CAA2015

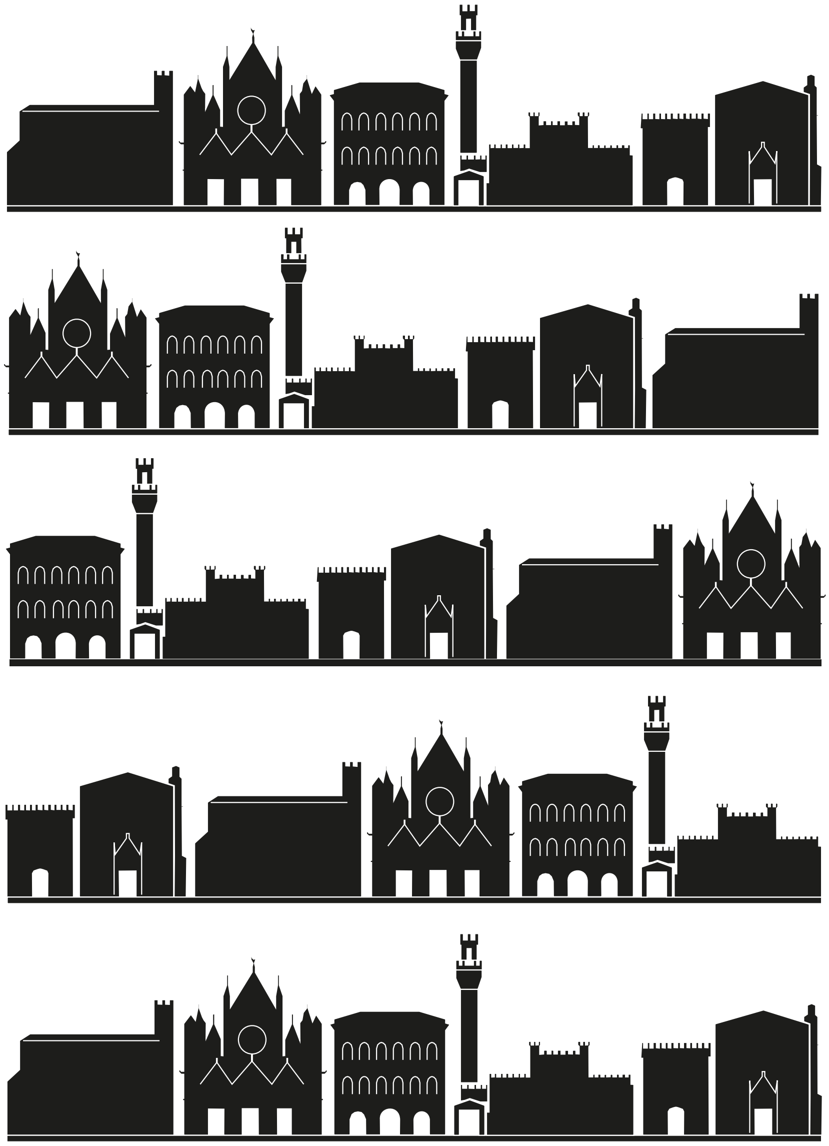
KEEP THE REVOLUTION GOING >>>

Proceedings of the 43rd Annual Conference on Computer Applications and Quantitative Methods In Archaeology

edited by

Stefano Campana, Roberto Scopigno, Gabriella Carpentiero and Marianna Cirillo

Volumes 1 and 2



UNIVERSITÀ DI SIENA 1240

CAA2015

KEEP THE REVOLUTION GOING >>>

Proceedings of the 43rd Annual Conference on Computer Applications and Quantitative Methods in Archaeology

edited by

Stefano Campana, Roberto Scopigno, Gabriella Carpentiero and Marianna Cirillo

Volume 1

Archaeopress Archaeology

Archaeopress Publishing Ltd
Gordon House
276 Banbury Road
Oxford OX2 7ED

www.archaeopress.com

CAA2015

ISBN 978 1 78491 337 3
ISBN 978 1 78491 338 0 (e-Pdf)

CAA2015 is availabe to download from Archaeopress Open Access site

This book is available direct from Archaeopress or from our website www.archaeopress.com

Table of Contents

Palaeontology 2.0 - Public Awareness of Palaeontological Sites Through New Technologies

Tommaso Empler
tommaso.empler@uniroma1.it
Department of History, Representation and Restoration in Architecture, Sapienza University of Rome

Fabio Quici
fabio.quici@uniroma1.it
Department of History, Representation and Restoration in Architecture, Sapienza University of Rome

Luca Bellucci
luca.bellucci@uniroma1.it
Department of Earth Science, Sapienza University of Rome

Abstract: This research is part of a wider project concerning the use of new technologies to communicate, disseminate and promote palaeontology.

There is a clear need to pursue this objective, which, when translated into the cultural context of Italy, has led us to start working with palaeontologists to find a way to use new technologies to develop applications specific to the field of palaeontology. Dissemination methods based on new technologies are collectively known as Palaeontology 2.0. The main aims are: providing evidence to museums and sites using the latest visualisation technologies along with more open shared knowledge; creating an accessible network on the World Wide Web between sites and museums that are currently isolated and unknown; giving the public the opportunity to interact with scientific knowledge through Real Time 3D during their site visit or via remote, web-based access to information.

Keywords: Palaeontology, APP, 3D modelling, Interactive multimedia, Real time 3D

Introduction

This research is part of a wider project concerning the use of new technologies to communicate, disseminate and promote palaeontology, in which the last 2 million years, which have been fundamental for the evolution of humans and modern ecosystems, are taken as a case study (Kahlke 2011).

How can a greater knowledge and understanding of palaeontology – the gateway to an understanding of complex concepts such as ‘deep time’, the evolution of ecosystems and ‘landscapes’ – be brought to a non-specialist audience? How can scientific research and dissemination come together to deliver information to a wider audience?

Since 2009, thanks to the Palaeontological Resources Preservation Act (PRPA, United States Congressional Record, Omnibus Public Lands Act, 2009), within a regulatory framework aimed at safeguarding palaeontological resources located on federal sites, the US government has also been promoting a planned action to make the general public more aware of the importance of these sites. Awareness is considered the best tool for preserving this heritage.

There is a clear need to pursue this objective, which, when translated into the cultural context of Italy, has led us to start working with palaeontologists to find a way to use new technologies to develop applications specific to the field of palaeontology. Applications (App) for smartphones and tablets now enable us to translate the information obtained from scientific research into visual information that is easier to understand for the general public. Traditional cataloguing and storage tools translating scientific data into accessible information in museums are no longer considered adequate.

Today, people can learn about palaeontology at museums and prehistoric and palaeontological sites, which are opened for access with the intent to preserve the link between the digs and their actual place of discovery.

Museums are still largely organised as places of research and scientific communication as they were in the nineteenth century. The use of excavation sites as educational resources, as opposed to merely places of scientific research, is a more recent phenomenon based on policies that are trying to take hold in exhibition circuits and specific methods for communicating their history and content to the general public.

Museums introduce people to a kind of traditional knowledge based on the collection, cataloguing and systematisation of data and finds. As ‘knowledge hubs’ traditional museums with their large heterogeneous collections tend not to be identified with the particular area of origin of their exhibits.

Since the nineteenth century, palaeontology has been based on a taxonomic organisation, where message boards and display cabinets are used to present the collections of remains, along with reconstructed of skeletons and reconstructive illustrations of men, animals, plants and entire ecosystems. Over the years, the increasing success among children and the general public

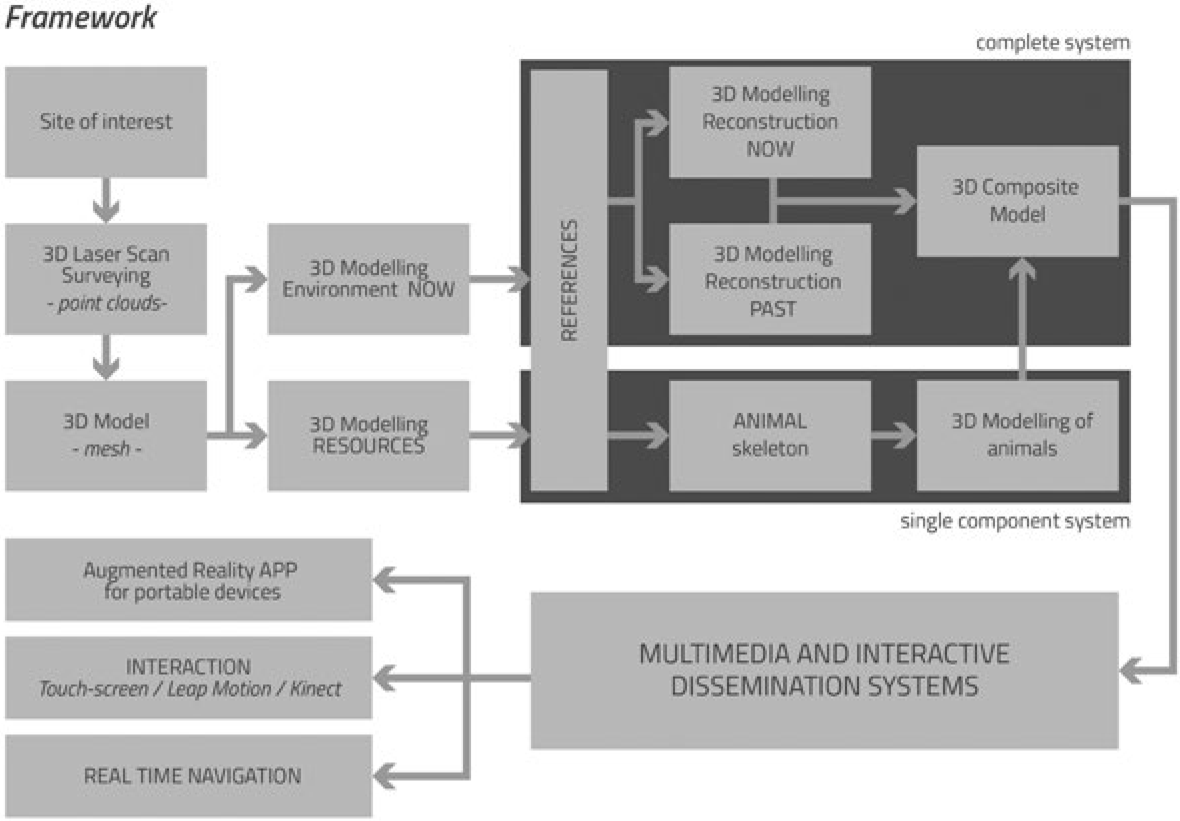


Fig. 1. The organization of the framework research named Palaeontology 2.0.

of full-scale three-dimensional models (Cameron 2010) of dinosaurs in theme parks and museums has made palaeontology more popular than ever before, thanks also to the success of films such as the Jurassic Park series.

Palaeontological sites open to the public first undergo excavations before being turned into museum sites with the relocation of the finds to where they were initially recovered. This method of exhibiting objects highlights their place of origin and, because they are seen in their original state of conservation, it also familiarises the public with the research and excavation methods used.

Some finds, however, are ‘invisible’. These are sites which are covered back up after digs – which is what makes them invisible – because , although interesting scientifically, the finds have insufficient evidence and physical substance to make them ‘visitable’ or understandable to most people.

Lastly, in addition to ‘invisible’ sites, we should also consider sites that have ‘disappeared’, namely those that have been destroyed, for example by urban expansion and the construction of roads or buildings (Lipps 2009). Our knowledge of these sites is based ‘only’ on fossils and the photographic archives found in museums and/or scientific institutions. In order to bring these sites ‘back to life’, it is essential to preserve and disseminate the historical memory of ‘landscapes’ that have been lost forever.

1 What is Palaeontology 2.0

In all of those places dedicated to the dissemination of palaeontological knowledge (Ferrara 2007), recent technologies provide several tools to organise and display information that can enhance knowledge, promote the places where artefacts are studied and preserved and narrate the evolution of ‘landscapes’ over time.

Dissemination methods based on the use of new technologies can be named Palaeontology 2.0[1] when referring to systems that implement traditional scientific information with new experimental tools for knowledge.

The main objectives of Palaeontology 2.0 are:

- providing evidence to museums and sites using the latest display technologies along with more open shared knowledge;
- creating an accessible network on the World Wide Web between sites and museums that are currently isolated and unknown;

[1] We can define Palaeontology 2.0 a new mode of address and communicate all that is connected to the field of palaeontology using visualization technologies. For Palaeontology 1.0 is meant the traditional mode of communication, linked to a communication logic lasts until 10 years ago.

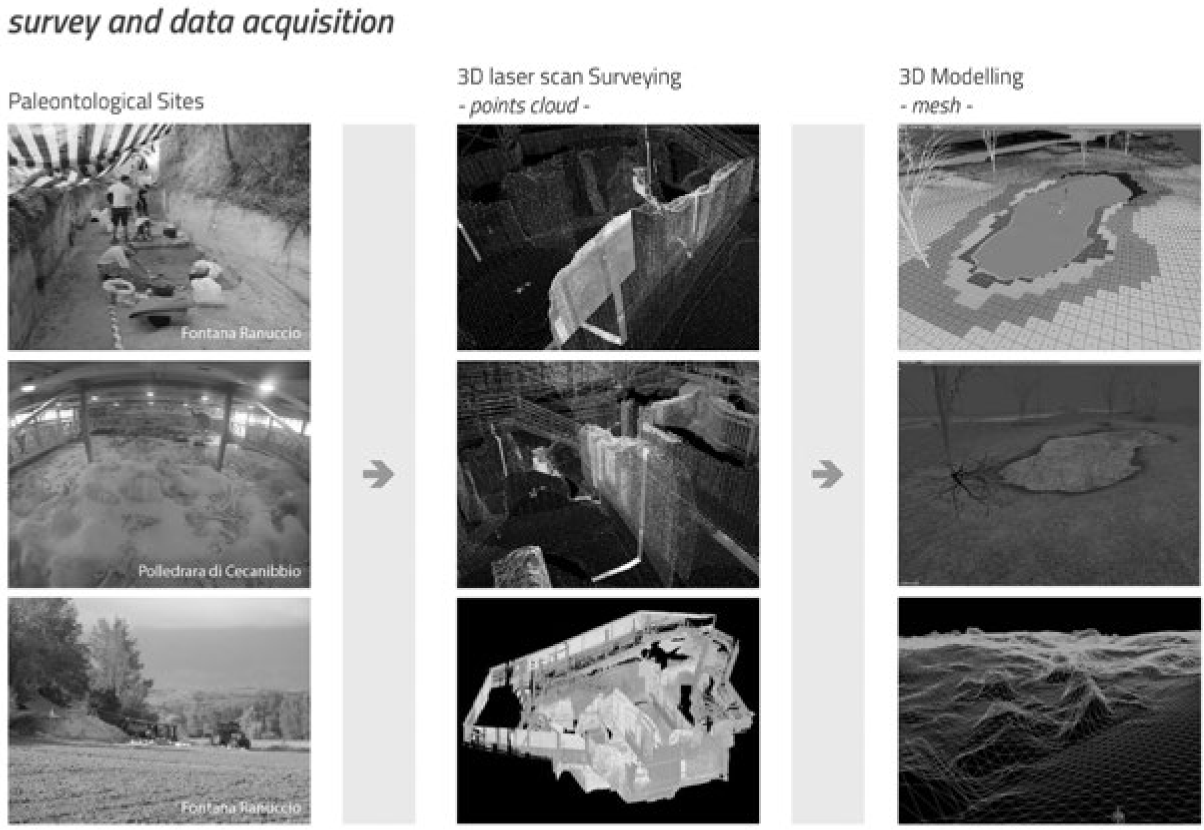


FIG. 2. SURVEY AND DATA ACQUISITION OF PALAEONTOLOGICAL SITES: FROM ANALOGUE TO DIGITAL DATA.

- giving the public the opportunity to interact with scientific knowledge through Real Time 3D during their site visit or via remote, web-based access to information.

2 The Framework

The research framework (Fig.1) for Palaeontology 2.0 methods of the implemented applications is organised into a series of related stages.

After the prehistoric site has been identified and excavated (if the site is 'invisible'), or the finds have been located (if the site is 'visible'), the first operation is to map the area morphologically (Fig. 2), which can be done by photogrammetry or 3D laser scan and also provides a 3D point cloud geometric model (Barber, 2011). The point cloud is later decimated and transformed into a 3D polygon mesh model (Fig. 2), which is easier to manage with a solid modelling application. This step enables us to select, separate and place on different layers the various elements that make up the landscape detected, distinguishing the 3D model of the area from the 3D model of the finds.

The whole modelling process is handled with an open source modeller as Blender[2] (Brito 2010).

Blender allows us to manage a large part of the procedure described in this framework using tools and routines that support multiple modes of representation (Siddi 2010).

The method described allows researchers to assess reconstruction hypotheses on different scales.

Documentary sources and the assistance of the palaeontologists who analyse fossils and the palaeo-botanists and geologists who provide an understanding of the environment in deep time, reconstruction hypotheses can be made of the landscape and the animals that once inhabited it.

The work of geologists and palaeo-botanists helps reconstruct a model of the 'lost' landscape, which can be compared with the model of the same place today. The types of seeds found, along with the stratigraphy of the soil, give us a reliable reconstruction of environmental factors (Fig. 3).

Palaeontologists (Bellucci 2012) cross analyse the finds with other more complete discoveries and similar reconstructive hypotheses to identify the animals that once belonged existed on site. The reconstruction method uses systematic and morphological studies of living animals and fossils found in museum collections (Fig. 4). This leads to the 3D

[2] Overview Engine Game. Blender has its own built in Game Engine that allows you to create interactive 3D applications. The Blender Game Engine (BGE) is a powerful high-level programming tool. Its main focus is Game Development, but can be used to create any interactive 3d software, such as interactive 3d architectural tours or educational physics research. See *Blender* in wiki.blender.org

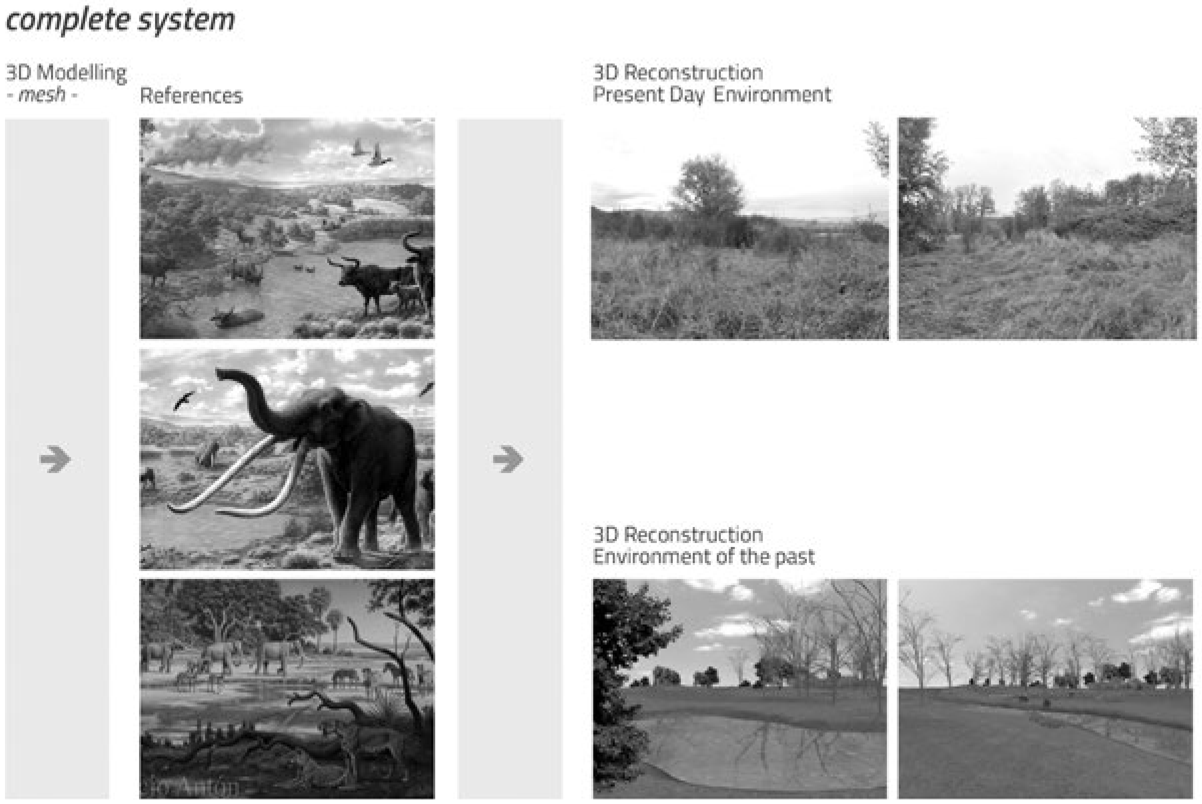


Fig. 3. 3D reconstruction of the site's condition: from present day environment to the visualization of lost landscape. The traditional work of the illustrators is translated into a digital way of working.

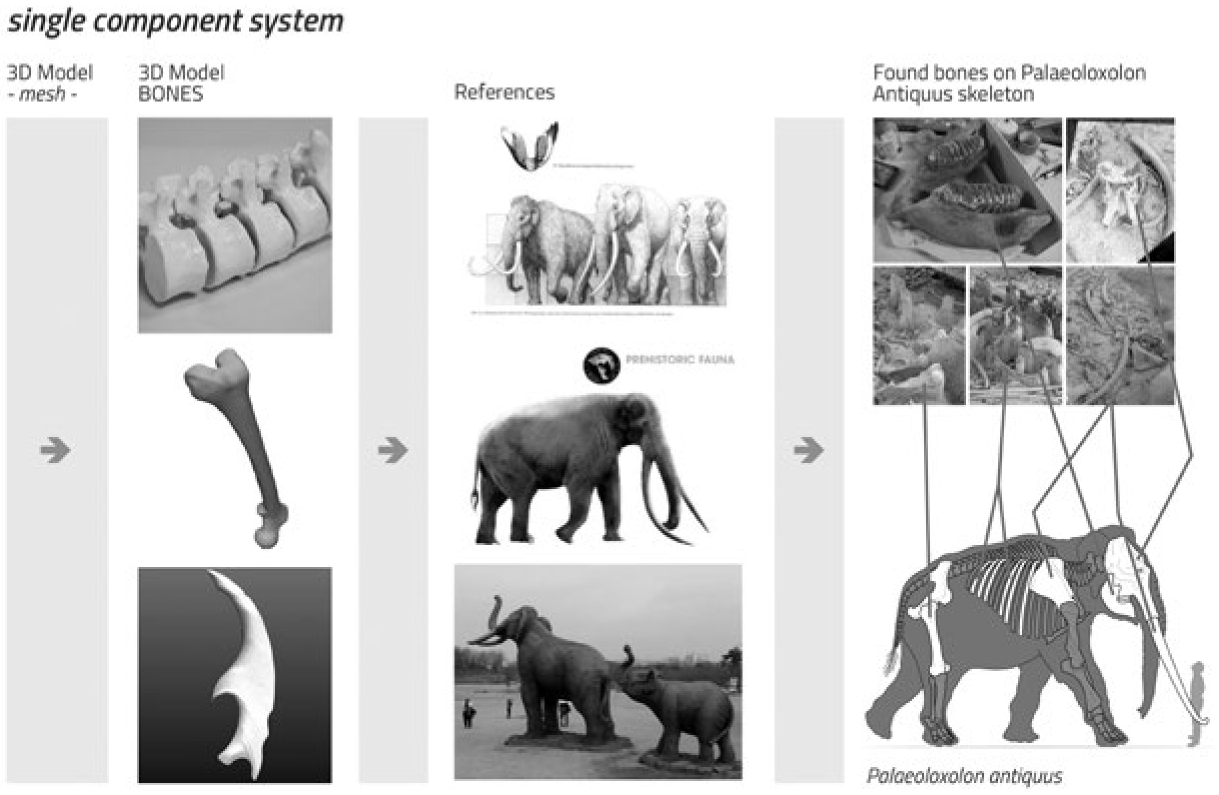


Fig. 4. Single component of the research framework: the reconstruction method uses systematic and morphological studies of living animals and fossils found in museum collections.

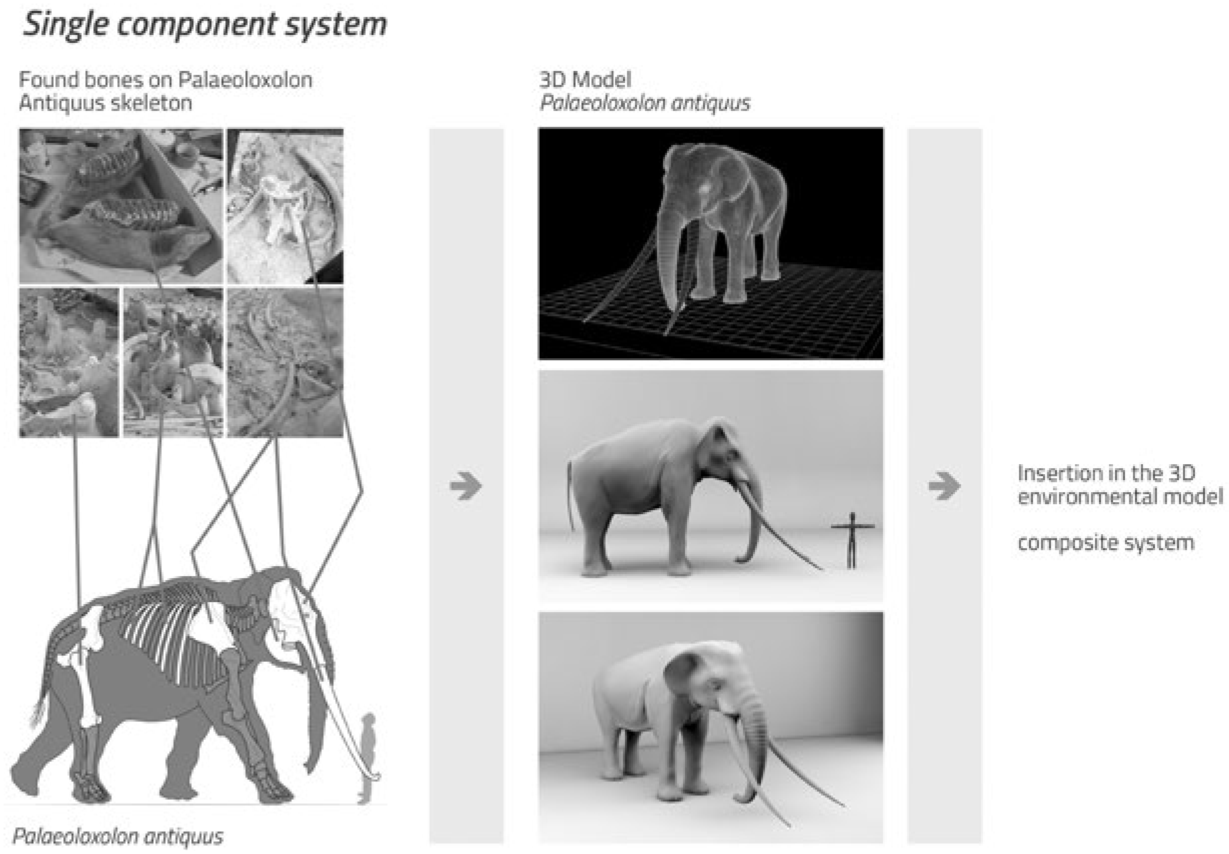


FIG. 5. SINGLE COMPONENT OF THE RESEARCH FRAMEWORK: 3D MODELLING OF THE ANIMALS BASED ON FOUND BONES.

FIG. 6. INTEGRATION OF DATA: THE "TIME BUBBLE" VISUALIZATION SYSTEM PROVIDES AN IMMERSIVE LINK BETWEEN THE PAST AND THE PRESENT CONDITION OF THE ENVIRONMENT.

FIG. 7. INTEGRATION OF DATA: THE "TIME BUBBLE" VISUALIZATION SYSTEM PROVIDES AN IMMERSIVE LINK BETWEEN THE PAST AND THE PRESENT CONDITION OF THE ENVIRONMENT.

reconstruction of the area (Fig. 5), where an inclusion of 3D models of animal enables the complete reconstruction of the prehistoric environment.

Two of the most important methods used for displaying the complete prehistoric environment are the '360° time bubble' and real-time 3D navigation.

The 'time bubble' provides an immersive link between the past and the present, enabling us to compare in real time the view of the current landscape with the view obtained from our graphic reconstruction of its condition millions of years ago (Fig. 6). The operation is possible thanks to photorealistic reconstruction (which uses synthetic images integrated with photographic images). This is an innovative operation to a sector where reconstructions are mainly assigned to the communicative effectiveness of traditional sketched drawings. To display a 360° view of the current state of the site, photographs are taken which are then mounted into a sphere using photo editing software (Fig. 7). These are then edited to reconstruct a past view of the site. This graphical intervention is somewhat

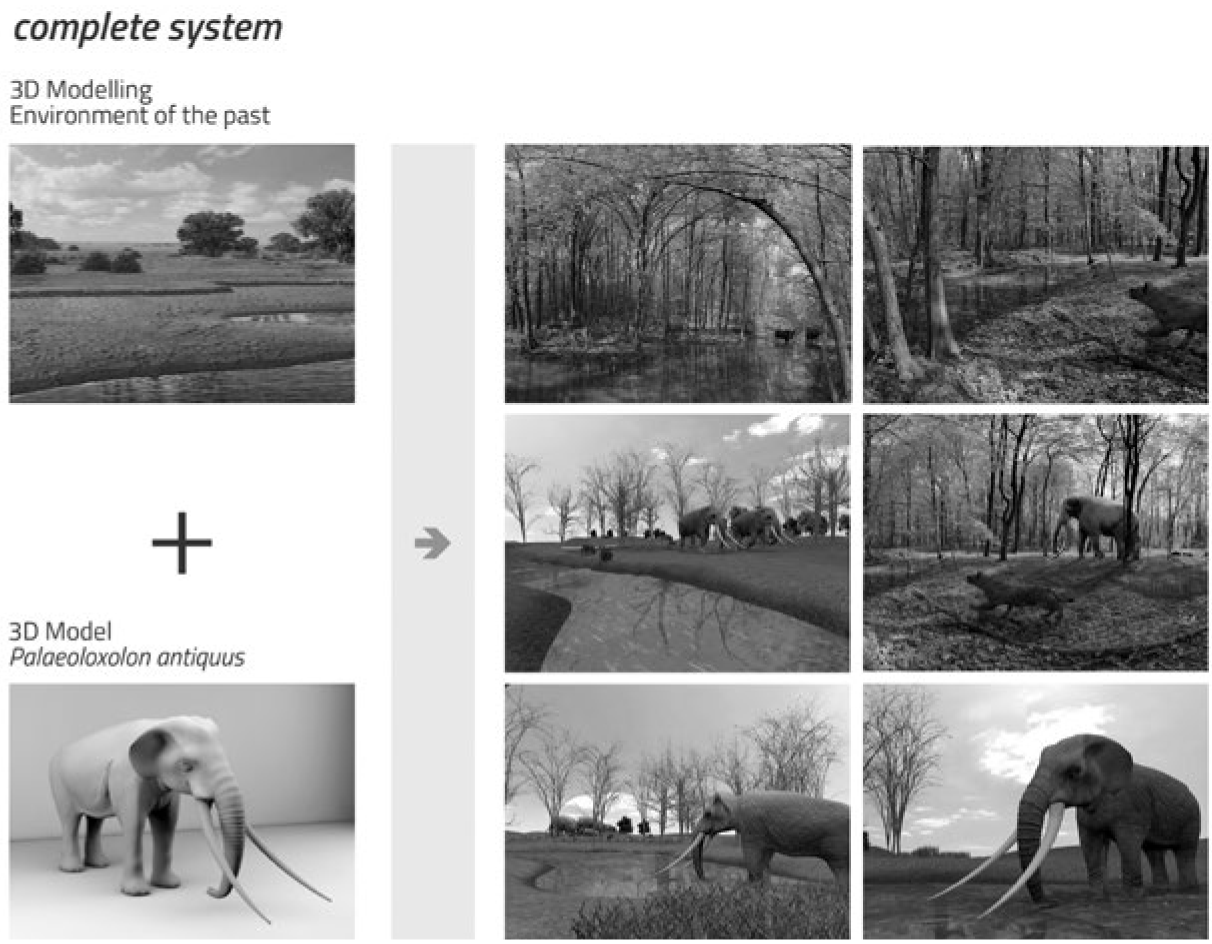


Fig. 8. Integration of data in real time 3D navigation interface.

complex, as it has to adapt to the 360° development of the image. Indeed, in order to work optimally in a photo-editing program, a raster image should be applied to an undistorted sphere so that images of vegetation and prehistoric animals can be inserted.

Real-time 3D navigation (Fig. 8) involves the use of Blender, which contains several internal tools and/or modules to gain directly explorable real-time 3D output via a *game engine* and *blender4web.* These can be used on portable devices, such as smartphones and tablets. Adaptation of the tools to 3D models not only requires Logic Bricks[3], but also works on the source code and programming strings to manage the controllers used in the interactive exploration.

Links, tabs and references to other 3D models and documentation about the former environment can be inserted into the 3D model implemented with the Game Engine.

[3] The core of the BGE's structure are Logic Bricks. The goal of Logic Bricks is to offer an easy-to-use visual interface for designing interactive applications without any programming language knowledge. There are three types of Logic Bricks, Sensors, Controllers and Actuators. There are Sensors Links Controllers. You can write games using Python, the game engine also has its own Python API, separate from the rest of Blender, which you can use to write scripts to control your game. This is done by creating a Python Controller and linking it to a python script. See *Blender* in wiki.blender.org

3 Conclusions and Results

By reconstructing the environment and 3D models of the animals found, we can create/manage interactive and multimedia systems of dissemination (Fig. 9).

The first output is in real-time 3D, possibly moving between a 3D model of the object today and a 3D model of the reconstructed object.

Another output is the IsIPU App[4] which augmented reality guiding visitors through several prehistoric sites, and displaying an information sheet for each of them containing scientific/descriptive texts and important iconographic support, as well as 3D reconstructed models of the animals living there millions of years ago.

The final output is the creation of interactive systems to teach students about the nature of the prehistoric sites and the importance of finds, however small and apparently insignificant, which are important for identifying the characteristics of animals that are now extinct.

[4] App for iOS, download free at: https://itunes.apple.com/it/app/isipu/id743901181?mt=8.

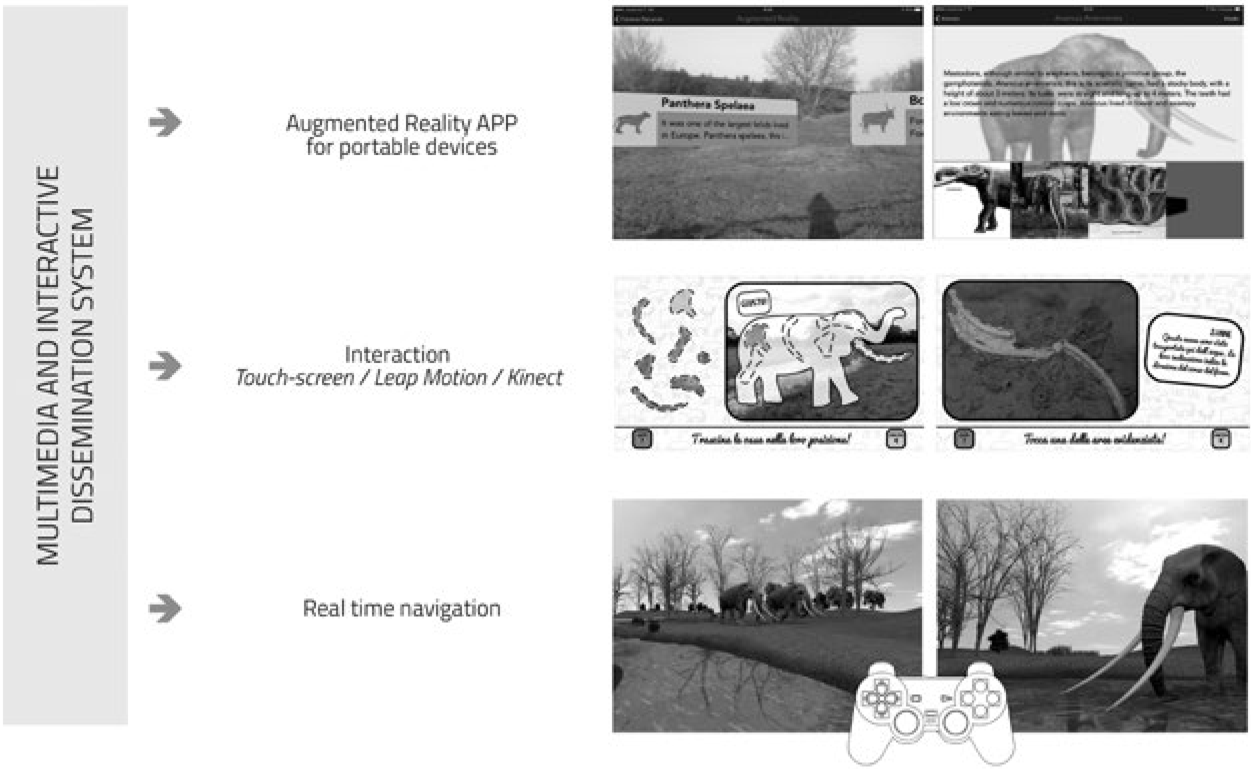


FIG. 9. PALAEONTOLOGY 2.0 INVOLVES THE USE OF INTERACTIVE AND MULTIMEDIA SYSTEMS OF DISSEMINATION FOR PALAEONTOLOGICAL SITES. AUGMENTED REALITY, INTERACTION SYSTEMS AND REAL-TIME NAVIGATION TECHNOLOGY ARE DATA VISUALIZATION TOOLS THAT CAN BE USED IN ORDER TO GUIDE VISITORS THROUGH PREHISTORIC SITES, AND MAKE AVAILABLE SCIENTIFIC INFORMATION.

Bibliography

Barber, D., Mills, J. 2011. *3D Laser Scanning for Heritage. Advice and guidance to users on laser scanning in archaeology and architecture*. Swindon, English Heritage Publishing.

Bellucci, L., Mazzini, I., Scardia, G., Bruni, L., Parenti, F., Segre, A. G., Segre Naldini, E., Sardella, R. 2012. The site of Coste San Giacomo (Early Pleistocene, central Italy): Palaeoenvironment analysis and biochronological overview. *Quaternary International* 267: 30-9.

Brito, A. 2010. *Blender 3D 2.49. Architecture, Buildings and Scenery*. Birmingham, Packt Publishing Ltd.

Cameron, F., Kenderdine, S. 2010. *Theorizing Digital Cultural Heritage: A Critical Discourse.* Cambridge, Mit Press.

Ferrara, C. 2007. *La comunicazione dei Beni Culturali. Il progetto dell'identità visiva di musei, siti archeologici, luoghi della cultura.* Milano, Lupetti.

Falser, M., Juneja, M. 2013. Archaeologizing Heritage? Transcultural Entanglements Between Local Social Practices and Global Virtual Realities. In *Proceedings of the 1st Intenational Workshop on Cultural Heritage*. Berlin, Springer-Verlag.

Kahlke, R. D., García, N., Kostopoulos, D. S., Lacombat, F., Lister, A. M., Mazza, P. P., Titov, V. V. 2011. Western Palaearctic palaeoenvironmental conditions during the Early and early Middle Pleistocene inferred from large mammal communities, and implications for hominin dispersal in Europe. *Quaternary Science Reviews* 30, 11: 1368-95.

Lips, J. H. 2009. PaleoParks: Our paleontological heritage protected and conserved in the field worldwide. In J. H. Lipps and B. R. C. Granier (eds.), *PaleoParks - The protection and conservation of fossil sites worldwide.* Carnets de Géologie / Notebooks on Geology: 1-10. Brest, Book.

Segre Naldini, E., Muttoni, G., Parenti, F., Scardia, G., Segre, A. G. 2009. Nouvelles recherches dans le bassin Plio-Pléistocène d'Anagni (Latium méridional, Italie). *L'anthropologie* 113: 66-77.

Siddi, F. 2010. *Grafica 3D con Blender*. Milano, Apogeo.