of this, see Gerasimov [(5, p. 40) or (6, p. 28)]). We begin this overview by addressing the erroneous views that have been circulating in the published literature for at least the last 10 years, and as recently as 2009 (see, e.g., [13,14]).

Confusion Concerning Gerasimov's Method

The English facial approximation literature distinguishes between two main types of methods: anatomical methods and soft tissue depth methods (see, e.g., [1–4,14–18]). Anatomical methods are said to require only the construction of the facial muscles (to the exclusion of mean soft tissue depths), and these methods are often termed “Russian methods” after Gerasimov who is said to be their founder (1–4,14–18). Such anatomical/Russian methods are commonly understood to involve the construction of both the muscles of mastication and facial expression (see, e.g., [1–4,14–18]). Soft tissue depth methods, on the other hand, are said to depend on mean soft tissue depth values to the exclusion of any facial muscle construction (1–4,14–18). Since Gerasimov is recognized as the founder of “anatomical methods,” it is under this classification that his methods are currently, but erroneously, categorized as outlined below.

Gerasimov thought mean soft tissue depths so important that he measured 71 freshly deceased individuals to determine his own values, which he published (see [11, p. 105, 108] or Table 1) and heavily used in his work. This is confirmed by the examination of published photographs of partially complete facial reconstructions that Gerasimov constructed, which reveal single isolated markers on the skull (small mastic pyramids) to indicate the mean soft

TABLE 1—Mean soft tissue depths (mm) as measured by Gerasimov in 71 freshly deceased individuals. Adapted from Gerasimov (9, p. 105, 108).

Landmarks	Males	Females
Median Plane		
Metopion	6	5
Glabella	8	6
Nasion	6	6
Rhinion	3	2
To the side of the anterior nasal spine	11	10
Upper lip	12	10
Lower lip	8	9
Mentolabial sulcus	9	8
Pogonion	9	8
Frankfurt Horizontal Plane		
Near the edge of the aperture piriformis	3	2
Middle of the frontal process of the maxilla	4	2
Just under the orbit	4	3
The most prominent point at the frontal part of the zygomatic arch	7	5
At the zygomaticotemporalis suture	7	3
The most prominent lateral point on the zygomatic arch	6	3
Above the temporomandibular joint	5	4
In the area of the ear, behind the zygomatic arch	4	3
At the lambdoidal suture	6	4
At the most prominent point on occipital bone	8	5
Additional Points		
Over the anterior lacrimal crest	3	2
Alongside the aperture piriformis at the height of the crista conchalis	3	2
Adjacent to the corner of the apertura piriformis where the inferior rim turns into the lateral rim	3	3
Lateral rim of the orbit near the malar tubercle	3	3
Gonion	6	4

tissue depths: see *Vosstanovlenie lica po cerepu* (11, p. 133), and *Ich suchte Gesichter* (5, p. 161); or see Fig. 1 for simulations. As especially common in his later work, Gerasimov incorporated soft tissue depth markers directly into the “profile lines” that he constructed on the skull (see [11, p. 133], or [5, p. 151], or Fig. 1 for examples), so it was these structures (not single isolated markers) that represented the mean soft tissue depth measurements. Thus, the exclusive classification of Gerasimov’s technique as “anatomical” is not justified because his method heavily depended on mean soft tissue depths.

Moreover, Gerasimov deemed it dubious to determine the attachment sites of the muscles of facial expression from the skull and he did not, therefore, pursue their representation (19,20). Only the two superficial muscles of mastication (the temporalis and the masseter muscles) were ever constructed by Gerasimov (5,6,11,19,21), thus explaining why the muscles of facial expression never appear in Gerasimov’s partially completed faces (see, e.g., [5,11]). This adds further weight to the erroneous classification of Gerasimov’s method as purely “anatomical” under current categorical definitions.

Clearly underpinning much of the confusion over Gerasimov’s methods (especially in the English literature) is an overreliance on the English translation of *Ich suchte Gesichter* (6). This text overemphasizes an atypical case where Gerasimov worked “purely by eye” (see p. 22); fails to adequately acknowledge the mean soft tissue depth data that Gerasimov calculated; and fails to adequately describe the role of profile lines in the method. Moreover, *The Face Finder* (6) omits figures (present in the original German version of the text) that highlight the role of soft tissue depths (see [5, p. 24, 54, 161]). These factors generate the erroneous impression that Gerasimov did not use mean soft tissue depth data in his work.

It should also be noted that while Gerasimov was the first to invent many new soft tissue prediction rules, he was not the first to

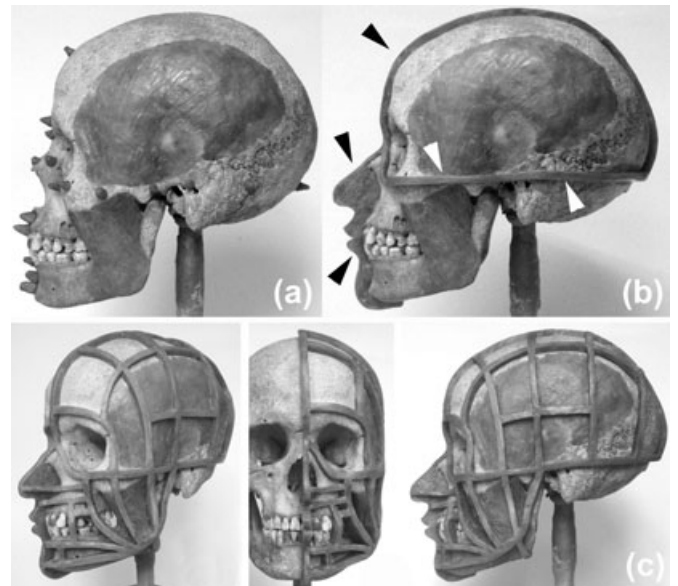


FIG. 1—Soft tissue depth representation as simulated by the authors on a skull but following Gerasimov’s method. (a) Wax pyramid markers: see [11, p. 113; 5, p. 161] for examples in Gerasimov’s own figures. (b) The “profile line” (black arrows) and the line following the Frankfurt horizontal plane (white arrows) that incorporated most of Gerasimov’s mean soft tissue depth values (see [11, p. 133] for Gerasimov’s own illustration of these points or see [11, p. 105, 108] for data values). (c) The subsequent meshwork of “profile lines” that Gerasimov established over the skull (see [11, p. 133] for original examples) that enabled the measurement of the simulated tissue depth at many craniofacial sites in addition to the typically used landmarks (e.g., glabella, zygion, and pogonion).

construct the superficial muscles of mastication on the skull as commonly implied in the literature (1–4,14–18), even if he might be renowned for such methods. The first construction of the muscles of mastication goes to P. Richer of France who in 1913 worked on skeletal remains thought to belong to Descartes (see [22–24]; especially see the masseter and temporalis muscles evident in figures on p. 140–141 of Ref. [24]). Note here that Gerasimov self-reports developing an interest in facial reconstruction in 1920 and undertook his first facial reconstruction attempt in 1924 (5,6), 11 years after Richer’s work. Thus, the first face Gerasimov produced fell almost at the same time that McGregor not only considered, but actually published on, facial reconstruction methods that utilized muscles of mastication (see [25]).

Of What Did Gerasimov’s Modeling Mastic Consist, and How Was It Produced?

In general, Gerasimov used a mixture of beeswax (1 kg) and chalk (100–150 g) to construct his faces. However, he used beeswax (400 g), plastilin (600 g), and colophonium (100 g) for criminalistic purposes. A typical mix, as now employed by the first author, includes one part colophonium (rosin), one part plastiline, and five parts beeswax. The beeswax gives the mastic excellent detail while the colophonium is used to give the mastic hardness and permanence. As cited in *Ich suchte Gesichter* (5), the mastic was specially derived by Gerasimov to suit facial approximation needs. That is, the material was designed to be rigid so that its position was set only with specific intention and permanent accuracy. Its hardness also facilitated precise measurements to be taken during face construction (e.g., along the profile lines to check soft tissue depths) and without the risk for disturbing the previously

modeled face (a problem more readily encountered when using clay). To carve the mastic, Gerasimov favored a single handmade metal modeling tool—evident in the foreground of the dust jacket image on *Ich Suchte Gesichter* (5) and *The Face Finder* (6). Figure 2 provides a scaled depiction of this instrument.

Because of the high melting point of the colophonium ($>100^{\circ}\text{C}$), the ingredients must be combined in a ceramic dish. Thermal decomposition of the constituents should be avoided and so mixing

should take place with well-controlled and slowly applied heat under a fume hood. After cooling to room temperature, the mastic is typically hard (almost the equivalent of dried clay and much harder than dental utility wax), but it becomes increasingly malleable (equivalent to very stiff plasticine) with concerted manipulation by the fingers. For increased softness/pliability, a heat lamp can be used, but the mastic is meant to be firm for the reasons outlined earlier. When the mastic is allowed to stand for a period of weeks to months, it becomes even harder than the initial preparation, thus strengthening the permanency of the material (and any face modeled from it).

As some practitioners have reported finger soreness soon after using the mastic, unsubstantiated concerns have arisen outside the published literature that the mastic is highly toxic. To the contrary, however, all of the mastic's ingredients possess low hazards at room temperature (see, e.g., [26,27]) and all are common products routinely used in the arts. A much less sensational and more reasonable explanation for the finger discomfort is that the mastic is very hard when it has been standing and needs to be intensively manipulated with the fingers to soften it for facial reconstruction work. Of course, since facial reconstruction takes several days, manipulation of the mastic must also be maintained while the face is built. To the fingers, the mastic can therefore be physically taxing particularly for those persons who have never used it previously. In the second author's experience, the most discomfort arises from shear forces that act on the pads of the fingers when the mastic is first worked and this discomfort readily dissipates when manipulation of the mastic has ended.

How Did Gerasimov, in Practice, Predict the Projection of the Nose?

Despite seemingly clear-cut directions in the literature for predicting the nose projection using two tangents, one following the "last third of the nasal bone" and the "general direction of the nasal spine" (11, p. 59, 129), Gerasimov did not precisely adhere to these directions. Here, we can confirm Rynn and Wilkinson's (15) suspicions that the literal direction for placing the tangent from the nasal bones was misleading and that Gerasimov more accurately used only the tip of the bones at rhinion (e.g., the last 1–2 mm). However, Rynn and Wilkinson's variation on Gerasimov's method (see [15,28,29]) continues to use a literal translation for the second nasal tangent, and on this account their studies also fail to represent Gerasimov's authentic method for nose projection prediction in common with Stephan et al. (30). That is, Gerasimov did not use the general direction of the nasal spine to predict the second tangent as it is published. Instead, he followed

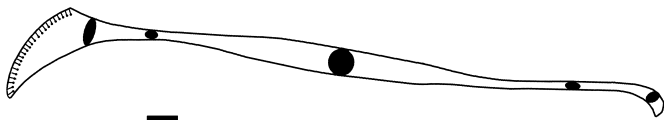


FIG. 2—A scale diagram of Gerasimov's favored modeling tool. Cross-sectional views are illustrated along the instrument's length. The tool was manufactured from metal, by hand. The bar represents 10 mm.



FIG. 3—Determination of the nose projection. The maxillary regions used to estimate the direction of the lower nose tangent outlined on either side of the anterior nasal spine. Note here that the nasal spine was not considered in the method as implied in the prior published literature.



FIG. 4—Modeling the temporalis muscle after unpublished directions by Gerasimov. (a) Packing of the temporal fossa with paper. (b) Oblique view of the modeled muscle demonstrating the change in muscle contours adjacent to the lateral orbit. (c) A superior view of the constructed temporalis muscle to illustrate the muscle contours. (d) A superior view with the muscle contours schematically depicted.

the general direction of the left or right floor of the anterior part of the nasal aperture (maxillary bone) laterally adjacent to the anterior nasal spine and vomer bone (Fig. 3). Thus, neither Stephan et al. (30) nor Rynn and Wilkinson's (15) studies provide adequate tests of Gerasimov's authentic nose projection methods, which remain open to future scientific verifications or refutations. The reason for the imprecise published description of these nose prediction guidelines by Gerasimov on repeated occasions is not clear.

What Parts of Gerasimov's 1955 Methods Were Updated by Gerasimov Prior to His Death?

Although *Vosstanovlenie lica po cerepu* provides the most comprehensive account of Gerasimov's methods, Gerasimov continued to improve his methods 15 years following this publication and prior to his death. Differences between Gerasimov's 1955 account and his post-1959 teachings include, for example, that the height of the ear was approximately equal to the distance between glabella and subnasale with the addition of 2 mm—in *Vosstanovlenie lica po cerepu* this guideline is reported without the 2-mm addition. Also excluded from *Vosstanovlenie lica po cerepu* were the following:

- The projection of the eye was typically set 1–2 mm in front of a tangent that connects the anterior borders of the supra- and infra-orbital margins in their mid-plane, but that this distance depended on the depth of the orbits.
- The width of the ear equaled half its height, plus 2–3 mm.
- The temporalis muscle was not constructed to be a uniform arch in transverse section but rather, it alternated from being concave anteriorly, to convex above the center of the zygomatic arch, and then concave above the root of the zygomatic arch (Fig. 4).
- The shape of the masseter muscle, along its long axis, should be slightly convex but not reaching beyond the bounds of a tangent touching the lateral aspect of the zygomatic arch and the angle of the mandible.

Despite major problems with repeating Gerasimov's nose projection prediction methods from the published literature, it is worth noting that recent empirical tests of many other soft-to-hard tissue relationships that Gerasimov used often provide for more accurate soft tissue estimations than those used by other practitioners. For example, by placing the globe 1–2 mm in front of a tangent connecting the infra- and supra-orbital margins, Gerasimov's eye projection method does not underestimate eyeball projection as much as other recently used methods that are identical except that they do not use a 2-mm addition (see [31,32]). Also, by establishing the height of the ear as equal to the distance between glabella and subnasale plus two additional millimeters, Gerasimov's ear prediction method aligns closer to empirical data of Farkas et al. (33) that the ears are 9–10 mm taller than the nose than do prediction methods that establish the ear as the same height as the nose (see, e.g., [2,34]). Furthermore, Gerasimov's use of the 2nd premolars to predict mouth width (11) instead of the canines as in some prediction methods (2,34) can only produce closer estimates of actual mouth widths as the premolars fall slightly lateral to the canines—the canines are known to underestimate interchelion distance by c. 13 mm (15,35–37).

Conclusions

The incomplete prior publication of Gerasimov's facial reconstruction method and the misleading impression given by the English translation of *Ich suchte Gesichter* (6) has not facilitated

repeatability of Gerasimov's authentic methods. In Gerasimov's absence, the only avenue left to resolve many of these issues is consultation with Gerasimov's former students and closer review of Gerasimov's less heavily translated and edited works.

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