Computer models and applications for the management of anthropological data

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Introduction

Recent developments in the excavation and osteological studies of human skeletal remains have shown the need to adopt a computer and digital approach, which is both practical and methodological, and able to integrate the knowledge and skills acquired in recent years by different branches of archaeoantropological studies, using modern and innovative tools. JASs has repeatedly promoted a “renewal” of the practices related to information management, both through the creation of the forum “Sharing databases in digital Anthropology” (Bruner, 2009), and through the publication of many international works linked to this topic (Canals et al., 2008). To this aim, it is clear that the first step consists in creating a set of integrated applications, capable of managing the various areas investigated in this widespread field. In order to address the management of large amounts of anthropological and paleopathological data and their subsequent processing and interpretation, the Division of Paleopathology of the University of Pisa has created an extensive project relating to excavation and laboratory activities designed to develop a number of data storage protocols and subsequent inclusion into a GIS system (for an extended version of this project see Coschino, 2009).

This project has been essentially organized into a tripartite structure; the information system includes two main protocols designed by the research team of the Division of Paleopathology (University of Pisa) which work on an OS Windows™: 1. the software SIUS manages the skeletal unit computer records, which aim to store all the archaeological, taphonomic and anthropological data recorded on the field during archaeological excavation; 2. the software BONES stores and handles the dozens of anthropological and paleopathological records compiled during the examination of the skeletal remains in the laboratory. The GIS system allows interaction between the protocols using the two types of software.

SIUS

The first of these applications regards a completely unpublished Skeletal Unit Record, defined by the acronym SIUS (Scheda Informatica di Unità Scheletrica; fig. 1, supplementary online material): it is a compilable protocol for the management of the anthropological evidence recovered during one of the excavations. The application was developed from the works published by Canci and Minozzi (Canci & Minozzi, 2005) and Duday (Duday, 1990), and has been enriched thanks to the valuable contribution of Dr. Angelica Vitiello of the University of Pisa. The record comprises two specular parts, one on paper, to be completed during the excavation campaign and resulting from the direct observation of burial evidence; the other on a computer interface, where the same data have been processed. These data will become part of a larger
system of compatible relational databases which will integrate the software BONES.

Part 1: taphonomic, thanatological and archaeological observations

General Observations: a) brief description of the Skeletal Unit; b) general position of the body; c) state of conservation of the skeleton; d) bed-sore; e) sepulchral typology; f) deposition type; g) orientation; h) synoptic inventory of bones; k) graphic sketch; j) documentation.

Archaeological Observations: a) stratigraphic reports; b) funerary set; c) stratigraphic matrix.

Taphonomic Observations: a) characteristics of the grave; b) characteristics of the corpse.

Anthropological and anthropometric observations: a) gender; b) age at death; c) morphological alterations; d) diseases; e) measurements on the field.

Part 2: anthropological and morphological observations of individual skeletal districts

Skull and teeth: a) order of appearance of the skull bones; b) skull position; c) joints; d) denture; e) inventory of dental elements.

Vertebral column: a) joints; b) disconnection points.

Girdles: a) scapular girdle joints; b) pelvic girdle joints.

Upper limbs: a) position; b) joints.

Lower limbs: a) position; b) joints.

Compressions: a) compression type; b) nature of compression.

Compilation of the record is guided and facilitated by a system of homogeneous and pre-disposed fields which can relate to text forms, selection forms, check forms and multiple choice forms. The abundant presence of fieldnotes allows the user to describe any kind of unexpected situation and store the most detailed information, also thanks to the computer-logic features that lie behind the project, reducing imprecision and redundancy of information, thus normalising the quality of the data.

Therefore, it has been possible to create a commutative database, which is compatible with BONES, and able to transfer the information to the GIS platform in order to obtain related tables so integrating the geo-spatial information.

BONES

BONES may be considered an application designed to enter, manage, edit and search dynamic data by means of a navigable GUI (graphical user interface) (Fig. 2, supplementary online material). The aim of the software application is to collect, analyse and report large amounts of anthropological, anthropometrical and pathological data available on human remains in archaeology. In this respect, it takes on and develops all the investigation and processing methods used in university research laboratories. The software application was created ad hoc for the entire management of the laboratory study of a skeletal sample from arrival at the lab to final storage.

Basically, the entire programme consists of seven parts:

- the first is the access screen, which contains links to the other six screens (Fig. 2a);
- the second, explained in the definition of “Districts”, focuses on the inventory of skeletal elements, metric and epigenetic features (Fig. 2b, c);
- the third section is devoted to paleopathological examination;
- the fourth section makes it possible to calculate and evince sex and age at death by combining different methods;
- the fifth collects the skeletal markers of muscular development (generally involving functional complexes), which would not have found a proper place within the district;
- the sixth facilitates the production of reports and develops statistics and graphic representations that can be printed or exported;
- finally, the seventh allows the users to make targeted or comparative research between records in the database.

BONES was designed as a software for users with basic computer skills, people with no programming or advanced data management capacity. Almost all the functions appear on a clear user-
friendly graphical layout for which no instruction manual is necessary. Moreover, most of the internal program applications can be reached from the main screen by intuitive and dynamic links (Fig.2). The software also offers the possibility to compile the different tabs without having to follow a linear order. The user can navigate freely through the tables, following the logical succession that best fits the progression of his/her bone analyses. Each screen presents uniform visual appearance and is divided into independently recordable tabs.

In the design of the software, the greatest effort was devoted to the implementation of a methodological and practical apparatus procedure for the qualification and quantification of the pathologies identified in human remains in archaeology. The most difficult challenge consisted in developing a system of coding and cataloguing at the basis of the data-collection protocol. Furthermore, there was a need to create an information support able to provide the user with a direct and intuitive compilation and to maintain the integrity of the information entered, avoiding repetition and redundancy. It was thus decided to divide the bone diseases into nine groupings based on the typical pathogenetic classes of anatomopathologic taxonomy (Waldron, 2009; Brothwell, 1965; Fornaciari & Giuffra, 2009), each of which contained the most statistically available diseases on the remains buried. The classes are shown in Tab.1.

### GIS and software functions

Over the years, GIS applications in archaeology and anthropology have become essential for a correct understanding of the topographic maps related to the territory and environment in which the study is taking place. Independent of the software used, the data obtained from a georeferenced drawing function as *trait d’union* between the graphic representation of archaeological (or skeletal) evidence and multi-level characterizing information.

Vector files derived from the georeferencing of skeletal human remains include not only geographical information (topographical localization, dimensional scale, aspect ratio, etc.), but also an informative DataSet containing a whole series of
data related to the skeleton (stratigraphic report, bone portion, laterality, pathologies, grave goods, etc.). In our case, this information, obtained directly on the field, (overlaps and) is related to the complementary data, recorded \textit{a posteriori} in SIUS and BONES. The outcome of this operation is a relational database which combines the elements of three different protocols in a single computer system. A skeleton will be characterized by a set of data recorded in a management and analytical multi-level system formed sequentially by:

- Geographical data (GIS)
- Anthropological and taphonomic “on field” data (SIUS)
- Anthropological, paleopathological and ergonomic data studied in the laboratory (BONES)

These archives, which can be defined as “relational”, are compatible by means of intrinsic links, called “keys” (in our case, for instance, the US code or the abbreviation of a site), and can be read at many levels without losing their referential integrity. Once processed, the data inserted in the database and elaborated inside BONES (by comparison, diachronic superposition or standard deviation research) can be used at different levels of study, such as:

- recognition of human groups based on geographical location, taphonomic traditions, anthropological and paleopathological markers, etc.;
- creation of diachronic curves showing population and economic distribution;
- elaboration of pathocenotic models within one or more communities in one or more periods;
- comprehension of stress factors in a skeletal sample;
- lifestyle and dietary evolution of a community over different periods;
- etc.

**Practical applications**

The package of applications developed has been applied to the management of the anthropological documentation of the Benabbio site, a medieval fortress located on a hill in the Val Lima Lucchese, Tuscany. An unspecified number of individuals of the late Middle Ages and 46 inhabitants of the village near the Castle, who died during the cholera epidemic in 1855, were buried close to the Church located within the walls. The fortress is likely to have been built during the centuries of the so-called “Encastlement” (late 10-12\textsuperscript{th} centuries) and gradually abandoned after the demolition of a part of the structure ordered by the governors of Lucca in 1334 (Fornaciari, 2008).

A representative sample of over thirty buried individuals were exhumed and studied in the years 2007-2009 by the team of Professor Gino Fornaciari. This sample was successfully tested by the computer system developed. The skeletons were first included in the GIS geodatabase and catalogued in SIUS by the same archaeoanthropologists who had performed the digging. Once transferred to the laboratory, the skeletal remains were then anthropologically, paleopathologically and ergonomically analyzed using BONES.

The extracted data created a functional and analytic computer base, able to process comparative, semantic, geographical and logical research. A geographic dataset of necropoles with plants of phase has been created and, simultaneously, a model of pathocenosis developed on the basis of analytical observations has been accomplished on individuals of the 19\textsuperscript{th} century.

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**References**


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