3D scanning, study and reconstruction of the “Tavolette Enigmatiche” (Brotlaibidole)

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We present the activity performed by the Laboratory in the 3D investigation of the “Tavolette Enigmatiche”, manufacts of the bronze age found in various locations around northern Italy and other countries. The need to investigate and compare the symbols carved on these objects gave rise to a collection of 3D images from a considerable number of them, and to the subsequent development of a user friendly software tool, to be used by the arcaheologists working on this project, for comparing the point clouds to find similarities and to aid classification.

1 Introduction

The “Tavolette Enigmatiche” (Brotlaibidole) represent a sort of enigma for the specialist in the studies of the Bronze Age archaeological findings [1]. They are small, baked-clay objects of prevalently ovoidal shape of the 2100-1400 b.C. period, disseminated in Italy (mainly the Garda-Lake Region, between Lombardy and Veneto) and northern Europe. These objects are engraved with a reduced number of symbols which seem to be quite similar in all the findings, despite the large distance between the settlements.

In order to help the archaeologist to perform a comparative analysis among the object on a quantitative basis, we carried out an extensive measurement session with a 3D scanner, to acquire as many “Tavolette” as possible, and developed a software environment whereby the symbols engraved on them can be quantitatively compared to check for similarity.

2 The optical setup of the system

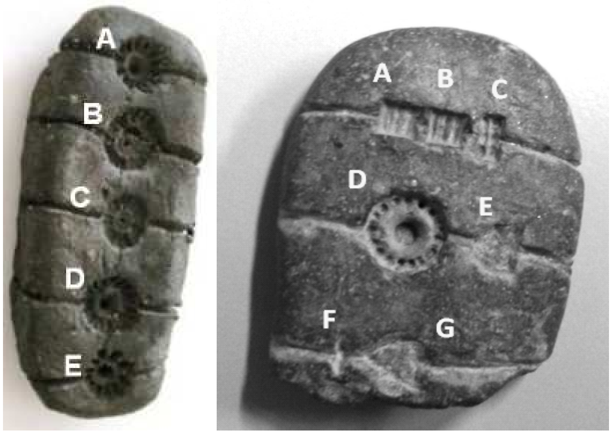

Fig. 1 *Two examples of “Tavolette Enigmatiche”. Left: The ‘VESELE’ piece, found in Slovenia. Right: the LOVERE piece, found in Northern Italy.*

Two examples of the “Tavolette Enigmatiche” are shown in Fig. 1.

We performed an extensive measurement campaign in Europe, to produce and collect the 3D models in a unique database of 3D models, in view of their future study by the specialists. To carry out the measurement, we used the Vivid 910 sensor (Konica Minolta Inc.). Besides the measurement performances, which well suit to the resolutions required in this application, the system is rugged, portable, and fast in the setup and the acquisition processes. So far, 30 specimens have been acquired, modeled and organized in a database.

Figure 2 shows the 3D models of the objects depicted in Fig. 1. Their resolution is 120µm.

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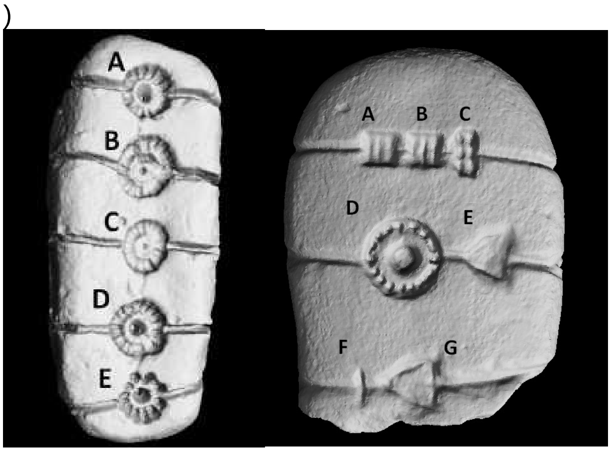

Fig. 2 *3D models of the “Tavolette” presented in Fig. 1, after acquisition and point-cloud elaboration.*

Each sign has previously been catalogued, in order to build up a sign database. Thus, The snapshots in Fig. 3 are the zoomed views of the signs denoted by letter ‘A’ in the model of Figure 2 (left), and by the letter ‘D’ in the model in Figure 2 (right). The availability of these representations is of outmost importance in view of carrying out the comparative analysis among the objects on a quantitative, objective basis.

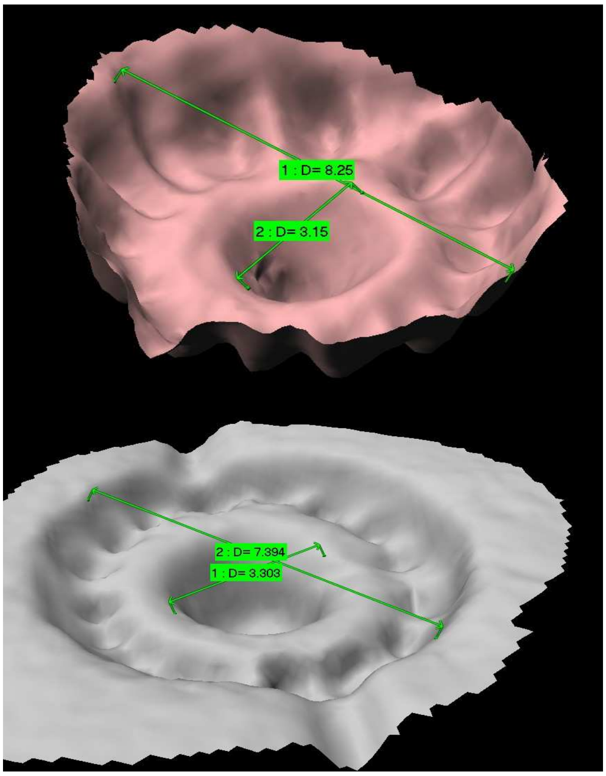

Fig. 3 *Upper: Zoom of the detail labeled by letter 'A' in the 3D model of Fig. 2 (left). Lower: Zoom of the detail labeled by letter 'D' in the 3D model of Figure 2 (right).*

3 The ATEC-3D software

Following the acquisition and point-cloud elaboration, we carried out a selection of symbols to be compared. The different symbols were extracted from the model, properly oriented in a suitable reference frame, and organized in a 3D database, as shown in Fig. 4.

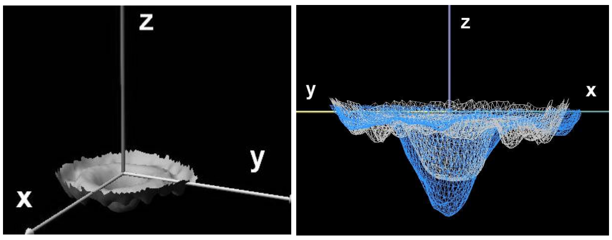

Fig. 4 *Symbol extraction, orientation and overlapping*

Symbols from different "Tavolette" were then superimposed and aligned, in a totally automatic way. Color coding was used as a user-friendly way to obtain information about the amount of overlapping between the two symbols, as shown in Fig. 5.

All these steps were performed by the self developed "ATEC-3D" software: a user-friendly environment, specifically intended to be used by a non software expert such as an archaeologist. The typical layout of the ATEC-3D window is shown in Fig. 6.

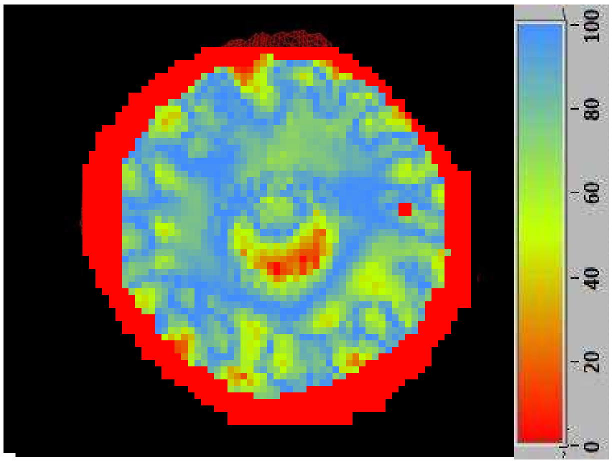

Fig. 5 *Color coding of the quality of superposition of the symbols*

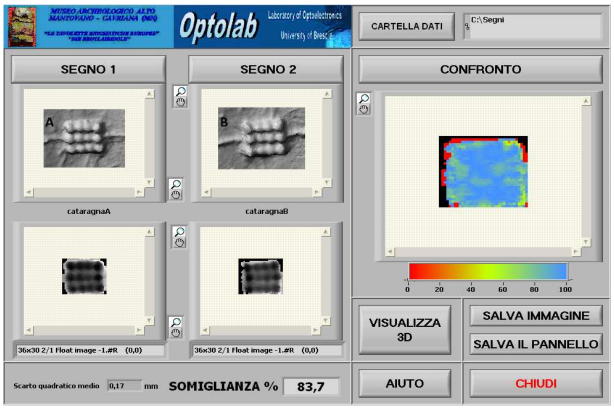

Fig. 6 *The ATEC-3D interface panel*

In the ATEC-3D panel, the signs to be compared are chosen, and they appear as 3D models, point clouds and their superposition in color coding is presented after suitable automatic registration and distance compensation. An index of similarity (rms value of the differences) is obtained to quantitatively assess the goodness of overlapping. This process has been tested on a suitable number of self-made signs used as references, printed onto clay surfaces under different angles and with different pressures.

The ATEC-3D software has been delivered to the archaeologists, who have now started the overall comparison of all signs derived from the 30 "Tavolette" whose 3D acquisition has been made and whose signs are now in the common database.

4 References

[1] G. Sansoni, G. Cavagnini; N. Modonesi, A. Piccoli, S. Marchesini: Generazione ed elaborazione di misure mediante sensori non a contatto per l'analisi e l'interpretazione di reperti archeologici. Proc. XXV Congresso Nazionale Associazione GMEE 2008, 289-290.