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Original article

From survey to integrated digital documentation of the cultural heritage of museums: A protocol for the anastylosis of archaeological finds

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ABSTRACT

The conservation, development, and enjoyment of the artefacts in museums can benefit greatly from the application of integrated digital technologies. This topic is of great interest not only to researchers in various disciplines, but also to the managers of this heritage, the producers of technologies, innovative companies and start-ups, and the wider public. However, it does not currently seem to be possible to identify methods and protocols shared between the actors involved for the purpose of managing the phases of acquisition, definition of data models, management of digital content, and its later implementation. "Tailor-made" approaches therefore have direct consequences on the efficacy of the digitalisation processes currently available when applied to conservation and restoration, and to the promotion of cultural heritage. In this paper, we propose a protocol for the digitalisation of archaeological artefacts for the purpose of their display in museums. The method is illustrated with reference to a case study involving very rare artefacts from a wooden throne from the Villanovan Age. Finally, the work is part of the results of a wider project for the definition of protocols for the surveying and modelling of cultural heritage, from the architectural scale down to the scale of artefacts, carried out through public-private partnerships.

Introduction

Digitalisation and the cultural heritage of museums

The conservation of an asset with recognised economic-financial, historical, scientific, artistic, cultural or testimonial value, whether tangible or intangible, and its public use [1] requires a multitude of skills, both interdisciplinary and specific, methods, techniques and abilities. Recently, the missions of collection, protection and conservation-restoration [2–5] to enable the transmission of the cultural value of artefacts to museums have been given a new goal to create active learning experiences that are able to fully engage the user. These goals currently represent an area of great interest, with experimentation by researchers, experts and many other actors, focusing in particular on the application of technological innovations in the field of IT.

From the application of integrated digital technologies to museum heritage, and the resulting field of research defined as *Digital Cultural Heritage Objects*, a useful support emerges in current scientific debate for the implementation of strategies aimed at counteracting the phenomena of deterioration and loss of original material. It is not only the principles of compatibility, reversibility and non-invasivity that are driving ever more widespread experimentation, but also the possibility of conserving digital models of movable heritage, which is facilitating a more widespread use of high-quality 3D models.

In contrast to activities of conservation and restoration it is feasible to establish a prevalence of applications related to the interaction with the user [6]. This contribution aims to highlight the challenges offered by the application of digital technologies [7] in a context that is still strongly characterised by more artisan skills and expertise.

The essay presents the outcomes of the contribution made by the working group from the University of Ferrara, Department of Architecture, to the project for the recovery of the wooden throne with inventory number 8641, an artefact discovered in 1969 inside

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Tomb 26 at the Villanovan Necropolis known as "Moroni-Semprini" in Verucchio, Rimini, Italy, and coordinated by the Soprintendenza Archeologia, Belle Arti e Paesaggio for the Provinces of Ravenna, Forlì-Cesena and Rimini, Ministry of Culture.

Although examples of the application of digitalisation processes to museum collections - whether displayed or stored - are constantly increasing, it seems that a general tendency persists to experiment on a "case by case" basis, resorting to the use of the technology available on each occasion. Indeed, the approach that emerges lacks the aim of defining operational protocols that help to connect the fields and purposes of application with the transferability of the results, which do not always prove to be replicable due to various factors: temporal, economic, relating to the availability of specific skills; relating to the maintenance and obsolescence of the information and digital models developed.

Integrated digital procedures for conservation and restoration

The field of *Digital Cultural Heritage Objects* [8,9] makes use of the digital technologies that are currently available - such as 3D surveying, photogrammetry [10–12], photo-modelling, HBIM, VR and AR, and immersive technologies - often in an integrated way, to understand, document, and protect, conserve, publicise and promote tangible and intangible heritage. An ever-higher number of cultural resources and educational resources around the world are produced, distributed and consulted digitally and this itself is therefore becoming a cultural asset [13]. Whether the purpose is the acquisition of geometric-formal or material characteristics, states of preservation, or contexts for use and display, the development of a digital model or several models to support the different phases of the life cycle of the cultural asset, or the production of digital content for the various types of final user the result is the ever-increasing diffusion of digitalisation processes.

Various lines of research can be identified. The application of rapid three-dimensional surveying and modelling technologies is oriented towards: comparative historical analysis in archaeology [14]; the digital documentation of archaeological sites in urban areas [15–18]; communication to a non-expert public of the evolution phases, characteristics and state of conservation of the asset [19]; the definition of digital databases of museum artefacts and archaeological finds [20–26]; the applications of VR and AR as a means of enhancing cultural heritage [6,27,28]; the application of semantic methods for the management and enhancement of digital cultural assets according to open approaches to knowledge [27,29,30]. Lines of research dedicated to the application of digital technologies to sculptures, from surveying to the construction of narratives that describe the changes they have undergone over time [11,20,31]. And still more specific fields of research involve scientific collections and the application of digital technologies, integrated with 3D printing, for the restoration of mechanisms [31–33] and museum display for educational purposes [9]. The digitalisation of collections of books, photography or other items on paper is becoming more and more widespread at institutions and undertake digital transition processes with the aim of equipping themselves with integrated tools and platforms. Less frequently documented cases are those that apply digitalisation processes to provide with more effective decision-making tools for restoration. Indeed, while the use of digital technology has become widespread in colour restoration [34,35] and to support better understanding of the characteristics of surface treatments and finishings on sculptural elements, canvases and murals, the use of digital technologies for anastylosis processes, where the original material has been lost, is much less common. Definitely, there are more frequent examples of digital anastylosis of architectural heritage [1,20,36–38], for which it is possible to turn either to documentary information sources or to comparative and typological comparisons of the stereometric characteristics of the architecture. However, regardless of the fields of application, the digitalisation of cultural heritage entails the use of advanced technologies and specialised skills and abilities. It is not only the phases of data collection that require verification of the conditions and methods of application of the currently available technologies; phases involving modelling or the calculation of models for photographic, photogrammetric or point cloud data are even more in need of specialised skills in order to guarantee the accessibility and usability of the digital information over time.

Better awareness of the risks connected to the loss of tangible and intangible cultural heritage has led to more financial resources being designated to the sector, starting with the latest European funding plan, and consequently also within the EU member states. Starting with Strategy 21 for cultural heritage and the goals set by the Recovery Plan, EU policy has identified the digital transition as a priority.

Research aim

In this research project, which aims to define a protocol for the optimisation of the production of digital 3D models, to support activities to conserve and restore the cultural heritage of museums, a case study involving the archaeological finds belonging to a Villanovan Age wooden throne is the context for the verification and implementation of the methods and procedures adopted.

The definition of a dedicated protocol for the digitalisation of assets for restoration and museum display is intended to provide a basis for shared discussion and a decision-making support for the public administration responsible for the processes of protection, conservation and promotion of these assets [39,40]. The uniqueness and specific character of the cultural heritage is therefore considered in the development of the protocol, with the goal of connecting indicators relating to individual cases and their material, conservational, geometric and morphological characteristics, with economic and temporal factors, and also factors relating to technological availability, reliability, accuracy, security, and the implementation of the digital data acquired over time.

Materials and methods

The utilization of recent digital advances can considerably enhance the conservation and restoration operations of museum artifacts. Additionally, the renewed interest in digital anastylosis methods [38,41], or anastylosis aided by digital technologies as opposed to the most traditional techniques [42], demonstrates the value of applying new technology to the discussion surrounding the "fragment" [1,43] issue.

Reversibility, recognizability or distinguishability, and also the limits related to the interpretation and historical understanding that precede a process of anastylosis, are challenges that are believed to be surmountable partly thanks to the use of the most modern digital resources [44]. To define a protocol that aims to optimise the production of 3D models that support critical and technical processes such as anastylosis, it is therefore necessary to consider, first, the intended use of the model. In the anastylosis process, it is primarily the geometric and formal characteristics of the fragments and the adjacent surfaces, joints, between them, that guide the critical process of reassembly [45]. The possible errors resulting from the initial phases of surveying the fragments are therefore critical when it comes to the following phases of interpretation, recognition and repositioning of these fragments.

The workflow implemented considers: the wide range of technologies for 3D surveying currently available for the purpose of verifying compatibility between the resolution requirements and the material and conservational characteristics of the materials;

Fig. 1. Conservation status of the archaeological finds: Villanovan wooden throne, Moroni Necropolis, Verucchio, Rimini, Italy.

the accuracy requirements connected to the type of cultural heritage involved in the investigation; the economic and temporal requirements; the anastylosis techniques adopted, whether traditional, digital or integrated; the methods of development for the final model and the verifications and quality controls; and the conservation and usability of the digital data over time.

Every action in the workflow is intended to serve as a verification of the requirements of the model, the purposes of the intervention, and the economic and temporal resources available. The documentation phase carried out in parallel with the integrated 3D survey phase provides for the organisation of the information into metadata and paradata [5,11,46]. Moreover, the protocol therefore considers the compatibility between the quality of the data and the models, and other purposes, also in connection to later phases, such as: the application of automatic procedures to segment [11,47] the models into point clouds; three-dimensional design for communication to the public; and the production of semantically enriched databases [30,32,36,48] designated for researchers.

The case study: Villanovan wooden throne, Moroni Necropolis, Tomb 26/1969 in Verucchio, Rimini, Italy

The case study consists of the wooden throne fragments identified with inventory number 8641, an archaeological asset discovered in 1969 inside Tomb 26 at the Villanovan Necropolis known as “Moroni-Semprini” in Verucchio, Rimini, Italy, and dated between the end of eighth century and the early seventh century BC. The 3D survey protocol and the subsequent recomposition of the overall data model are verified with reference to this case study.

Verucchio’s past and significance “lead us back to a historical-archaeological question relating to the ancient history of central-northern Italy, to the lives and actions of the Umbrians, to the dynamics of Etruscan expansion, and to the trade circuits of the Adriatic” [49]. As evidenced by the artifacts discovered in the four different necropolises, the orography of the Verucchio territory, and mainly its proximity to the sea, is strongly related to the key economic role that the Verucchio community played during the Villanovan period [28]. The gender attribution has been completed, during the various excavations, mostly on the basis of anthropometry as well as with reference to the peculiarities of the burial goods [50].

These objects were most likely intended for members of noble households. The Lippi and Moroni burial grounds are two of the four burial sites that can be associated to the two main aristocratic groups.

The wooden thrones, which were associated with numerous meanings amongst the various surviving burial goods made of delicate and perishable materials, such as textiles and amber, are particularly significant. Male and female thrones were in fact tied to status indications just as much as the ancestor cult or banqueting customs.

The “Tomb of the Little Princess,” also known as Tomb 26/1969, was found by G.V. Gentili in 1969 and was situated in the East/South-East region on the slopes of the rocky spur on the Pian del Monte plateau, in the vicinity of the Moroni and Semprini es-

Fig. 2. Before the damage incurred by the exhibition "Princesses of the Mediterranean at the Dawn of History," Athens, 2012: digital reconstruction of the support, Villanovan wooden throne, Moroni Necropolis, Verucchio, Rimini, Italy.

Fig. 3. Museum of Verucchio, "Sala del Trono": Lippi Tomb 89/1972.

tates [50,51]. Its oval shaft morphology measured roughly 2 m by 1 m in depth. The tomb can be dated to anywhere between the last decades of the eighth century and the early seventh century BC. The above-mentioned tomb with throne belongs to a group of three graves that are all female and are attributable to two adult deceased (Moroni Tombs 24/1969 and 25/1969) and an infant (Moroni Tomb 26/1969) [27].

The fragments of the throne from the Moroni Tomb 26 are distinguished by an internally hollow cylindrical base with a flared and decorated back, and they share several similarities with the

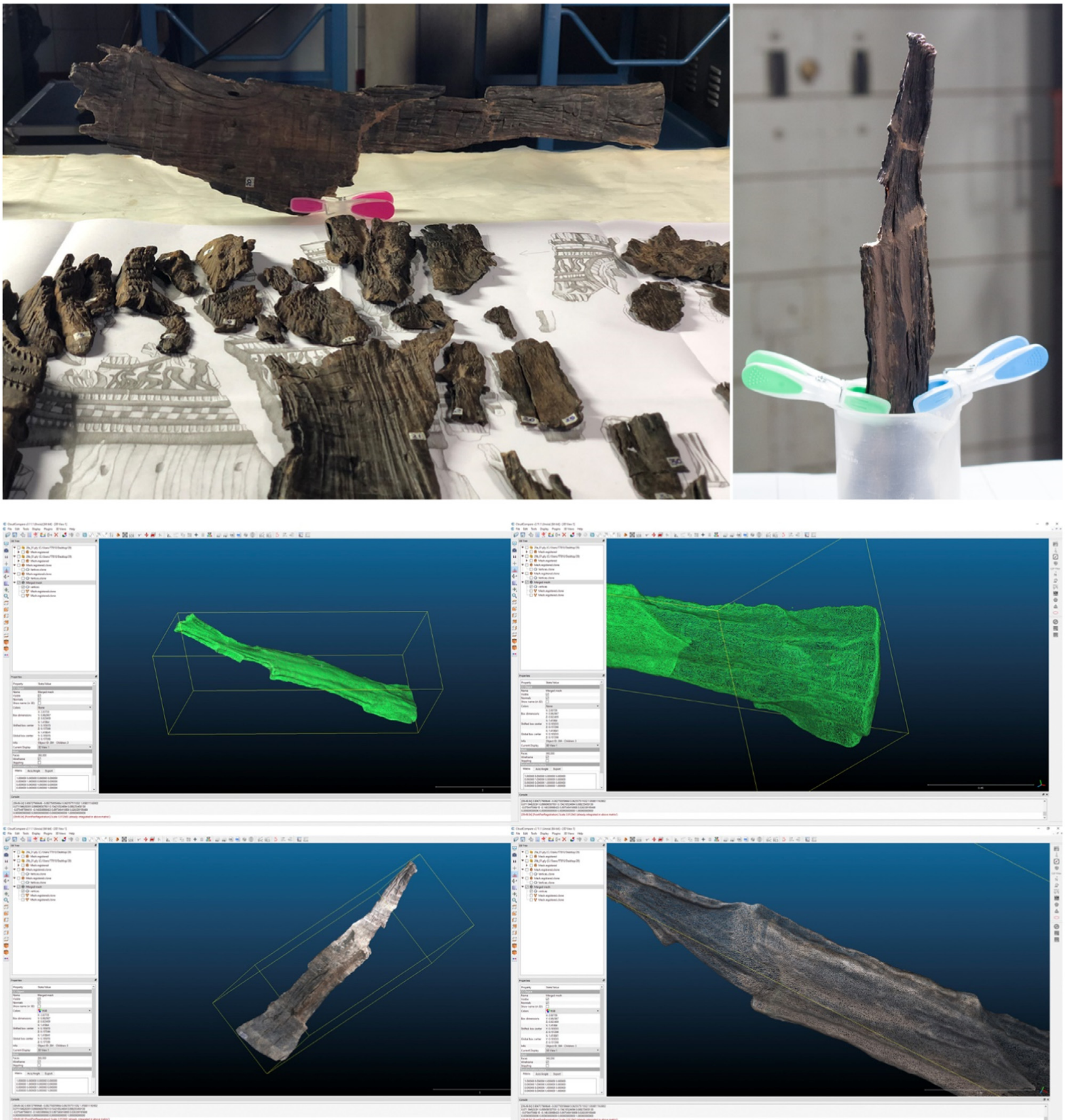

Fig. 4. From survey to integrated digital documentation of the archaeological finds: 3D surveying, modelling and integrated digital databases.

decoration of the throne from the Lippi Tomb 89/1972, which is currently on display in the permanent exhibition at the Museum of Verucchio, "Sala del Trono" [52]. Male figures, wild creatures, and armed warriors are all represented. In a nod to the more well-known bronze thrones, spoked wheels punctuate the figurative motifs on the back [27] (see Fig. 3).

Since their discovery, the fragments of the wooden throne from Moroni Tomb 26 have undergone various interventions of restoration and been significantly damaged.

Following the first restoration in the 1970s, the throne from Moroni Tomb 26 was loaned to the exhibition "Princesses of the Mediterranean at the Dawn of History"(see Fig. 2), organised by the Nicholas P. Goulandris Foundation at the Museum of Cycladic Art in Athens, in 2012. On its return to Italy, before it even reached the Museum of Verucchio, the box containing the artefact was dropped. Following this fall, the condition of the throne was such that museum display was not possible within a short timeframe.

A protocol for surveying and digital modelling

Design and management of the survey process

Starting with a multi-scale approach, the point cloud is a fundamental element of the integrated geometric-informational model implemented. In the survey of the fragments of the wooden throne from Moroni Tomb 26, the point cloud created through various data acquisition techniques primarily takes on the value of a con-

Fig. 5. The four-degree morphologies of the Moroni tomb fragments: decorations on one visible surface or on both belonging to the seat or back. Integrated digital survey and modelling models.

sistently organised digital memory and an interface with the purpose of direct interrogation, multi-scale analysis from the fragments to the object, and dialogue/verification between different data sources.

The survey described here is essentially made up of two types of point clouds connected to a single system of coordinates: a point cloud of measurements of the throne's volume from the physical model, from before the damage suffered following its loan to the exhibition "Princesses of the Mediterranean at the Dawn of History", Athens, 2012; and point clouds of derived coordinates obtained in parallel with a campaign of photographic acquisition of the individual fragments.

The common element characterising the two types of point cloud resulting from the survey campaign carried out is the large amount of associated information, which is not only geometric - such as morphological features - but also colorimetric and characterising of the surface texture.

The objectives of the investigation and analysis, which are primarily geometric and morphological, relating to the volume of the reconstructed throne and the individual fragments, have been set as an essential prerequisite of the survey campaign, with a view to the economic and temporal sustainability of the project. Consequently, accuracy, redundancy and noise were considered for the geometric and spatial verification of the elements, and for the purpose of the study for reciprocal repositioning.

The survey phases therefore had the objectives of: low-impact acquisition (at a scale of 1:1), through high definition photographic survey, of the individual fragments under controlled ambient light, which was methodologically consistent for all the variations in morphology and dimension; low-impact acquisition (at a scale of 1:1), using terrestrial laser scanner survey, of the volumetric measurements of the throne from the physical model, carried out prior to the damage suffered following its loan to the exhibition “Princesses of the Mediterranean at the Dawn of History”, Athens, 2012; registration of the overall data models, and definition and implementation of a 3D database of the individual fragments.

Digital modelling and reconstruction

During the survey campaign, the following was acquired and developed: a three-dimensional model, from the physical model, of the volume of the throne, consistent with its appearance prior to the damage suffered; 72 three-dimensional models of the corresponding wooden pieces, accurately catalogued for the purposes of the survey campaign (see Fig. 4).

The three-dimensional point cloud model used for the verification and control of the overall dimensions and morphology of the asset was carried out with Konica Minolta Range 5 laser scanner technology.

For the calculation of the three-dimensional models of the individual pieces, three-hundred and twenty frames were acquired per piece, on average, corresponding to eighty frames for each of the four camera positions, two parallel and two at an angle with respect to the primary planes of each piece, taken following a circular trajectory around the entire piece.

The two models produced from the acquisition phase and an initial calculation for each piece were then developed through the use of MetaShape software, in order to define the overall dense point cloud for each fragment (see Fig. 5).

The calculation phases for the overall data models and digital reconstruction therefore had the objectives of: calculating the models by photo-modelling the elements acquired; digitally simulating the positioning and assembly of the pieces; developing, in a digital environment, a support model generated from the morphological and morphometric understanding of the individual pieces assembled, and from the study of the three-dimensional model of the throne’s volume prior to the damage suffered.

During the phases of the process described, tests on the following phase of 3D printing (*layer by layer*) were also carried out, in order to: verify the geometric control in the phases of acquisition, digital modelling of the individual fragments and digital reconstruction of the positioning of the fragments; define the final material for the printing with regard to the technologies available, and the timings and costs of the prototype phase; identify the material with the best chemical-physical compatibility and lowest level of qualitative alteration over time, also in relation to the environmental conditions in the museum, with evaluation of the structural characteristics and the base colour.

From the formulation of the measurement model to the physical model

The fragments of the throne from Moroni Tomb 26 can be subdivided, from a morphological perspective, into four different levels: fragments belonging to the chair which present superficial decorations on only one visible surface; fragments belonging to the chair that present superficial decorations on both visible surfaces, front and back; fragments belonging to the chair that present portions of superficial decoration on one visible surface or portions on both surfaces, front and back. Along with the types of fragments described above, the fourth type is fragments with smaller dimensions, with scarce, if not absent, traces of decoration, whose position remains uncertain.

During the resulting phases of design and execution of the digital survey and formulation of the overall data model, the validation and geometric control of the models of the pieces followed the same organisation and structure of data and metadata.

Indeed, the geometric measurements of the pieces studied show spatial deformities attributable to surfaces of rotation and quadric surfaces, which are the result of the environmental conditions of preservation of the wooden material before its discovery, its original characteristics, and the production of the artefact.

The procedures and technologies used therefore pursued the objective of stereometric control of the fragments also in the joint portions. Consequently, lower priority was given to the documentation and digital and physical modelling of the characteristics of the surface carvings, as the survey and representation of these would have made it necessary to use more accurate, costly techniques and technologies, such as tomography.

However, given the specific morphological characteristics and the types of deformity in the pieces, a simple protocol for digital anastylosis was not considered adequate for the reconstruction of the collection of fragments preserved from the asset. Indeed, while the subdivision of the fragments into the morphological categories allowed us to correctly position the fragments in the digital model into the areas of the backrest and seat, the stereometric verification of the gaps in the joint areas did not appear to be as consistent.

The later solid prototyping of the pieces at a scale of 1:1 therefore pursued the goal of creating study models compatible with annotation processes related to the main decorative elements, to guide a protocol of anastylosis based on the integration of traditional analogue techniques with digital ones (see Fig. 6).

The protocol for digital anastylosis and its integration with the traditional anastylosis process was essentially structured through a workflow organised into different phases: (a) photogrammetric survey of the pieces; (b) calculation of the point clouds subdivided into two separate parts; (c) calculation of the clouds, the overall data model for individual fragments; (d) meshing; (e) 3D terrestrial laser scanner survey of the physical model of the throne’s volume prior to the damage suffered; (f) digital anastylosis; (g) solid prototyping of the fragments; (h) traditional anastylosis; (i) 3D terrestrial laser scanner survey of the artefact created through the anastylosis process without the pieces, with the purpose of creating a digital model of the support and the missing parts; (l) development of the overall data model; (m) meshing; (n) verification of the morphology of the settings and margins, in order to later slot together the pieces in relation to the meshing process and the printing methods and accuracy; (o) printing of the physical model of the support made up of missing areas and joints; (p) reconstruction of the artefact by slotting the fragments into their settings.

Fig. 6. From the formulation of the measurement model to the physical model: Villanovan wooden throne, Moroni Necropolis, Verucchio, Rimini, Italy.

Results

Working towards an integrated protocol for digital anastylosis

Starting from an approach that considers 3D models of ancient artefacts to be the most flexible media for the documentation [53] and restoration of cultural heritage, the comparison of digital models of the asset with different configurations has been made possible in accordance first with the principles of compatibility and reversibility of the fact-finding and conservational activities.

As a result, the protocol developed implies the following phases for the method's exportability: (1) identification of the objectives of the digital documentation activity for the knowledge of the archaeological heritage (research, conservation, restoration, musealization, valorization); (2) identification of direct and indirect survey methods and techniques integrated in relation to the

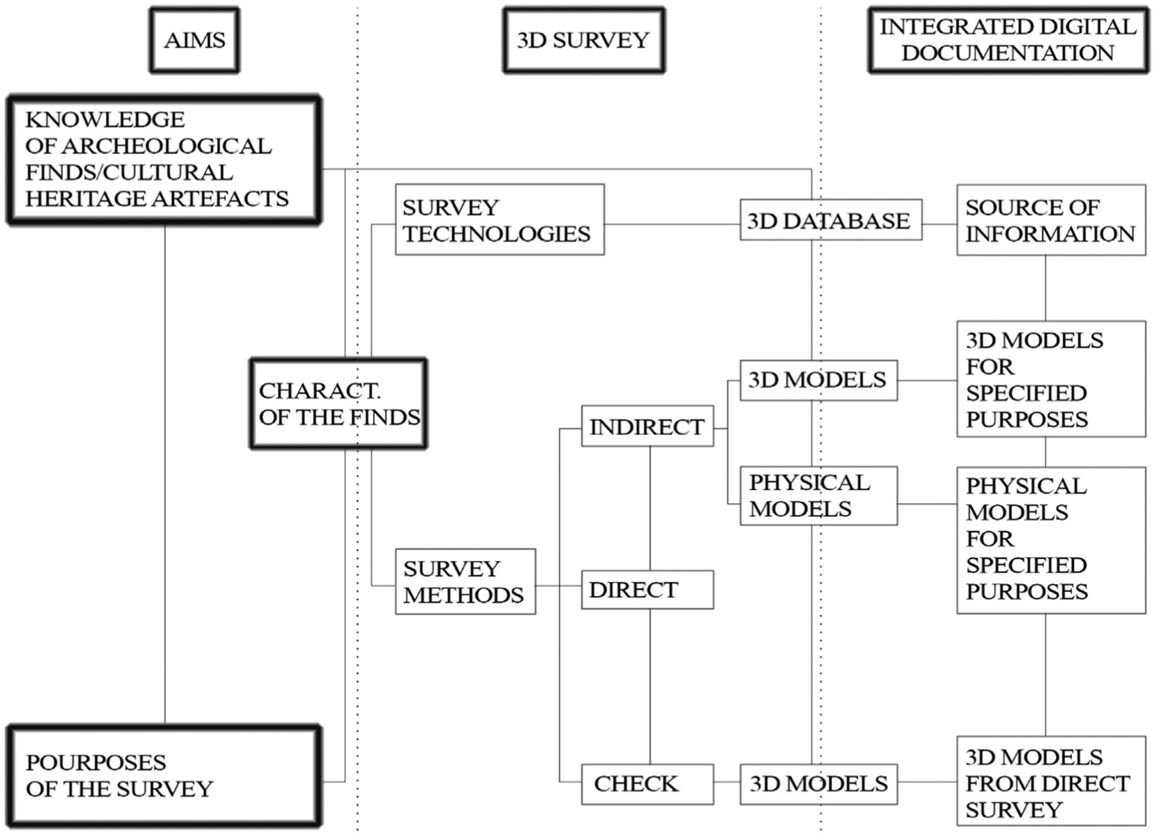

Fig. 7. Identification of direct and indirect survey methods and techniques integrated in relation to the characteristics of the finds and digital documentation aims for the implementation of the digital anastylosis protocol.

geometric-morphological characteristics and surface characterization of the finds (see Fig. 7); and (3) application of direct and indirect survey techniques integrated in relation to the conservation characteristics of the finds; (4) implementation of the digital anastylosis model in relation to the geometric and morphological characteristics of the finds; (5) digital anastylosis of the specimens have not altered in shape (due to environmental conditions related to the nature of the material, e.g. ceramic materials); (6) digital anastylosis of the specimens have altered in shape for the definition of the digital model of the lacunae of artefacts that have changed shape (organic materials, e.g. wood); (7) development of the solid models of the artefacts and lacunae in order to digitally verify digitally implemented anastylosis model; (8) direct digital survey of the implemented physical model; (9) model comparison and verification; (10) validation of the final integrated digital model to support the anastylosis process.

Verification of the data in the new workflow

Therefore, is identified, starting with a typical reverse modelling and industrial product design-based approach, a *workflow* that considers the condition of artefacts and materials with specific stereometric characteristics, often associated with slow, irreversible deformation phenomena, as well as the intrinsic characteristics of the material and the way it was produced.

Museum artefacts that are fragile due to being made from organic materials, such as wood, or artistic materials such as papier mâché, require special care in the application of integrated digital technologies.

Indeed, the specific conditions due to the nature of the material, on one hand, and on the other, the state of preservation can create barriers to the effective use of direct surveying technologies, such as 3D laser scanners, and even more so for indirect surveying, such as photogrammetry, on account of the response in terms of reflectance and image acquisition that specific geometric and spatial configurations and surface treatments of the artefacts can cause.

Furthermore, both in the case of digital anastylosis processes with the aim of enhancing the asset, and in the context of anastylosis processes adopted for conservational or museum-based purposes [41,54,55], such as in the case study presented, there is a clear need to introduce additional phases of intermediate verification into the *workflow* for the acquisition and development of models, which would not be indispensable - in fact, quite the opposite - in protocols for the digital documentation of materials with other morphological characteristics, such as ceramics or stone [16].

In comparison with the prototype development phases, even following reverse-engineering operations, the procedure thus defined allows for progressive checks, in addition to *layer-by-layer* tolerance checking during prototyping.

Discussion and conclusions

This paper illustrates a protocol for the integrated digital anastylosis of museum artefacts. The method is illustrated with reference to the fragments of the wooden throne from the Moroni Necropolis, Tomb 26/1969, located in Verucchio, Rimini, and dating from between the end of the 8th century and the first decades of the 7th century BC.

The acquisition, integration and implementation of digital information connected to the cultural heritage of museums, and models in the form of *Digital Cultural Heritage Objects* [37,40], is one of the most important challenges in the present day, for researchers of this heritage, for managers and legislators of EU member states, and many others. The production of digital "geometric memories" opens up the challenges of accessibility and usability of the digital data, the conservation and obsolescence of the models created, and methods for the implementation and reuse of the information over time.

The technologies available today offer scalable levels of accuracy in the phases of acquisition, digital modelling, and solid prototyping, in relation to the goals for the development of the digital cultural heritage, and the stereometric and superficial characteristics of the artefacts examined.

The timeframes and costs of the application of integrated digital technologies to the documentation of museum heritage are factors that are closely linked to the optimisation of processes that use surveying and modelling procedures in connection with the goals of the intervention.

One of the objectives of this project is to share the criteria that make a protocol for the integrated digital anastylosis of museum artefacts sustainable and transferable.

The research is based on the understanding of the state of the art of the application of procedures of digital anastylosis to cultural heritage. The main tendency that emerges is towards the application of integrated digital technologies for the promotion and documentation of cultural heritage, also for the wider public. However, the use of digital anastylosis procedures for the purposes of conservation, restoration and museum display [31,44,56] appears to be a field that is still little explored.

The categories taken into consideration regard the geometric and morphological characteristics and the surface characteristics of the artefacts.

The case study presented is also representative of the extra complexity related to specific types of museum heritage, involving fragility and stereometric complexity. The result is an integrated protocol of digital and traditional techniques, with the latter considered as a support, first for the phases of developing the components, and then for the entire physical prototype.

The advantages of the methods described can be primarily identified in terms of the principles of compatibility and reversibility of the restoration and reconstruction activities for the assets studied. Indeed, the physical models of the pieces, obtained through 3D printing, allow the use of annotation procedures that would otherwise not be possible on the original material.

Nonetheless, in the presence of particularly complex geometric and morphological characteristics, such as the intersection of quadric surfaces, digital anastylosis must be integrated with the development of prototypes that allow analogue control of the joint sections in the phases of repositioning the fragments.

It follows that the physical models take on the function of tools for dimensional verification, on one hand, and on the other, of the model of a digital memory made available not only to researchers and experts, but potentially to all experienced actors not affected by the value chain.

In the context of the approach described accessibility [18,41,44,57] to all actors involved in the integrated digital anastylosis process, understood as organised information and documentation of the different, alternative possibilities explored, is considered to be a primary goal. Nonetheless, the protocol for integrated surveying and solid modelling also aims to offer a response to the complex issue of the definition of digital documentation procedures and methods to support activities for conservation, restoration and museum display, with reference to the variety of types of movable and archaeological cultural heritage in terms of material characteristics and states of preservation.

However, challenges remain. First of all, with respect to the skills needed for the application of the procedures described, which are not always available in the context of public administration. Secondly, with respect to the usability of the digital information produced –the *Digital Cultural Heritage Objects* [18,58]– their obsolescence and the resulting methods and costs of archiving [44,53], maintenance and updates (Fig. 1).

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