

Sustainable touristic value from digitization of archaeological heritage

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SUSTAINABLE TOURISTIC VALUE FROM DIGITIZATION OF ARCHAEOLOGICAL HERITAGE

Digital approaches to the promotion of
archaeological landscapes in the Danube region



**Sustainable touristic value
from digitization
of archaeological heritage**

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EXECUTIVE SUMMARY

Virtual archaeological landscapes of the Danube region (Danube's Archaeological eLandscapes) is a project co-financed by the Interreg Danube Transnational programme. The project's major goal is to regionally, nationally and internationally increase the visibility of the cultural heritage, and in particular the archaeological landscapes of the Danube region, making them more attractive for an integration into the region's tourism offers. In order to achieve this goal, new technologies are employed throughout the project.

Within the framework of the project, a strategy has been adopted by the partners from 10 countries of the Danube region. The strategy approaches the topic of archaeological heritage from an archaeological, social and a technological standpoint. By using SWOT (Strengths, Weaknesses, Opportunities, and Threats) analyses conducted by the working groups, major challenges in the sector were defined, leading to two main strategy units. The first unit focuses on working processes from the archaeological discovery to a virtual visualisation, and the second on the potential of archaeological heritage in the digital world. To support the further adaptation and development of new technologies for the archaeological sector, the strategy concludes with 12 recommendations for heritage stakeholders. Priority lists are adopted for the implementation of the recommendations at national level for each participating country.

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LEGAL FRAMEWORK

The values of every community are reflected in its legislation. The constitution and body of laws, by-laws and regulations, reveal principles, standards, values and agendas that society regards as important at the time of implementation.

Cultural heritage is an important cornerstone of society and, therefore, its protection is usually part of national laws and international conventions. Like all other areas of society, the protection of our cultural heritage is subject to constant change, which is reflected in legislation. This is reflected in the most relevant international legislative documents for monument protection and the research of monumentalised (pre)historic landscapes. These are, in chronological order:

- European Cultural Convention (1954)
- Convention for the Protection of Cultural Property in the Event of Armed Conflict (1954)
 - European Convention on the Protection of Archaeological Heritage (1969)
- Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transfer of Ownership of Cultural Property (1970)
 - UNESCO Convention concerning the Protection of the World Cultural and Natural Heritage (1972)
 - European Convention for the Protection of the Architectural Heritage of Europe (1985)
 - ICOMOS Charter for the Protection and Management of the Archaeological Heritage (1990)
 - European Convention on the Protection of the Archaeological Heritage (revised) – Valletta Convention (1992)
 - International Cultural Tourism Charter – Managing Tourism at Places of Heritage Significance (1999)
- UNWTO Global Code of Ethics for Tourism (1999)
- European Landscape Convention – Florence Convention (2000)
 - Convention on the Protection of the Underwater Cultural Heritage (2001)

DANUBE'S ARCHAEOLOGICAL ELANDSCAPES – Digital Archaeology and Virtual Landscapes

- The Budapest Declaration on World Heritage (WHC, 2002)
 - Convention for the Safeguarding of the Intangible Cultural Heritage (2003)
- Convention on the Protection and Promotion of the Diversity of Cultural Expressions (2005)
 - Council of Europe Framework Convention on the Value of Cultural Heritage for Society – Faro Convention (2005)
- Europe Framework Convention on the Value of Cultural Heritage for Society (2005)
- Fifth “C” (WHC, 2007)
 - ICOMOS Charter on the Interpretation and Presentation of Cultural Heritage Sites (2008)
- Europae Archaeologiae Consilium (EAC) Guidelines (2014-2015)
- Declaration of Namur (2015)
 - European Union Strategy for Danube Region and Action Plan: Culture and Tourism (2016)
- Salalah Guidelines for the Management of Public Archaeological Sites (2017)
- UNWTO Framework Convention on Tourism Ethics (2017)
- The European Heritage Strategy for the 21st Century (2017)
 - Operational Guidelines for the implementation of World Heritage Convention (1976-2019)
- The Faro Convention Action Plan Handbook (2018-2019)

During the Iron-Age-Danube project, which can be regarded as a pilot project to the current project on Danube's Archaeological eLandscapes, the focus had been placed on the research, protection and sustainable touristic use of our archaeological heritage. As a result, methodological tools and strategies for monumentalised (pre)historic landscapes in the Danube region were published¹ offering a complete overview of the international legal basis covering heritage protection, research, and landscape management on the one hand and heritage use in tourism on the other². These legal frameworks are also the basis for the strategy for the digital visualisation and presentation of archaeological heritage introduced in the following sections.

The rich and culturally diverse archaeological heritage of the Danube region is a testimony to millennia of social and cultural development and an important source of information about our past. Nevertheless, its huge potential for the development of tourism in the region is far from being fully exploited. One of the main reasons for this situation is the fact that prehistoric heritage, in particular, is largely hidden underground; even where archaeological remains have been preserved above the surface (e.g. in the form of ramparts, burial mounds or stone monuments) and they may be accessible, these sites are often covered by vegetation. As a consequence, archaeological heritage often remains invisible and thus calls for innovative ways to be successfully, sustainably managed and utilised. 'Visibility' entails more than only the sheer physical presence of archaeological artefacts or the reconstructions of sites, but also the visibility, and thus accessibility, of archaeology to the general public. At the same time, new technologies enable us not only to visualise archaeological knowledge in completely new ways, but also to share and communicate this knowledge attractively.

Therefore, the main aim of Danube's Archaeological eLandscapes is to make archaeological heritage, especially the archaeological landscapes of the Danube region, regionally, nationally and internationally more visible, and thereby more attractive for their integration into a sustainable cultural tourism. The backbone of this task are the major museums of any region, as they extend their focus beyond their own premises and reach out to the most prominent archaeological landscapes of the Danube region. By involving state-of-the-art virtual reality (VR) and augmented reality (AR) technologies, these museums, which attract the majority of tourists, will encourage their visitors to experience the archaeological heritage in its original landscape and explore not only the archaeological landscapes of their own country, but also those of the partner countries.

Landscape archaeologists study human ecodynamics, the interplay and feedback loops between humans and nature within the landscapes they have dwelled in. The Danube region represents a multitude of archaeological landscapes with thousands of archaeological sites from the Palaeolithic caves of the Upper Danube region to medieval churches in Bulgaria. However, archaeologists also create landscapes. These are 'institutional landscapes' shaped by rivers of knowledge, by routes of information exchange but also by challenges, their very own moun-

¹ Czajlik, Zoltán; Črešnar, Matija; Doneus, Michael; Fera, Martin; Hellmuth Kramberger, Anja; Mele, Marko (eds) (2019): Researching Archaeological Landscapes Across Borders. Strategies, Methods and Decisions for the 21st Century. Graz-Budapest: Archaeolingua.

² <https://zenodo.org/record/3601139#.YQKwAkBCSUK> [accessed 01/06/2021]

tains to overcome. Altogether, this forms an archaeological landscape of the Danube, which knows no boundaries; as European partners, we collaborate across national borders.

Danube's Archaeological eLandscapes not only aims to support one of the largest networks of major institutions with archaeological collections and knowledge, but also focuses on a long-term cross-promotion campaign for archaeological cultural heritage. Therefore, the partnership will continue the work of the Iron-Age-Danube project – Regio-Stars2018 finalist – by promoting the new Iron Age Danube Route, which was certified as a cultural route of the Council of Europe. In an aim to make archaeological landscapes more accessible and attractive, the project explores the potential of 'eLandscapes' – a concept that takes archaeological landscapes and landscape archaeology onto the next level.

In the 21st century, archaeological landscapes are increasingly developing towards landscapes of digital data. The digitisation of archaeological data both on-site during excavations, and at museums as well as

heritage protection offices creates a digital mirror image of the Danube region, making its archaeological heritage ever more accessible. At the same time, we all are increasingly living in a digital landscape – a landscape shaped by streams of information and clouds of data, populated by virtual communities and digital tribes. The project Danube's Archaeological eLandscapes brings these landscapes together, promoting the archaeological landscapes of the Danube by using the tools and resources grown in this digital landscape. The project is thus creating Danube's Archaeological eLandscapes to bring researchers and audiences from across the geographic and institutional landscapes together, to share and enjoy the knowledge about our archaeological past. As a foundation, a strategy and recommendations for the use of digital technologies in the visualisation of archaeological heritage have been drawn up.

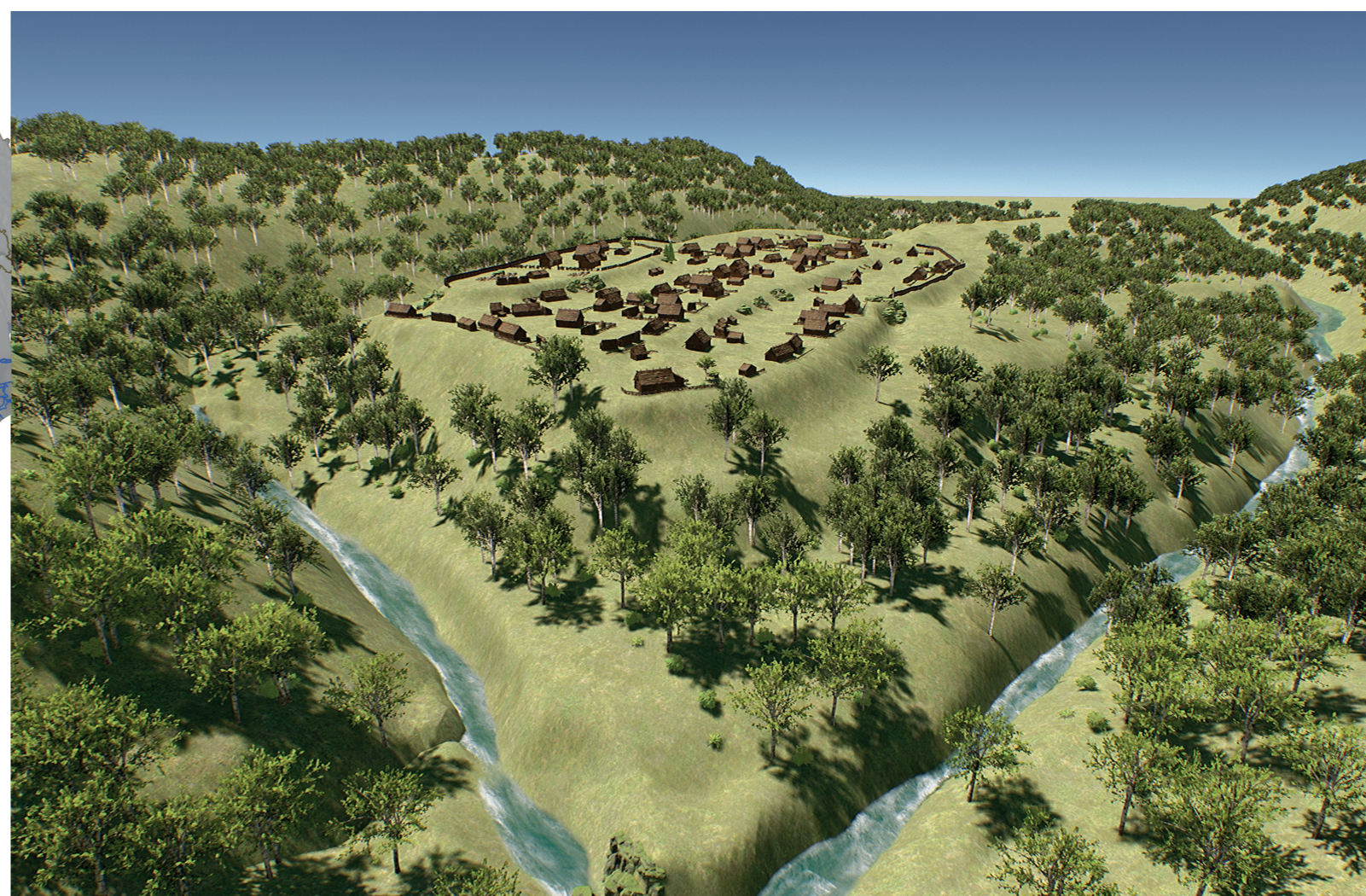
Figure 1

Partner Institutions of the Danube's archaeological eLandscapes



Figure 2

Digital archaeological landscape of Kaptol (Croatia)
©Miroslav Vuković - Lupercal j.d.o.o.



3

TOWARDS A STRATEGY FOR DIGITAL VISUALISATIONS –

Objectives, challenges and target groups

3.1. INTRODUCTION

In the summer of 2020, Danube’s Archaeological eLandscapes started with three separate approaches in order to create a common strategy for the use of digital technologies in the presentation and promotion of archaeological landscapes. Three international working groups were established with a specific focus on archaeological, technical and social aspects of the project, and combined their research in three international studies. Each group approached the archaeology of the Danube region from a different angle. The **Archaeological objectives** aimed to support stakeholders in the development of state-of-the-art digital visualisations of archaeological landscapes, sites or objects, based on scientific data. The **technological objectives** mainly focused on a cost-benefit analysis of technological solutions for the development and presentation of archaeological visualisations and their promotion across the partner institutions. A third group discussed the **social aspects** of archaeological heritage, e.g. its digital visibility, accessibility and sustainable utilisation in a tourism setting. These studies are the basis for defining the strategic approach to the implementation of digital technologies in the presentation and promotion of archaeological heritage in the Danube region.

3.2. CHALLENGES REGARDING THE DIGITAL VISUALISATION AND PROMOTION OF ARCHAEOLOGICAL LANDSCAPES

Following the analysis and joint review of the various study results, the project partners identified a range of challenges often experienced in the development of digital visualisations of cultural heritage. Challenges arise from adapting archaeological work to technological, but also social developments.

As part of archaeological digitisation projects, these challenges often begin with incomplete project planning from the research on-site to the final visualisation. Collaboration with experts from the field of digitisation of cultural heritage, who should be included in such projects from the beginning, is often missing. Due to the relative novelty of using digital tools within the heritage sector, common terminology, standardised vocabulary, and detailed documentation guidelines are yet to be developed. With research data often not appropriately documented, this frequently results in lacking meta- and paradata. Consequently, creating recognisably scientifically approved digital models that can be repurposed and shared is encumbered. Sustainable long-term preservation and data management plans for digital models are often missing; on the contrary, many projects, institutions and countries have developed their own digitisation strategies and the collected data is often exclusively embedded in project-specific or institutional data models. Moreover, an overview of the many cultural heritage databases has yet to be compiled and accessibility and data copyright are insufficiently defined. Finally, following their creation, virtual visualisations have to be scientifically credible as well as attractive and engaging to capture their audience.

MISSING DIGITAL EXPERTS

LACKING DOCUMENTATION

INADEQUATE DATABASE MODELS

DISAPPOINTING VIRTUAL VISUALISATIONS

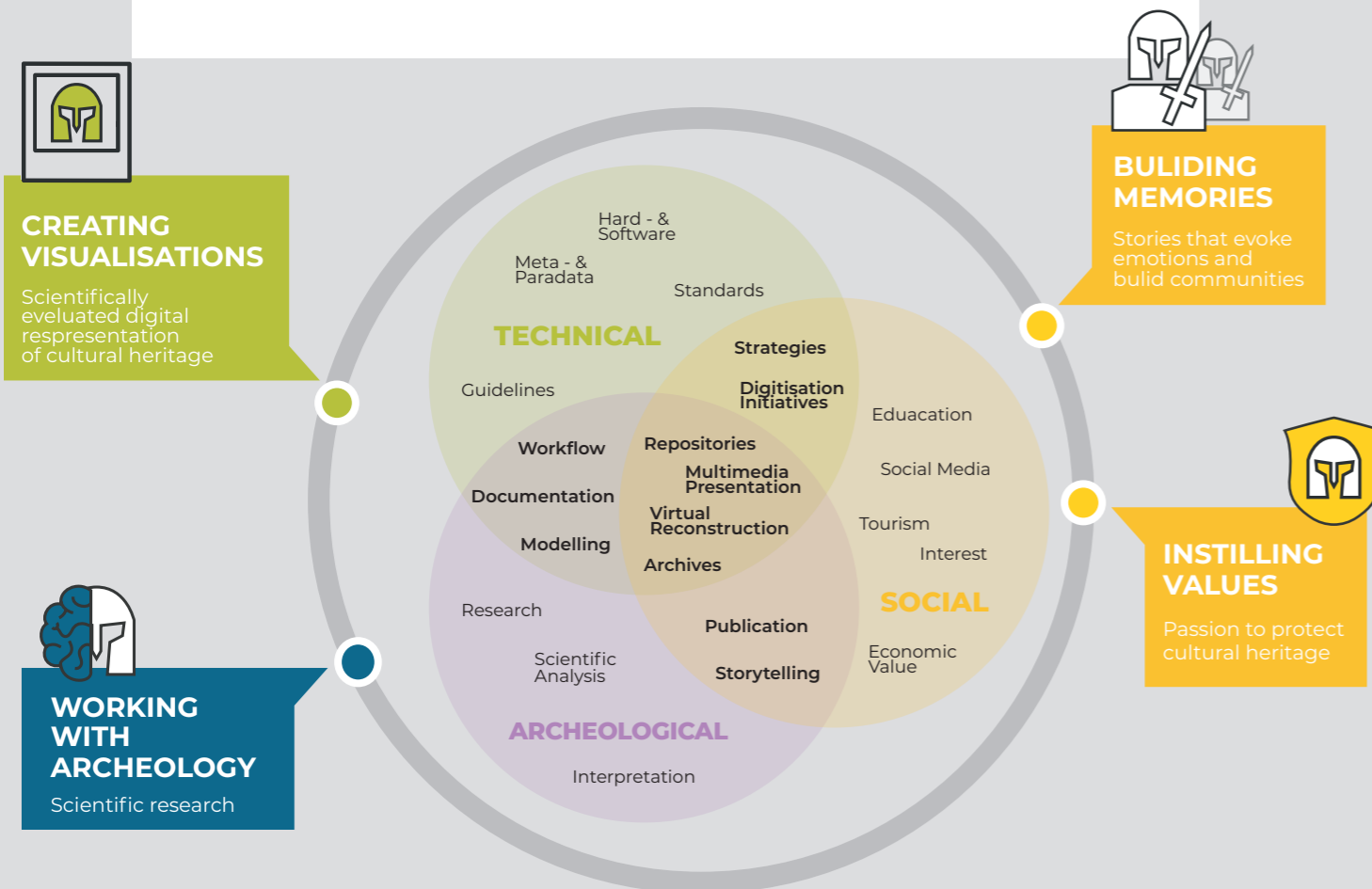


Figure 3 Correlation between the strategic approach to digital visualisation and the three aspects of the strategy

Figure 4 Challenges chapter 4

Engaging a diverse audience – from academic and professional colleagues to archaeology aficionados and the general public – is one of the biggest challenges faced by museums and cultural heritage institutions using digital tools, either in their galleries and exhibitions or in the virtual space of the internet.

Whilst digital tools used in museums and for exhibition purposes require systematic funding for long-term maintenance and a sustainable infrastructure, virtual platforms, including websites and online databases, blogs and podcasts but also social media and video sharing platforms usually come at a low price. However, a successful virtual presence requires visibility and accessibility of high-quality, research-based content, which in turn needs to be regularly updated, curated and monitored – the latter especially in the context of social media and other interactive platforms. These tasks are often added to the workload of curators and other members of staff without the necessary

training or an adequate digital strategy for remote and interactive access to cultural heritage. In order to fully utilise digital solutions as a way of opening cultural heritage to a diverse and inclusive society such strategies need to be based on visitor research regarding their needs, interests and capabilities

The lack of digital strategies is further emphasised at the interface between virtual space and museums. Interoperable systems and digital management tools require curators of online databases, such as virtual catalogues, to constantly adapt to the development of new formats. Inequalities between big national institutions and smaller regional museums become particularly apparent where the heritage economy has to rely on the financial and personal contributions from individual members of society.

Digital and physical access to cultural heritage, on the other hand, begins outside the museum and monument sector. One of the most impactful challenges faced by the cultural heritage sector is the slow but steady withdrawal of archaeology and related topics from school curricula. Without an appreciation for archaeological heritage fostered through education, any promotion of the archaeological landscapes of the Danube region may lose its future audiences.

ENGAGING DIVERSE AUDIENCES

LACK OF DIGITAL STRATEGIES

LACK OF LONG-TERM FUNDING

INSUFFICIENT STAFF TRAINING

INEQUALITIES BETWEEN LARGER AND SMALLER INSTITUTIONS

ARCHEOLOGY AND CULTURAL HERITAGE MISSING FROM SCHOOL EDUCATION



Figure 5
Challenges
chapter 5

3.3. MAIN OBJECTIVES OF THE STRATEGY

In 2021, the technological possibilities for the presentation and promotion of cultural heritage seem almost infinite. However, not all existing solutions are adequate and many are cost-intensive. Therefore, we need a joint approach to cost-benefit and best-practice analyses for the archaeological heritage sector. The strategy's main objective of recommending a common approach to the use of new digital technologies in the visualisation of archaeological heritage considers all three main aspects of the project – the archaeological work, the technological tools and the social focus. All three aspects are linked through their objective to make archaeology visible and to raise awareness for this fragile heritage of the Danube region, forming the foundation for the network established through the trans-Danube partnership.

3.4. SPECIFIC STRATEGIC OBJECTIVES

Conservation and preservation

The strategy aims to support the development and use of digital technologies for the preservation of archaeological heritage, especially archaeological landscapes. Digital technologies can support monument protection not only as documentation tools used by experts, but also enable an interactive involvement of other stakeholders in the process.

Research

The strategy encourages the use of digital technologies in archaeological research and for the communication of archaeological knowledge to the general public.

Visibility and presentation

The strategy supports the visibility of archaeological heritage by using digital communication channels.

Accessibility

The strategy fosters the accessibility of archaeological heritage through the use of digital technologies to make archaeological knowledge widely available.

Value creation

The strategy enables stakeholders to create new, added value for communities through tourism by investing in new ways of visualising archaeological landscapes.

3.5. STAKEHOLDERS AND TARGET GROUPS

Stakeholders of the strategy are:

- Heritage institutions (museums, monument protection offices...)
- Scientific organisations (universities, research institutes...)
- Local and regional public authorities (municipalities, regional governments...)
- Educational institutions (schools on all levels)
- Cultural enterprises (event organisers...)

The Strategy impacts the following target groups:

- General public
- Researchers
- Communities (including societies...)
- (Self)educators
- Business enterprises (mostly SMEs)

The strategy has been developed alongside Strategy 21 (European Heritage Strategy for the 21st Century). The Strategy 21 divides challenges, recommendations and good practices into three components: knowledge and education, a social component, territorial and economic development. Our goals, target groups and stakeholders have been linked to these components.

EUROPEAN CULTURAL HERITAGE STRATEGY FOR THE 21ST CENTURY

K **Knowledge and education**
with the contribution of research and training

S **Social component**
Promotion of social participation and good governance

D **Territorial and economic development**
with due regard for the principles of sustainable development

Interreg Danube Transnational Programme
Danube's Archaeological eLandscapes

Digitalisation and Visualisation of Archelogical Heritage

GOALS

- Conservation & Preservation
- Research
- Visibility & Presentation
- Accessibility
- Value Creation

TARGET GROUPS

- Broad Public
- Researchers
- Community
- (Self)Educators
- Economy

STAKEHOLDERS

- Heritage Institutions
- Scientific Organisations
- Communities
- Educational Institutions
- Cultural Enterprises

Figure 6 Interlink between Strategy 21 and Danube's Archaeological eLandscapes project

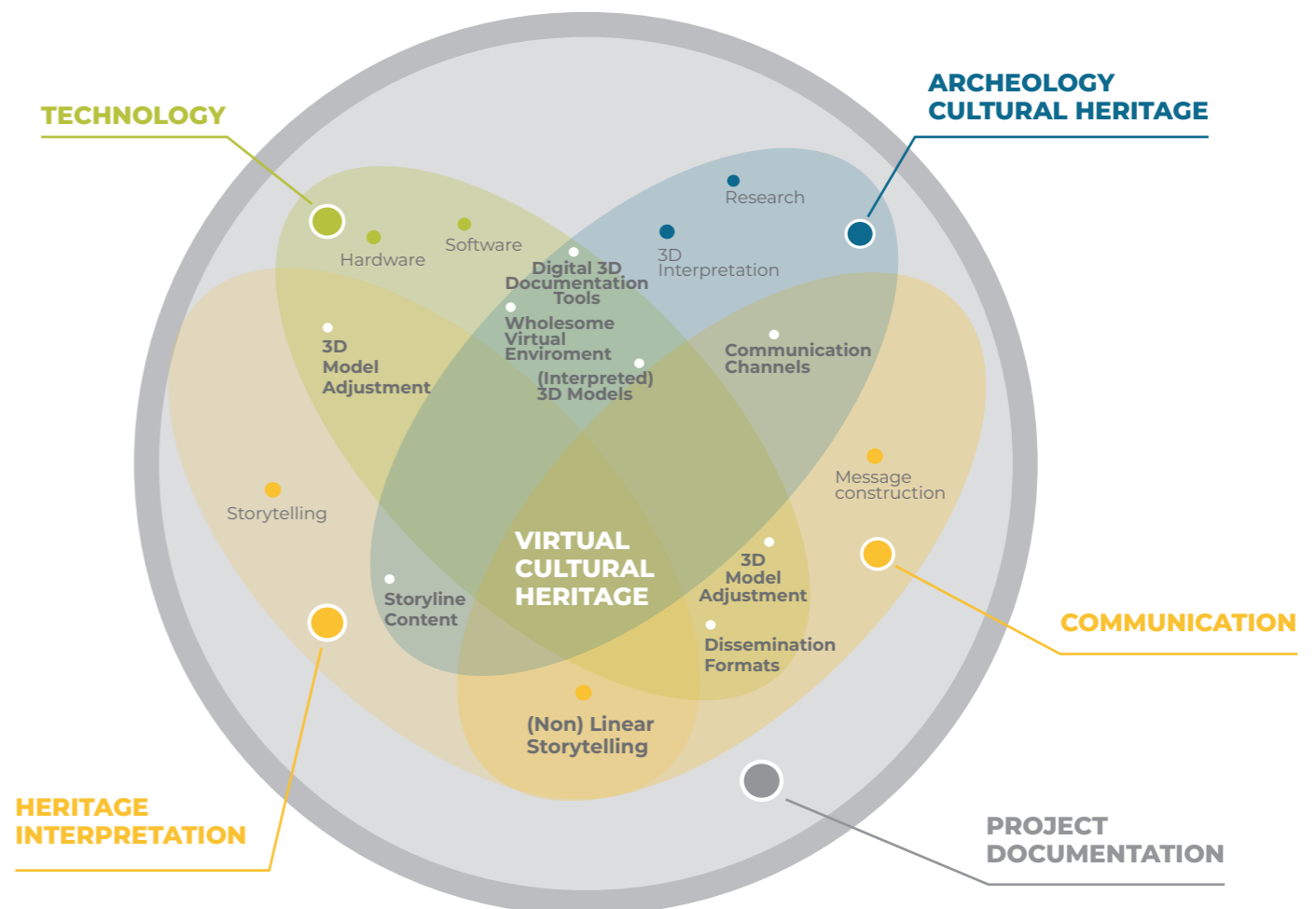
FROM ARCHAEOLOGY TOWARDS HERITAGE INTERPRETATION –

Strategic approach to the digital visualisations of archaeological heritage

Virtual visualisations of cultural heritage sites often mainly focus on the design of virtual 3D models. However, the whole process requires a more holistic approach to reach the full information and communication potential of such presentations. The development of virtual visualisations sits at the intersection of the fields of technology, cultural heritage (archaeology), communication, heritage interpretation and documentation⁷. Each of these aspects plays an important part in the optimisation of the final product. Therefore, a workflow including all of these facets is vital for a better targeted and more goal-orientated presentation.

In the following chapters, project-related specific topics from our holistic approach to cultural landscape virtual visualisations will be focused on and presented in greater detail.

Figure 7 Relationships between the different aspects of the visualisation process and their impact on the composition of the virtual 3D visualisation. (Lužnik-Jancsary, PhD Thesis, in progress)



4.1. PLAN! – STRUCTURING THE WORKFLOW

Considering the goals stated above, an essential workflow covering the interdisciplinary aspects of the virtual visualisation of cultural heritage was created. This workflow comprises nine stages, each of them focusing on particular tasks (Figure 8):

1. Project Planning: selection of archaeological (cultural heritage), technical, and social strategies;
2. Data Acquisition: gathering of data through active near & remote sensing techniques, passive near & remote sensing techniques, legacy data digitisation, analogies research etc.;
3. First Interpretation: archaeological/cultural heritage interpretation with the focus on virtual digital enhancement;
4. 3D Model Creation: integration of data, virtual reproduction, and virtual reconstruction;
5. Communication Strategy: selection of best communication channels and file formats;
6. Second Interpretation: design of a storyline;
7. 3D Model Adjustment: adjusting of the 3D model according to expert demands and chosen format, and post-processing of the renderings;
8. Dissemination: finished communication formats (and their use);
9. Documentation: documenting para- and metadata.

It is important to note that stages 2 and 3 influence each other upon careful evaluation of the interpretation and design decisions.³



Figure 8
Virtual visualisation workflow. (Lužnik-Jancsary, PhD Thesis, in progress)

³ Lužnik-Jancsary, N. (unpublished). Information and Communication Potential of Computer-Aided Visualisation of Archaeological Objects, PhD Thesis, in progress. Lužnik-Jancsary, N., Horejs, B., Klein, M., & Schwall, C. (2020). Integration and workflow framework for virtual visualisation of cultural heritage. Revisiting the tell of Çukuriçi Höyük, Turkey. *Virtual Archaeology Review*, 11(23), 63. <https://doi.org/10.4995/var.2020.13086>

The whole process can be divided into three different interwoven aspects: the archaeological/cultural heritage aspect, the technical aspect, and the social aspect (Table 1). Their involvement in each stage varies from high involvement (3) through medium involvement (2) to low involvement (1). At some stages, they are not involved at all (0).

	Workflow Stages	Archeology CH Aspect	Technical Aspect	Social Aspect
0	Project Planning	3	3	3
1	Data Acquisition	3	2	0
2	I. Interpretation	3	0	0
3	3D Model Creation	1	3	0
4	Communication Strategy	1	1	3
5	II. Interpretation	2	1	3
6	3D Model Adjustment	0	3	0
7	Dissemination	1	3	3
8	Documentation	3	3	3

Table 1
Level of involvement of archaeological (CH), technical, and social aspects through the workflow.

4.2 EXPLORE AND STUDY! – FROM ANALOGUE TO DIGITAL ARCHAEOLOGICAL DATA

The nature and state of archaeological data have changed significantly over the last couple of decades. With the introduction of modern technologies and new methods derived from the field of natural sciences, archaeological excavations became more complex and their findings are now both of, and also a starting point for numerous additional analyses. The amount of data created during these activities is growing and is becoming very diverse. Although this is highly beneficial for advancements in archaeology, it also complicates tracking, organising and assessing all this data.

Another possibility that has emerged with the rise of new technologies is the re-examination of old data – in some cases well over a century old. Such re-examinations produce new data that can considerably impact our current knowledge.

The first step in any archaeological research is to gather all available data concerning the studied subject. This is even more important

when we want to reconstruct archaeological landscapes (or any archaeological heritage). After the data have been gathered, their quality and credibility need to be assessed. The credibility of data is a delicate matter and cannot be generalised. Each set of data needs to be examined and an expert needs to decide whether the data have scientific (archaeological) legitimacy – i.e. whether they were produced acknowledging and using the standards at the time.

The quality of the data, on the other hand, can be generalised to a degree. Having diverse and good quality data is a prerequisite for a scientifically credible interpretation and further on digital reconstruction. For assessing data quality and their digitization, numerous standards can be consulted.⁴ Data from older research will often not meet the quality criteria, but in creating interpretations and reconstructions all available data are important since they can, even if not the best quality, provide important insights into function and shape of the subject.

Purpose-specific digital tools are used for each task. Nowadays, open-source software is up to the task as well as commercial products.⁵

4.3. CLASSIFY AND ORGANISE! – STANDARDS & FORMAL LANGUAGES

Since the beginnings of systematic archaeology in the 19th century, the discipline has had a distinctly interdisciplinary character. Its nature of gaining knowledge through the research of material remains of historical cultures promoted the adoption and development of methods from humanities as well as the natural sciences. Today, these methods are core tools of the discipline. For example, since the beginning, the description of artefacts and excavation findings was at the centre of research documentation. Taxonomies, typologies, and comparisons created the framework for temporal structuring and chronologies as well as cultural classifications. However, nowadays, the collection of findings gained through large-scale archaeological prospection methods is as important as the physical remains themselves. These can include large-scale settlement structures or elements of past landscape-shaping activities, such as transport, mining agriculture, preserved in situ.

For the textual and graphical description of archaeological objects, subject-specific modes of representation have been developed by individual research schools and in different countries. Over the last decades, digital technologies emerged in nearly all areas of society, including archaeology. Recently, it has been recognised that there is a need for an international formalisation of the use of digital technologies in archaeological research, for example during data acquisition, data processing, data analyses and for data storage.

Currently, the field data collection sector is still very much entrenched in regional archaeology-specific traditions. Information exchange has mainly taken place in the form of digitising existing forms and classification systems. Whilst recorded data is increasingly collected

in spatial databases, country-specific requirements and institutional traditions complicate an international formalisation of archaeological field data. However, the influence of developments in the broad field of digital humanities offers initial approaches in this area, although these are also based predominantly on initiatives led by large research institutions.

European initiatives for data standards are particularly well established in areas of archaeology where technical equipment is predominantly used to record the location and state of objects.

For digitally 3D-recorded landscapes, excavation or architectural features and artefacts, the use of digital methods, such as 3D scanning and image-based modelling, is more influenced by technical disciplines. The fields of 3D digitisation and 3D visualisation of archaeological cultural heritage can be described as “virtual archaeology”, based on a definition by Reilly 1991⁷. Thus, the term 3D digitisation can be seen as the virtual description of an existing archaeological formation and 3D visualisation as the virtual description of simulated (currently non-existent) archaeological formations.

The best-practice models provide guidelines for various types of metadata, which should be collected within any digitisation process of cultural heritage. They are focusing on administrative and descriptive metadata. **Administrative metadata** contains general information about the process of creating a 3D model with an additional focus on hardware settings and software creation data. **Descriptive data** contains information about the virtually 3D-visualised object. How extensive this data will be is dependent primarily upon the nature and scope of the project for which the 3D models are intended.

Additionally, paradata is also crucial for the subject description. According to the London Charter, paradata documents all decision-making processes and thus the relationship between the sources and the final outcome of the visualisation becomes clear⁸.

The most commonly used standard of descriptive metadata within the field of heritage is the Dublin Core Metadata; a small set of vocabulary terms. Basic classes in Dublin Core are contributor, coverage, creator, date, description, format, identifier, language, publisher, relation, rights, source, subject, title, and type.

Another important step to secure futureproof modelling and collection of data is to use an “ontology” for heritage data, which “describes in a formal language the explicit and implicit concepts and relations relevant to the documentation of cultural heritage”⁹. For an ontological description of data and metadata in this field, the International Committee for Documentation – CIDOC (International Council of Museums – ICOM) proposes to store them as an extension to the CIDOC conceptual reference model (CIDOC CRM) that is also an ISO standard¹⁰. Its use secures semantic information in the data by providing a common language that enables experts to collect data from different fields and sources within cultural heritage. The schema extension focussing on the encoding of steps and methods of production of digitisation products is called CIDOC CRMdig¹¹.

⁴ See <https://guides.archaeologydataservice.ac.uk/g2gp/Main> [accessed 09/2021] for Good Practice Guide for archaeological research with many references to standards; see <https://archaeologydataservice.ac.uk/arches/Wiki.jsp?page=Main> [accessed 09/2021] for standards in archaeological archiving.

⁵ For example Sketchfab, ATON, and 3D HOP (3D models presentation software), PeriodO (timeline creation software), Arches (open-source software platform for the management of cultural heritage data), open atlas (open-source GIS software)

⁶ Czajlik, Zoltán; Črešnar, Matija; Doneus, Michael; Fera, Martin; Hellmuth Kramberger, Anja; Mele, Marko (eds) (2019): *Researching Archaeological Landscapes Across Borders. Strategies, Methods and Decisions for the 21st Century*. Graz-Budapest: Archaeolingua.

⁷ Reilly, P. (1991): *Towards a Virtual Archaeology*. In S. Rahtz, K. Lockyear (Eds.): CAA90. Computer Applications and Quantitative Methods in Archaeology 1990. Oxford: Tempus Reparatum (BAR International Series, 565), pp. 132–139.

⁸ Denard, H. (Ed.). (2009). *The London Charter for the computer-based visualisation of cultural heritage*. Retrieved from http://www.londoncharter.org/fileadmin/templates/main/docs/london_charter_2_1_en.pdf

⁹ <http://www.cidoc-crm.org/node/202> [accessed 04/082021]

¹⁰ <http://www.cidoc-crm.org> [accessed 04/082021]

¹¹ <https://www.ics.forth.gr/isl/crm-dig-model-provenance-metadata> [accessed 04/082021]

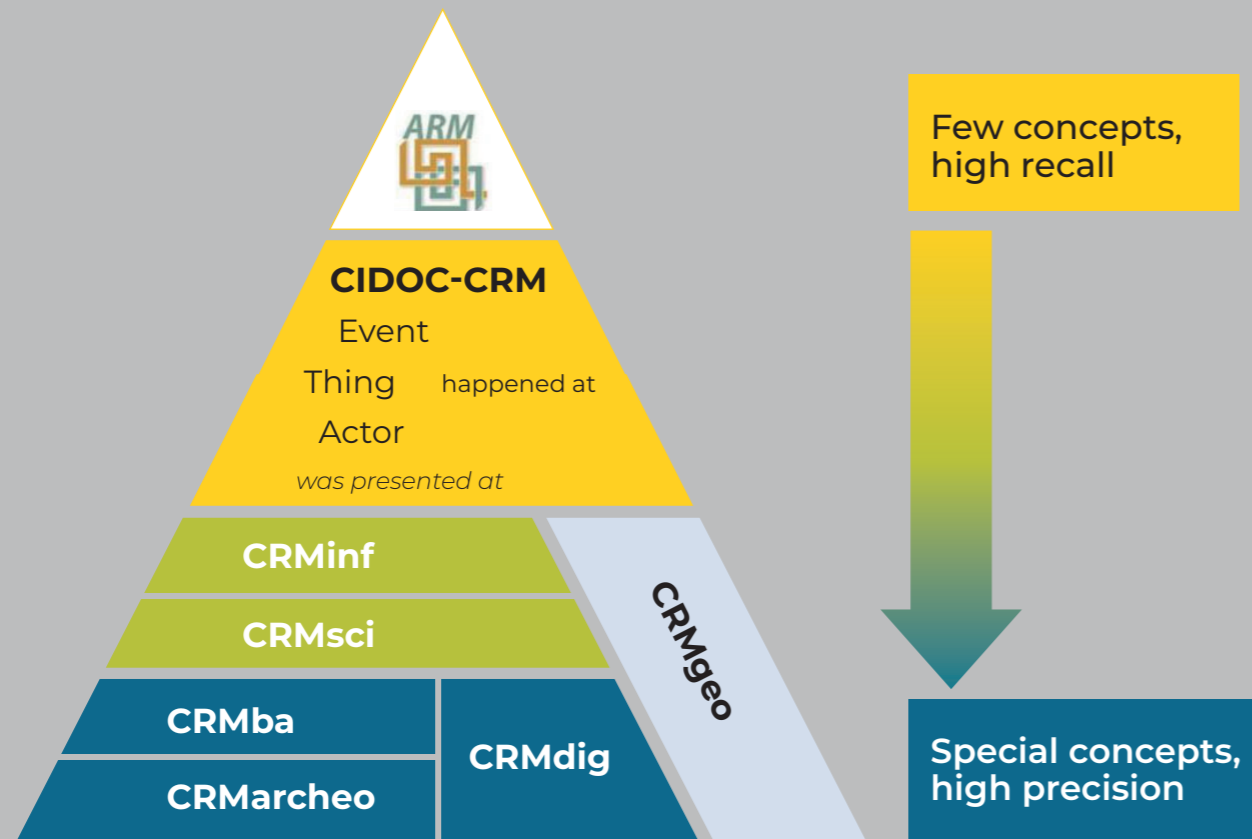


Figure 9
ARIADNE Reference Model (ARIADNE RM)
<https://www.semanticscholar.org/paper/Mapping-archaeological-databases-to-CIDOC-CRM-Doerr-Theodoridou/d31bacb148de1d7c7fec0ecf506fa1e499acb078> Fig.1

Another extension of the CIDOC CRM is CRMarchaeo, which has been created to support archaeological excavation processes and is currently (May 2021) at the proposal stage for approval by CIDOC CRM SIG.¹²

4.4. HARMONISE AND CONNECT! – VIRTUAL ARCHAEOLOGY AND INTERNATIONAL DIGITISATION STRATEGIES

Since the first definition of virtual archaeology was published in the 1990s, several groups and forums have been formed and have thus updated the definition in light of new technological possibilities and changing archaeological requirements, including

- Spanish Society of Virtual Archaeology (SEAV, 2008);
- International Forum of Virtual Archaeology (2008);
- Virtual Archaeology Special Interest Group (VASIG, 2001);
- Cultural Virtual Reality Organisation (CVRO, 2000);
- Virtual Archaeology International Network (2011).

These groups have developed best-practice models for the digitisation of cultural heritage seeking optimal solutions for the preservation, dissemination and usability of the recorded data.

The first general guidelines for new projects, which would use the tools of virtual archaeology, have been written under the keyword “visualisation” as part of *The London Charter for the Computer-based*

Visualisation of Cultural Heritage in 2006. The charter was updated in 2009 (The London Charter 2009). A year later, the directive was further expanded by the International *Charter of Virtual Archaeology* also known as the Sevilla Charter. The latter defines virtual archaeology as a scientific discipline that develops ways of using computer visualisations for the comprehensive management of archaeological heritage.¹³ Both the London and Seville Charter appear to refer primarily to 3D visualisations, but due to the rapid advance in 3D technologies, they have been written broadly enough to cover 3D digitisation processes as well.

Another initiative which forms a directive for best practice for 3D and virtual reality in the cultural heritage domain is the CARARE project¹⁴; a 3D and virtual reality add-on to the Europeana network¹⁵. Europeana is a European initiative that shares many cultural heritage works online. This has been made possible through connecting thousands of European archives, libraries and museums. CARARE is an association of experts that supports the creation, connection, enhancement and use of digital archaeological and architectural heritage resources for work, research, learning and enjoyment. To achieve this, it provides guidelines for good practice, technical services (for EU members) and continuously develops the CARARE metadata schema.

CARARE is not the only initiative to advise on best practice; many repositories, agencies, projects and other groups also provide technical guidelines¹⁶. Such guidelines do not only provide best practice for the practical creation of 3D models and advise on which file formats to use but also pay special attention to the documentation of the process itself (also called provenance metadata or paradata for technical information). Such documentation is important from many viewpoints, for example assuring interoperability and long-term preservation. Furthermore, metadata accompanying the 3D models can be used to evaluate their quality and authenticity. Such transparency is crucial for their reuse.

4.5. CURATE AND MAINTAIN! – DATA COLLECTIONS AND SUSTAINABILITY

Since the development of archaeology as an academic subject almost two centuries ago, a large amount of data has been collected. Except for the last couple of decades, this data had been created and archived in analogue form. The resulting data collections are generally located at museums or other institutions dealing with archaeological heritage. Although some collections have already been digitised or are currently in the process of digitisation, the majority are still exclusively analogue and thus much harder to access and review.

¹³ Grande and Lopez-Menchero 2011

¹⁴ <https://www.carare.eu/about/> [accessed 04/082021]

¹⁵ <https://www.europeana.eu/de/about-us> [accessed 04/082021]

¹⁶ For example:

-Archaeology Data Service / Digital Antiquity: 3D Models in Archaeology: A Guide to Good Practice: https://guides.archaeologydataservice.ac.uk/g2gp/3d_Toc [accessed 04/082021]

-Forschungsdatenzentrum Archäologie & Altertumswissenschaften (IANUS):

<https://www.ianus-fdz.de/it-empfehlungen/> [accessed 04/082021]

-3D-ICONS: <http://3dicons-project.eu/guidelines-and-case-studies> [accessed 04/082021]

-Expert Group on Cultural Heritage and Europeana:

<https://ec.europa.eu/digital-single-market/en/news/basic-principles-and-tips-3d-digitisation-cultural-heritage> [accessed 04/082021]

However, over the last decades, the number and range of archaeological digital databases have been rapidly increasing.¹⁷ Including different museum inventory databases and databases with archaeological content set up by archives and libraries, the list of archaeological databases is constantly expanding. These archaeological databases largely aim to provide public access to heritage (i.e. sites and objects), to support the protection of monuments, and to be used in field research or in support of researching specific academic questions – and these are by far not all, as many of the projects aim to achieve multiple goals. Unfortunately, many databases of short-term projects have only been set up to answer specific research questions and are not maintained any longer.

The digital presentation of archaeological knowledge on the internet has had a positive impact by allowing fast accessibility of data deriving from archaeological research. Most current databases are web-based, some open-access and often with free access for a wider public. Modern databases have improved the searchability of data through metadata enrichment and can provide a stable archive opportunity with a long-term preservation of research data. Quality certifications (e.g. CoreTrustSeal) are available and conformity to international standards should be aimed for.

As the number of databases increases, projects like ARIADNE and ARIADNE Plus¹⁸, which aim to accumulate metadata from various databases, provide easier access for the academic community. However, despite the many possibilities for wider accessibility and good intentions, many of the databases do not address (and attract) the general public; in many cases, they are stuck between two target groups – professional and non-professional stakeholders. Data from finished projects and the introduction of new data formats such as an increasing number of 3D visualisations create technical challenges regarding the interoperability of data.

To allow data that has been collected and curated in cultural heritage databases to be used as a valuable resource, which can help to advance research for scholars, some guidelines for data management have been established. As a general guideline, the F-A-I-R principles for data management have become accepted as best practice in this domain. The data should be findable, accessible, interoperable and reusable (F-A-I-R)¹⁹. Regarding questions of copyright, Europeana offers guidelines for institutions and cultural heritage professionals²⁰.

Digitisation has been on the agenda of many museums across Europe for many years. Those leading the drive towards digitised cultural heritage have compiled comprehensive digital (and often online) catalogues of their collections, created and acquired born-digital objects and fully embraced the beneficial impact of digitisation. Nevertheless, the vast majority of cultural heritage institutions have been slow to follow. The current COVID-19 pandemic, and the subsequent and often continued or repeated closure of museums, have once more emphasised the need to digitise existing museum archives and to create digital resources through which museums can share their expertise and knowledge – the tangible and intangible heritage they have been entrusted with

– with the wider public, at home, in schools and even in museums themselves.

Many museum collections (as well as those of other institutions dealing with cultural heritage) comprise archives compiled through excavations and research, some of which can be 100 years old. To make these archives or data collections easily accessible, they need to be digitised. Although most institutions are aware of this issue, it is not systematically approached and, in many cases, financial planning does not budget for additional costs. Digitisation, added to the day-to-day workload, is therefore slow. On the other hand, digitisation approached through dedicated projects is much quicker but is limited to the project scope.²¹

The digitisation of cultural heritage and museums is an unstoppable process. In many cases, however, this process does not follow a clear institutional strategy, which would enable sustainable development. Moreover, the lack of public investment into digitisation projects has increased the inequality between major museums and institutions with sufficient resources and smaller institutions with less funding and lower staffing levels.

A survey of 162 museums from seven countries involved in the project has revealed that almost all cultural heritage institutions are considering, or are already, investing in the digital management of their collections; they are developing digital tools of their own, or are buying finished products on the market. Implementing these tools is less of a challenge than securing resources for the digitisation of millions of artefacts in museum collections as well as the secure storage of data. Challenges regarding the long-term maintenance of databases and the upgrading and transfer of data between systems arise as the digital management of museum processes requires infrastructure (hard- and software) and a certain level of staff competencies. In addition, the automation and digitisation of processes could, to some degree, result in a loss of contact with the original objects and of the traditional skills of museum staff. Furthermore, digital collection management tends to focus on single objects instead of the wider subject or the context of the exhibition.

Despite the effort and resources many museums invest into digitisation, the results often remain within the respective institutions since their systems have not been developed for public use. However, access to digital collections and archived knowledge is crucial, if and when heritage is not physically accessible – as the COVID-19 pandemic has demonstrated. Those cultural heritage institutions and sites, which had already achieved a high standard of digitisation, were able to use the content for interactive websites, social media and other online offers during their period of closure.

The digitisation of museums is a long ongoing process, which was sped up immensely in 2020. Access to cultural heritage exclusively through digital solutions during periods of national or regional lockdown has emphasised the need for public investment into digital solutions. It demonstrated that digitisation is a crucial factor in establishing, maintaining and increasing the resilience of cultural heritage assets. The new digital output resulting from these exceptional but global circumstances has highlighted a range of new opportunities for future action.

¹⁷ <http://www.cidoc-crm.org/crmarchaeo/home-3> [accessed 04/082021]

¹⁸ <https://ariadne-infrastructure.eu/> [accessed 04/082021]

¹⁹ <https://www.go-fair.org/fair-principles/> [accessed 04/082021]

²⁰ <https://pro.europeana.eu/share-your-data/copyright> [accessed 04/082021]

²¹ Some of the projects, where individual project partners have been involved, focussing on digitising archaeological heritage and the data concerning them, are BorderArch, InterArch and the Danube's Archaeological eLandscapes project.

Over recent years, many big museums have already set up and tested their digital infrastructure and implemented it in collection management, restoration documentation and exhibition development (e.g. half-automated procedures for loans administration). Good results regarding optimisation of the digitisation of objects have been gained through the development of automated processes in collection management, restoration and administration. Tools have been partly adopted for public access and thus enable easier communication between institutions and the development of new inter-institutional collaboration projects. In addition, there have already been several initiatives to support the sharing of experiences and knowledge exchange regarding the digitisation process with smaller institutions that are without sufficient funds for the development of their own digitisation plans.

4.6. REVEAL AND VISUALISE! – INTERPRETING ARCHAEOLOGY AND VIRTUAL RECONSTRUCTIONS

Interpretation is defined as an act of explaining the meaning of something. Archaeological interpretation aims to assign meaning to and build stories around artefacts and their context based on archaeological data.

Such interpretation can be based on very limited physical data and mainly rely on topic-specific knowledge, intuition and imagination. Although this kind of interpretative storytelling can be very evocative and thus attract an interested public, it often is not scientifically credible. Therefore, quality data and established archaeological facts are fundamental for the interpretation of archaeological heritage for the purpose of its digital presentation in museums and to cultural heritage stakeholders in general.

However, the creation of visualisations and presentations of larger spatial areas like archaeological landscapes is particularly challenged by the objective to base every detail of past landscapes on hard archaeological evidence, since many details are impossible to reconstruct. This issue can be approached in two ways. On the one hand, all problematic details could be excluded from the presentation; the result is scientifically incontestable, however not very clear to the general public.

On the other hand, a complete interpretation of the respective landscape can be based on period-specific knowledge and thus fill all data gaps. This results in an attractive digital presentation of an archaeological landscape. However, this kind of presentation can lack scientific credibility, if there is no or little transparency about its source data. To account for this, it has to be evident which elements of the presentation are archaeologically proven; the journey towards the final interpretation should be clearly sign-posted. If the level of accuracy is transparent and understandable at any time, the scientific credibility of the presentation remains high.

The credibility of interpretations is important on many levels. First and foremost, there is the moral/ethical obligation of professionals in museums or other institutions dealing with archaeological heritage to objectively and correctly inform the public about the heritage. Secondly, building a positive image of archaeology requires the public to be able to see the difference between facts and an argument-based interpretation, and thus perceive archaeology as a fact-based modern science. Being informal but expert requires storytelling skills which find the right balance in tone and

format to present well-informed content to an interested audience. However, as an additional benefit, storytelling through interactive and immersive digital presentations can help to interest more children and young adults in museums and other cultural heritage sites.

Europeana tips for storytelling

The Danube region, its landscapes, communities and traditions, have been shaped by its (hi)stories. Retelling the history of this region from the Ice Age to medieval churches is always also storytelling. We are telling the stories of archaeological landscapes, of people and their heritage. Many of these landscapes have become invisible over time – the centres of power, burial mounds and settlements have disappeared. Using digital tools, we can create virtual and augmented realities for these hidden stories; stories that become personal and evocative. As a guideline, Europeana has released seven tips for digital storytelling (Figure 10)²². These are: 1) be personal, 2) be informal but expert, 3) tell hidden stories, 4) illustrate your points, 5) signpost your journey, 6) be specific, and 7) be evocative. These tips help to create a personal and emotionally engaging story, and are a great help to professional cultural heritage storytellers.

Figure 10

Europeana digital storytelling tips. Title: "Seven tips for digital storytelling with cultural heritage", Creator: Maggy Szyndkiewska, Date: 2021, Institution: Europeana Foundation, Country: Netherlands, CC BY-SA



- 1 Be personal**
 Personal stories can bring the past to life and help people relate to history on an emotional level. Consider the human significance of cultural artefacts and sites.
- 2 Be informal but expert**
 People want to learn but jargon can put them off. As long as the content is well-informed, the format of your story can be experimental and playful.
- 3 Tell hidden stories**
 So much cultural history remains untold. When choosing subjects, consider who is missing from the picture, and try to give a voice to a range of people and communities.
- 4 Illustrate your points**
 Long written or spoken narratives can be hard to engage with. Breaking up the story with visual (or audio) material, and building in time to reflect on it, can enrich the experience.
- 5 Signpost your journey**
 In digital storytelling - particularly on complex platforms - clear narrative structure is essential. Keep the navigation simple, so the visitor knows where they are at any point.
- 6 Be specific**
 Specific topics can still engage a broad audience. Start from a particular detail that lies at the heart of your story, then move to the bigger picture. Personal stories and well-chosen images can help keep your focus.
- 7 Be evocative**
 Cultural history stories need to be based in fact, but they don't need to be dry. Use descriptive terms and invite the viewer to place themselves within the scene.

²² <https://pro.europeana.eu/post/seven-tips-for-digital-storytelling-with-cultural-heritage> [accessed 04/082021]

BUILDING MEMORIES & INSTILLING VALUES -

A strategic approach to the promotion of archaeological landscapes with digital technologies

Digital storytelling can help to build memories and instil values, it can be entertaining and informative – bringing past stories to life – but it can also educate about our shared obligation to preserve these memories and our archaeological heritage. Above all, digital storytelling opens doors to our past and invites everyone to participate. Therefore, accessibility to archaeological landscapes goes beyond the physical access to open-air sites and museums. Digital tools can open access to remote sites either through their use in museum spaces or from the comfort of one's own home. Such access to archaeological knowledge, however, requires foundations to be laid in primary and secondary education, and digital technologies also have to be accessible themselves.

Professional archaeologists often develop a range of digital material, which includes not only digitally told stories but a wide range of important information about archaeological heritage. The contents and aims may vary substantially from educational tools for students to cultural heritage projects hoping to engage the public in the archaeological process, but also practical information about sites and museums for potential visitors. Information is shared via a variety of platforms from blogs, podcasts and forums, which often specialise in one topic, to social media and video sharing platforms, where archaeological content competes with a myriad of other topics. In addition, big encyclopaedic platforms such as Wikipedia include archaeological content, which is often curated by academic volunteers. Newspapers, magazines, and archaeologically-themed television programmes or cinemas also cover archaeology on their websites and frequently offer even more content than traditional and analogue media.

An analysis of various types of platforms within the digital public sphere, on which “archaeology” is searched for and discussed, underlines the importance of digital tools for the accessibility of archaeological heritage. Generally speaking, the search term “archaeology”, as far as analysed via Google Trends, demonstrates the relative popularity of this topic on the internet. Other, more popular, search terms such as “pyramids”, “mummies”, “castles” etc. will also lead to archaeological content. However, even these popular terms stand no chance against the highest trending – and as such daily changing – searches on the internet. Simple analytical tools like Google Trends can highlight certain trends like the increasing or decreasing frequency of specific searches, peaks and chronological links, but they do not help us to ascertain the full impact of archaeological heritage on the internet. Because analysis

through Google Trends refers to multiple topics, results are always ambiguous. Search results are biased as they are based on the pre-selection of search terms determined by the researcher. In addition, although analyses can reveal user interests, they do not verify which content users have found. We can only conclude that archaeological heritage is well represented on the internet – in very different forms, with very different levels of impact on the promotion of the archaeological landscapes of the Danube region.

5.1. VISIBILITY AND PRESENTATION

More than any other kind of media, digital media rely on visibility and presentation. In a virtual world, where “clicks” – i.e. visitors and users of a site, viewers and interaction – and “likes” – the pinnacle of 21st-century appreciation – are the currency of success, the online presentation of cultural heritage, its visibility in the world wide web, is crucial for its survival. The digital visibility of archaeological heritage and thus its accessibility are strongly entwined with successful storytelling. These stories can be written, they can be talked about, and they can come to life through animated imagery.

Write Archaeology! – Blogs, podcasts and forums

Blogs, podcasts and forums are a simple but efficient tool for the promotion of archaeological heritage on the internet. They can be used for the quick dissemination of results and ideas amongst colleagues and to present content to the wider public. Although social media have mostly replaced forums and may dominate today's digital media landscape, blogs and podcasts remain a great tool for digital storytelling.²³ Not restricted in their lengths, blogs and podcasts can go



²³ In more than a decade, Doug Rocks-Macqueen (Doug's Archaeology) has curated a list of 902 blogs. <https://dougarchaeology.wordpress.com/archaeology-blogs/> [accessed 21.1.2021]; podcasts are increasingly gaining on popularity: https://blog.feedspot.com/archaeology_podcasts/ [accessed 22.1.2021]

into detail, highlight specific topics and tell those hidden stories. At the same time, they allow academics to be expert but informal and break down their research for the wider public. Research not only becomes more accessible but blogs can also open a window to academic writing and nurture the writing process for many ECRs (Early Career Researchers). In addition, blogs and podcasts can be created and curated by project teams or individual academics; they can record progress made throughout a research project and thus serve as an academic diary. Similar to the latter, many blogs survive beyond the completion of projects and once the writers fall silent, become part of the archive landscape of the internet.

However, regular updates and new, exciting and well-prepared content are crucial to achieving long-term impact via a blog or podcast. Although the technical aspect of creating blogs and podcasts is relatively simple and free software is available to those with little knowledge of web design, careful consideration of design and navigation is needed. Good digital storytelling relies on clear sign-posting. In addition, a certain level of SEO skills is required to ensure visibility amongst the vast range of content available on the internet. Thus, the effort and potential costs underlying the creation of a blog or podcast have to be balanced against the expectations regarding its impact.

Talk Archaeology! – Archaeology and social media

Since their arrival in the mid-2000s, social media platforms have grown exponentially and are currently used by half of the world's population.²⁴ As with other digital media and platforms, archaeologists use social media not only to disseminate their work to a variety of audiences but also for networking purposes. There are, for example, Facebook groups for students and/or professional archaeologists; Twitter has become the main communication channel during many archaeological conferences, through which attendants pick up ideas and continue conversations started either during sessions or over refreshments. Meanwhile, Instagram is increasingly used for a wide range of digital storytelling that allows users to combine facts with descriptive and evocative imagery to create personal stories and showcase archaeological work, especially outreach events. Recently, some archaeologists have taken to TikTok, where they communicate especially with a younger audience of high school and university students.

Social media are one of the most powerful promotion tools available to a wide range of sectors including archaeological heritage. Notwithstanding its significance in sharing and exchanging information, it also entails many major challenges; from time-consuming content creation and support to mentoring social media accounts for hate speech and/or fact-checking. As with blogs and podcasts, content needs to be created and updated regularly to increase visibility, and create a virtual community. Such content should be audience-appropriate, accessible to audiences from a diverse background and simultaneously informative and entertaining. In addition to the guidance given by the Europeana Foundation on digital storytelling, professional (and creative) support can be useful



²⁴ Source: <https://wearesocial.com/digital-2020> [accessed 20.2.2021]

²⁵<https://www.omnicoreagency.com/youtube-statistics/> [accessed 20.2.2021]

– especially as some platforms come with their individual limits and constraints (e.g. no embedment of links on Instagram; 280-character limit on Twitter). All platforms require regular engagement with their respective communities and content needs to be continuously curated to prevent its misuse by third parties.

Despite these challenges, social media platforms offer a vast range of opportunities to promote archaeological heritage on the internet. Accounts or profiles are generally easy to set up and use. Most platforms support both computers and mobile devices, and regular and quick updates can be posted 'on the go'. Specialised apps enable their users to post content across various platforms and to embed social media feeds on websites.

Digital storytelling through social media supports heritage institutions in reaching new audiences. The vast landscape of social media also offers the tools for testing new approaches like interactive audience participation. Such dialogue with a social media community leads to engaging and devoted followers.

Animate Archaeology! – Archaeology and video platforms

As audiences have always been drawn to film and moving pictures, creating video content is becoming crucial for attracting public attention in any field. Thus, videos have become an essential element of various social media platforms, websites, blogs etc. Together with visual and audio material, they draw upon the key strength of cultural heritage – its wealth of visual material – and can help to structure stories. Platforms such as Twitter or Instagram allow sharing short videos or so-called reels, and content often developed primarily for video platforms such as YouTube or Vimeo, can be adapted and edited into a trailer or short taster clip linked, and leading, to the respective video platform. Films of varying length can highlight the work of archaeological institutions behind the scenes and showcase the tangible as well as intangible heritage they are entrusted with. Setting up an institutional channel not only offers the option to create a series of films, recorded lectures or webinars under an institutional name or labels, but also helps users to identify high-quality content.

YouTube hosts a vast amount of videos and, by early 2021, it had more than 2 billion users²⁵. Without investment into increasing visibility, however, stories told through videos remain hidden from the majority of users. Guidelines on digital storytelling such as those of the Europeana Foundation support the creation of high-quality videos, but overcoming language as well as accessibility barriers are two further issues, especially for smaller heritage institutions. In addition, even evocative content that showcases facts in high quality directly competes with popular but frequently false content labelled "archaeology" and thus often remains less visible. On the other hand, increased visibility will also increase the risk of attracting negative attention. As a video-sharing and communication platform, YouTube allows its users to vote and comment on content. Therefore, the forum or comment section needs to be either closed – and thus prevent any community interaction – or closely monitored.

5.2. ACCESSIBILITY

Access to knowledge is a key aspect of equality, diversity and inclusion. Accessibility, therefore, must be at the core of any project that promotes archaeological heritage. However, accessibility goes beyond the physical access to archaeological landscapes and historical sites. The current COVID-19 pandemic has highlighted the importance of digital access to cultural heritage. Many museums opened their doors virtually long before physical get-togethers were possible again and online exhibitions, webinars and quickly developed virtual events brought archaeology and cultural heritage into people's living rooms. The speed at which many institutions adapted to the situation was greatly facilitated by the progress made in digitising museum content. Access to cultural heritage, however, has to begin much earlier than the average age of museum visitors. The foundations of a good understanding of cultural heritage should be laid in school.

Invite and Come in! – The impact of COVID-19 and/or natural disasters on the physical accessibility of heritage

The accessibility of and to cultural heritage is a key priority not only of the Danube's Archaeological eLandscapes project. In 2020/2021, the physical accessibility options for a diverse and inclusive audience has received heightened attention when museums and archaeological and/or historical sites had to close all across the world due to Covid-related lockdowns. The cultural sector, which had already been hit by the economic legacy of the global financial crisis in 2007, was severely affected as social distancing and 'stay at home' orders are polar-opposite to the social character of knowledge exchange and the shared experience of our cultural heritage.

Within the area of the Danube River Basin, the Republic of Croatia suffered a particularly hard fate when Zagreb was hit by the strongest earthquake since 1880 (5.5 ML) at the beginning of the first national lockdown on 22nd March 2020, only to be affected again during the Petrinja earthquake on 29th December 2020 (6.2 ML), which caused further damage in the country's capital. Many historical buildings, museums and other cultural venues were badly damaged and the Historical Museum, which also houses the archaeological collection, had to be declared statically unsafe.

Whilst UNESCO, ICOM, ICOMOS, Europa Nostra, and NEMO (Network of European Museum Organisations) have monitored the closure of institutions and sites and the financial impact, archaeologists, curators and historians across Europe shared their expertise and knowledge remotely, invited their audiences to join them for virtual lectures, tours and exhibitions. The need for digital strategies increased, which enable easier access to our shared cultural heritage, not only during times of crisis but also acknowledge the needs of a diverse and inclusive society.

An analysis of the accessibility to cultural heritage during the SARS-CoV-2 pandemic (commonly referred to as the coronavirus or COVID-19 pandemic) has highlighted that restrictions to the physical accessibility of cultural heritage – from short-term restrictions to long-term closure – lead to a range of risks to the long-term survival of museums and other cultural heritage institutions and sites. This sudden "invisibility" and financial losses increase the already existing inequality between

smaller and larger institutions, rural and urban sites as well as between countries. The added challenges of costly repairs and renovations faced by Croatian institutions, which have suffered severe damages during the earthquakes of March and December 2020, highlight the necessity for long-term solution. The fact that, although Covid-19 has resulted in the unprecedented situation of an almost global lockdown, periods of access restrictions are not exceptional, and cultural heritage institutions require strategies for periods of crisis.

The COVID-19 pandemic has highlighted two fundamental weaknesses and threats to the cultural heritage sector – museums and other cultural heritage organisations heavily rely on income generated through admission fees and other paid-for offers; at the same time, their programmes often involve a large group of volunteers and other unpaid or only temporarily employed staff. Whilst the generation of income and the reliance on volunteers are dependent upon a society, which is able and willing to fund and support cultural heritage through their contributions, the financial impact of budget cuts on members of staff with temporary, part-time and/or zero-hour contracts as well as furloughed staff has made professional work within the cultural heritage sector increasingly unviable.

Decreased visibility and the loss of volunteers, as well as temporary and/or low-paid staff, threaten the physical security of cultural heritage and its place in society as centres for knowledge exchange, intergenerational communication and social venues, which allow their visitors to explore past and far worlds, experience old traditions and create new cultural connections. Although digital solutions such as online events and interactive websites as well as intensified social media participation have partially counterbalanced the physical inaccessibility of cultural heritage, the COVID-19 pandemic has also highlighted the lack of digital solutions across the sector, be it due to financial and personal limitations or reluctance and a negative perception of the potential impact of digital culture on traditions and long-held beliefs.

Although the COVID-19 pandemic has emphasised the lack of digital strategies and solutions within the cultural heritage sector, the situation has also highlighted the passion of academics and heritage professionals in creating digital content, 'opening' the doors of their collections virtually and enabling their audience to explore cultural heritage from home. These opportunities have often been long-anticipated by people with physical and/or mental disabilities or other impairments, for whom the physical visit of museums and other cultural heritage sites had been impossible.

Experts across the world have come together virtually and exchanged their expertise and skills in overcoming the challenges caused by the COVID-19 pandemic – and in the case of Croatian institutions the damage following two major earthquakes in 2020. Despite the threats to health, safety and financial security, the unprecedented circumstances have also created space for new ideas and approaches. This has enabled cultural heritage institutions to reach new audiences and build new relationships for the future.



Guide and Explore! – Digital archaeological heritage and visitor experiences in museums

In recent years, museums have undergone a constant transformation in an aim to maintain their educational role whilst also becoming places attractive for creative leisure time ('educative leisure'). Broadly speaking, museum visits can be perceived as a form of so-called experiential consumption; studies indicate that investing in specific experiences (e.g. travelling, going to restaurants, but also consuming culture and art) brings more satisfaction and happiness than material consumption because these experiences contribute to a person's identity and enhance social relations. Therefore, the role of museums in society is changing from traditional (collection-centred) institutions towards new (audience-centred) museological approaches – instead of showcasing what is pre-determined as collection highlights, curators and museum experts explore visitor needs and backgrounds to collaboratively develop meaningful experiences. Emphasising the importance of visitor experiences, the impact and possibilities of digital technologies are becoming a crucial part of this transformation. Public activities of museums – mainly in the form of exhibitions accompanied by visitor programmes – are key tools for the promotion of archaeological landscapes.

The use of digital tools can be highly beneficial to museums. During the COVID-19 pandemic, digital content and online resources have often been the only access to collections, exhibitions and museum outreach, and we have witnessed a development towards catering to a more diverse audience. Nevertheless, there are disadvantages and pitfalls not to be ignored. With many museums owning more artefacts in storage than can be shown on display, space is at a premium and

a difficult decision has to be made whether more space should be freed up to create a VR/AR room. Likewise, the limited time spent by museum visitors engaging with artefacts would be further diminished – the attraction of digital tools distracting from traditional exhibits; a danger increased following museum closures during the COVID-19 pandemic. On the other hand, digital content is often created without prior research of visitor needs, interests and capabilities, partly due to a lack of digital skills and experience with digital storytelling amongst museum staff. Furthermore, most museums lack tools for evaluating visitor experiences to collect information for future directions or a digital strategy. As it is almost impossible to find one digital solution catering for different visitor groups with varying levels of digital knowledge, these digital tools tend to be strongly oriented towards a specific target group. Furthermore, the lack of resources for new digital tools and quickly outdated equipment contribute to delays in the implementation of digital technologies in museums and lower the quality of visitor experiences. Finally, the use of digital technology for educational purposes can result in museum media losing aspects of their authenticity. With museums already competing for visitors against other leisure activity providers, most of whom can rely on better financial resources, these challenges become crucial for the development of a digital strategy.

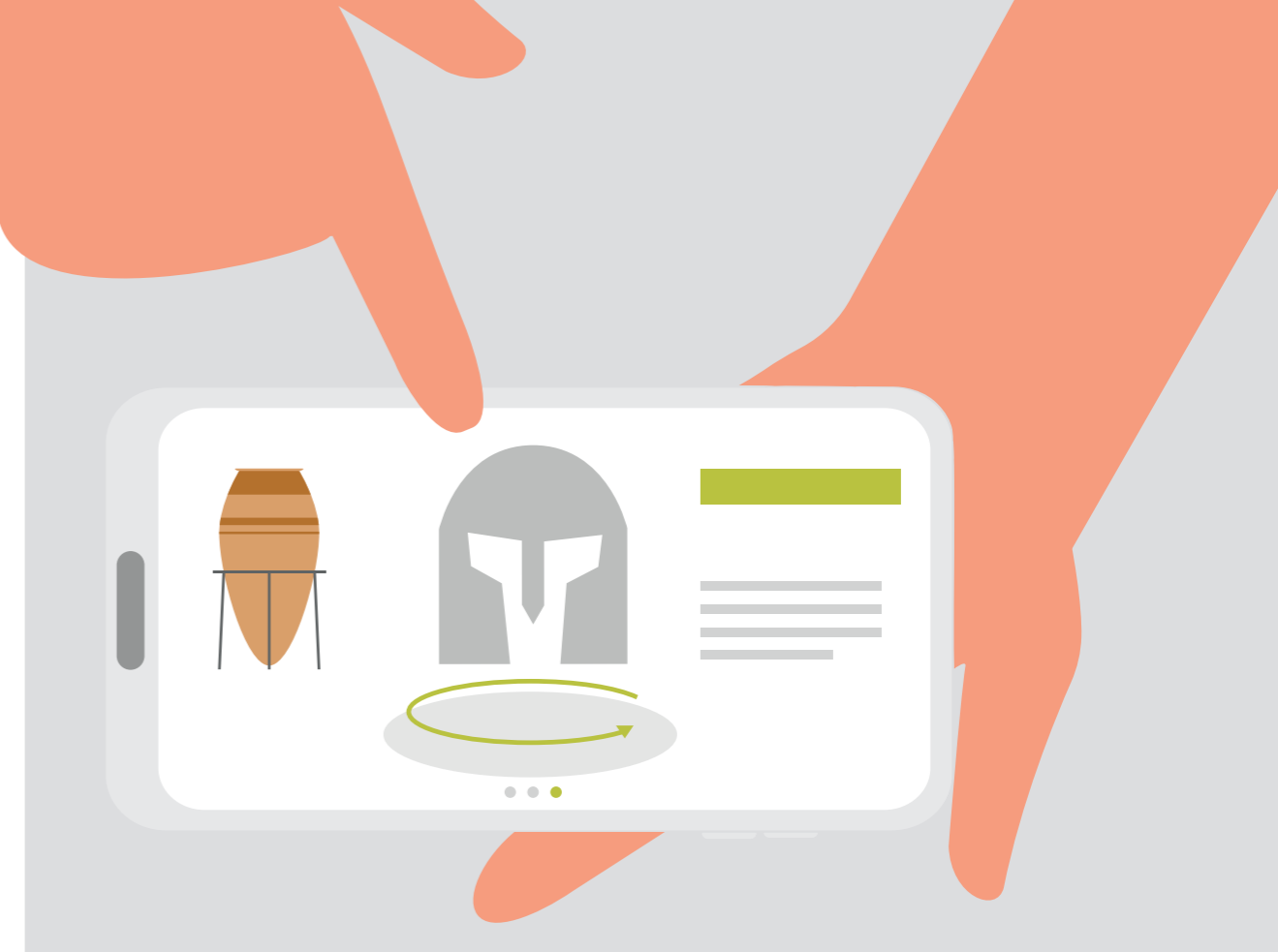
With digital technologies rapidly changing, museums try to follow the latest technological developments such as artificial intelligence (AI), virtual reality (VR), augmented reality (AR), and 3D imagery and videos. The expansion of the internet has led to a whole new kind of exhibitions developed in the virtual space – a development greatly accelerated by the COVID-19 pandemic.

On-site, museum resources based on computer-mediated reality (i.e. AR and VR) appear to be especially promising in enhancing museum content and making especially historical and archaeological museums more attractive. AR and VR installations are ideal tools for digital storytelling as they offer a good balance between fascination, fun, and entertainment as well as information and education. Artefacts can be explored in their original surroundings, people of the past come to life and interactive engagement with cultural heritage makes educational leisure in museums more fulfilling. Moreover, digital technologies have opened new opportunities for an improved connection between museum space, exhibits, and visitors.

Likewise, digital exhibitions open new, never seen possibilities for cultural institutions and their audiences. Real-time conversations through websites, social media, online galleries, and panel discussions have further strengthened the interaction between museum, artefact and visitors. Cultural experiences have become more accessible to a wider audience, moving away from their former elitist and privileged status.

With the help of digital technologies, cultural heritage institutions have the opportunity to receive more feedback than before. Online exhibitions can remain 'open' for longer periods and although this increases their reach, they may also lose some of their attraction of limited availability. Thus, museums are urged to compete for visitor attention, not just on-site but also online.

Ultimately, digital technologies have not only changed narratives



within the museums, but also physical exhibition areas, which have to be developed alongside technological evolution.

Teach and Learn! – Archaeological heritage in schools

Preservation of cultural heritage strongly depends on public consent and a shared perception of heritage and its value for society. The impact of cultural or archaeological heritage in education is crucial for the later understanding and appreciation of our common heritage. It there need to be addressed needs to be addressed in this strategy document. Before discussing archaeological landscapes and virtual archaeology in education it is necessary to address a few general remarks on the position of archaeological heritage in schools and try to formulate some general recommendations on transmitting knowledge on archaeological heritage in schools.

The aim of an analysis of school curricula in Austria, Croatia, Germany and Hungary was to identify the impact of archaeological heritage in school education. The results of the analysis represent trends which can be observed in most countries of the Danube region.

The studies demonstrated that terms like “heritage”, “cultural heritage” or “archaeology” are strongly underrepresented or do not even exist in the various school curricula. Even if the associated topics are included, the use of terminology is inconsistent. Some aspects of archaeological heritage are integrated into the general term “culture” and addressed in different lessons (e.g. History, Latin, Arts) – the academic subject of archaeology and archaeology as a profession, however, are insufficiently represented. The subject of history appears

#heritage
#archeology



to be particularly problematic because teaching history often remains data-intensive across the analysed curricula. Context-based learning of history appears to be largely restricted to the early years of primary and lower secondary school education. As a result of this data-intensive approach “Prehistory”, but also the “Roman period” or “Middle Ages” have almost disappeared from learning plans. Here, the oldest history of humankind must make way for topics from modern history. Thus, teaching about (regional and local) archaeological sites and heritage often depends on individual teachers and schools. However, even if the educational staff would like to set the emphasis on archaeological heritage, they often lack appropriate space in schools, heritage-related resources and funding that would support teaching outside of the classroom combined with hurdles set by administration.

In the long term, the loss of knowledge about archaeological heritage and periods in schools cannot be fully compensated for by other forms of education and knowledge exchange, and there is the general risk that the public will assign a subordinate role to the protection and research of archaeological monuments. Subsequently, this could also lead to a loss of interest in visiting archaeological museums. At the same time, museums have to adapt their programme to the knowledge about the archaeological and cultural heritage of the wider public. In the long term, a lack of historical teaching including the prehistoric periods and archaeological topics could limit the extent of innovative museums programmes.

It is without doubt that a good and balanced knowledge of history is one of the fundamental pillars of an equal, diverse and inclusive society. Teaching history in school is thus of utmost importance, and the subject of History benefits from its fundamental nature. Topics associated with cultural and archaeological heritage can be addressed through many different subjects, including, but not only, history, languages and, in particular, Latin and Arts. Despite their underrepresentation, terms such as “culture” and “cultural heritage” are part of many of the school curricula, which aim to strengthen the understanding of the importance of cultural heritage.

Over the past decades, learning and teaching methods have changed, and primary and secondary education aims to enable pupils to become independent learners. Although school curricula for History are still very data-centric and tend to focus on modern and political history, this change in education has opened the doors for museums and other cultural institutions. Outreach programmes can enrich children’s engagement with history and archaeology, and provide the context-based approach often missing from formal classroom teaching. Therefore, the involvement of heritage institutions in the development of future curricula and outreach programmes for schools are crucial. In Hungary, archaeologists and museologists who specialise in educational approaches have worked together in the development of the new National School Curriculum (NAT 2020).

With prehistoric and archaeological topics largely missing from the school curricula of the study areas, museums have already taken on the leading role in providing knowledge about these periods to children and young adults. Since many pupils are very interested in archaeology and cultural heritage, bottom-up initiatives coming from teachers and schools are often welcomed. These programmes can be enhanced through the use of digital technologies – dubbed ‘digital natives’, students and pupils of Generations Z and Alpha have grown up with digital technologies and often use them intuitively. Therefore, collaboration on the development of digital tools, or their exchange between schools and heritage institutions, can support learning about our shared archaeological heritage.

6

RECOMMENDATIONS AND NATIONAL PRIORITIES

The partners of the Danube's Archaeological eLandscapes project support the following recommendations for the visualisation and promotion of archaeological landscapes in the Danube region:

When dealing with digitisation and visualisation projects, take their **multidisciplinary character** into account. This can be aided by careful project planning that respects the archaeological, technical and social aspects of the project. If **suitable experts** cannot be found in-house, certain tasks should be appropriately outsourced. Furthermore, everyone dealing with the project must understand the possibilities and limits of 3D techniques as well as cultural heritage conservation. For a site-specific, local integration of the results, the local public can be included in any stage of the project.

Give special care to the integrity and suitability of the data! For this purpose, meta- and paradata including methods and workflows should be collected. This can be regulated by a **well-planned documentation system** supported by appropriate hardware and software resources. Wherever possible, established standards and formal languages should be used.

Furthermore, consider the recommendations of the expert groups on digital cultural heritage on the basic principles for 3D digitisation of cultural heritage (e.g. Europeana²⁶)! **Copyright** should be obtained and open-access should be planned; a minimum quality should be defined and best quality should be strived for; and finally, suitable file formats should be chosen.

Data should follow the **F-A-I-R principle** wherever applicable: findable, accessible, interoperable, reusable! Responsibility for the long term preservation and curation of data and digital products should be accounted for. Correspondingly, connecting with experts groups and following national as well as international initiatives that deal with digitisation can aid this task.

For virtual model creation, choose a **communication strategy** and technical solutions suitable for the data they are based on! In an iterative process, check the suitability of models and products for the chosen communication tools and hardware equipment. Finally, assure the intellectual integrity of the 3D model on different chosen platforms or artistic settings.

Furthermore, support **open-access** at all possible levels! For the scientific public, this includes sharing digital scientific data as well as supporting open-access publications. To bring heritage closer to the general public, several **social media** venues should be explored; from blogs, social media platforms to publicly shared videos. This content should be created in an understandable and clear language, shared over multiple platforms if possible and updated regularly. Social media engagement with the audience is of crucial importance.

In **museums, support the use of digital technology** for a better connection between the museum space, the artefacts and visitors! At the same time, these technologies can improve the user-centred experience and provide an optimal mix between education and entertainment. Online, parallel digital exhibitions can reach a wider audience and remain accessible even after the physical exhibition ends.

In schools, improve incorporation of, or re-incorporate, **archaeological topics on the curriculum!** Digital tools can support deeper pupil engagement and can be designed in cooperation with heritage institutions.

USE A MULTIDISCIPLINARY APPROACH BY INTERGRATING ARCHEOLOGICAL, TECHNICAL AND SOCIAL ASPECTS

INCLUDE A DIVERSE TEAM OF EXPERTS

USE A WELL-PLANNED DOCUMENTATION SYSTEM WITH ESTABLISHED STANDARD AND FORMAL LANGUAGES

CLEAR ANY COPYRIGHTS

FOLLOW THE F-A-I-R PRINCIPLE (FINADABLE, ACCESSIBLE, INTEROPERABLE, AND REUSABLE)

PREPARE AND FOLLOW A CLEAR COMMUNICATION STRATEGY

²⁶<https://digital-strategy.ec.europa.eu/en/library/basic-principles-and-tips-3d-digitisation-cultural-heritage> [accessed 04/08/2021]

On a wider scale, put **strategies to increase the visibility of cultural heritage** into practice! These include the use of digital technologies to share knowledge, expertise and skills about cultural heritage with a diverse and inclusive public. For this purpose, the digitisation of physical archaeological data should be encouraged and supported. At the same time, cultural heritage employees need to be adequately trained in the design and use of digital tools.

As a long-term application, we recommend that the approaches discussed in this strategy are applied in all relevant **educational institutions**. Add items raised in this strategy to the relevant subject curricula and draw up official **national guidelines for cultural heritage stakeholders!**

SUPPORT OPEN ACCESS DIGITAL DATA AND PUBLICATION

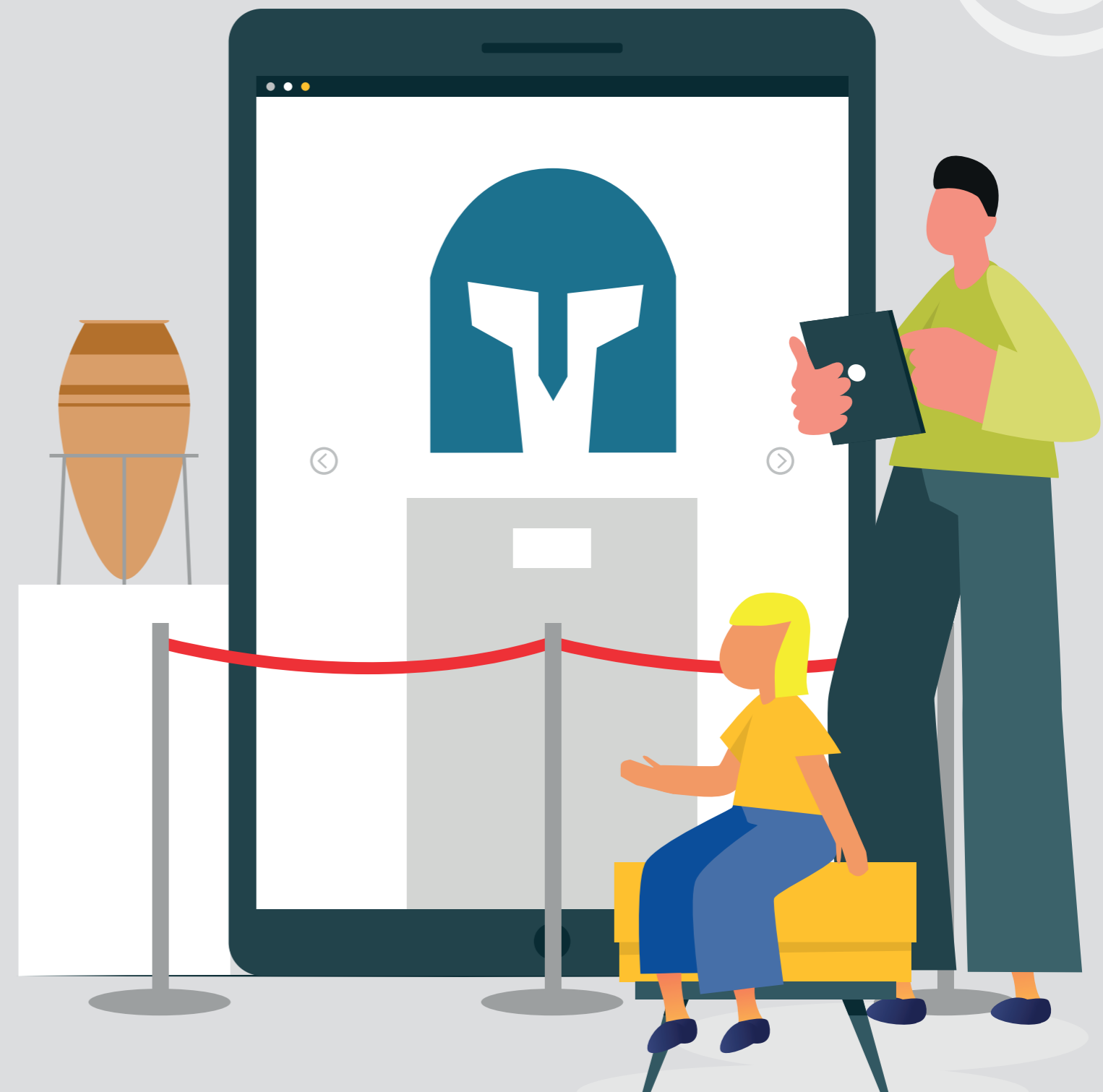
ENGAGE ON SOCIAL PLATFORMS

FOSTER THE USE OF DIGITAL TECHNOLOGIES IN MUSEUMS

DEVELOP DIGITAL TOOLS FOR INTEGRATION OF
ARCHEOLOGICAL HERITAGE IN SCHOOL CURRICULA

SUPPORT THE DEVELOPEMENT OF SOUND NATIONAL
GUIDELINES FOR CULTURAL HERITAGE SECTOR

INTEGRATE EDUCATION ON POINTS RAISED IN THIS
STRATEGY IN THE RELEVANT EDUCATIONAL INSTITUTES



NATIONAL PRIORITIES IN THE DANUBE REGIONS

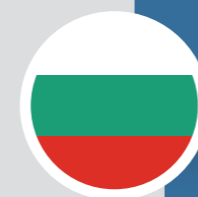
The partnership of the project sees all recommendations of the Strategy as equally important and should be integrated in the development and promotion of digital archaeological landscapes. Some of the recommendations are already largely implemented in some countries and non-existent in others. Due to the different developments in the countries of the Danube region the partners of the Danube's Archaeological eLandscapes support a priority list of recommendations, which in their opinion needs to be invested in first.

PRIORITY LIST FOR AUSTRIAN PARTNERS OF THE DANUBE'S ARCHAEOLOGICAL ELANDSCAPES PROJECT



1. Support the development of sound national guidelines for cultural heritage sector
2. Integrate education on points raised in this strategy in the relevant educational institutes
3. Develop digital tools for integration of archaeological heritage in school curricula
4. Foster the use of digital technologies in museums
5. Use a multidisciplinary approach by integrating archaeological, technical and social aspects
6. Include a diverse team of experts
7. Use a well-planned documentation system with established standards and formal languages
8. Follow the f-a-i-r principle (findable, accessible, interoperable and reusable)
9. Support open-access digital data and publications
10. Clear any copyrights
11. Prepare and follow a clear communication strategy
12. Engage on social media platforms

PRIORITY LIST FOR BULGARIAN PARTNERS OF THE DANUBE'S ARCHAEOLOGICAL ELANDSCAPES PROJECT



1. Support the development of sound National Guidelines for cultural heritage sector
2. Use a multidisciplinary approach by integrating archaeological, technical and social aspects
3. Foster the use of digital technologies in museums
4. Prepare and follow a clear Communication Strategy
5. Include a diverse team of experts
6. Integrate education on points raised in this strategy in the Relevant Educational Institutes
7. Follow the F-A-I-R principle (Findable, Accessible, Interoperable and Reusable)
8. Use a well-planned documentation system with established standards and formal languages
9. Develop digital tools for integration of archaeological heritage in School Curricula
10. Support open-access digital data and publications
11. Clear any copyrights
12. Engage on Social Media platforms

PRIORITY LIST FOR CROATIAN PARTNERS OF THE DANUBE'S ARCHAEOLOGICAL ELANDSCAPES PROJECT



1. Support the development of sound National Guidelines for cultural heritage sector
2. Use a multidisciplinary approach by integrating archaeological, technical and social aspects
3. Foster the use of digital technologies in museums
4. Prepare and follow a clear Communication Strategy
5. Include a diverse team of experts
6. Integrate education on points raised in this strategy in the Relevant Educational Institutes
7. Follow the F-A-I-R principle (Findable, Accessible, Interoperable and Reusable)
8. Use a well-planned documentation system with established standards and formal languages
9. Develop digital tools for integration of archaeological heritage in School Curricula
10. Support open-access digital data and publications
11. Clear any copyrights
12. Engage on Social Media platforms

THE PRIORITY LIST FOR CZECH PARTNER OF THE DANUBE ´S ARCHAEOLOGICAL ELANDSCAPES PROJECT



1. Use a multidisciplinary approach by integrating archaeological, technical and social aspects
2. Include a diverse team of experts
3. Use a well-planned documentation system with established standards and formal languages
4. Foster the use of digital technologies in museums
5. Develop digital tools for integration of archaeological heritage in School Curricula
6. Follow the F-A-I-R principle (Findable, Accessible, Interoperable and Reusable)
7. Integrate education on points raised in this strategy in the Relevant Educational Institutes
8. Support the development of sound National Guidelines for cultural heritage sector
9. Prepare and follow a clear Communication Strategy
10. Clear any copyrights
11. Support open-access digital data and publications
12. Engage on Social Media platforms

PRIORITY LIST FOR HUNGARIAN PARTNER OF THE DANUBE ´S ARCHAEOLOGICAL ELANDSCAPES PROJECT



1. Support the development of sound National Guidelines for cultural heritage sector
2. Use a multidisciplinary approach by integrating archaeological, technical and social aspects
3. Include a diverse team of experts
4. Integrate education on points raised in this strategy in the Relevant Educational Institutes
5. Foster the use of digital technologies in museums
6. Follow the F-A-I-R principle (Findable, Accessible, Interoperable and Reusable)
7. Use a well-planned documentation system with established standards and formal languages
8. Prepare and follow a clear Communication Strategy
9. Clear any copyrights
10. Support open-access digital data and publications
11. Develop digital tools for integration of archaeological heritage in School Curricula
12. Engage on Social Media platforms

PRIORITY LIST FOR GERMAN PARTNERS OF THE DANUBE ´S ARCHAEOLOGICAL ELANDSCAPES PROJECT



1. Prepare and follow a clear Communication Strategy
2. Support open-access digital data and publications
3. Foster the use of digital technologies in museums
4. Follow the F-A-I-R principle (Findable, Accessible, Interoperable and Reusable)
5. Engage on Social Media platforms
6. Include a diverse team of experts
7. Use a multidisciplinary approach by integrating archaeological, technical and social aspects
8. Use a well-planned documentation system with established standards and formal languages
9. Ensure long time preservation and curation of the data
10. Clear any copyrights
11. Develop digital tools for integration of archaeological heritage in School Curricula
12. Integrate education on points raised in this strategy in the Relevant Educational Institutes
13. Support the development of sound National Guidelines for cultural heritage sector

PRIORITY LIST FOR ROMANIAN PARTNERS OF THE DANUBE ´S ARCHAEOLOGICAL ELANDSCAPES PROJECT



1. Support the development of sound National Guidelines for cultural heritage sector
2. Use a multidisciplinary approach by integrating archaeological, technical and social aspects
3. Foster the use of digital technologies in museums
4. Prepare and follow a clear Communication Strategy
5. Include a diverse team of experts
6. Integrate education on points raised in this strategy in the Relevant Educational Institutes
7. Follow the F-A-I-R principle (Findable, Accessible, Interoperable and Reusable)
8. Use a well-planned documentation system with established standards and formal languages
9. Develop digital tools for integration of archaeological heritage in School Curricula
10. Support open-access digital data and publications
11. Clear any copyrights
12. Engage on Social Media platforms



PRIORITY LIST FOR SERBIAN (IPA PPI) PARTNERS OF THE DANUBE ´S ARCHAEOLOGICAL ELANDSCAPES PROJECT

1. Support the development of sound National Guidelines for cultural heritage sector
2. Use a multidisciplinary approach by integrating archaeological, technical and social aspects
3. Integrate education on points raised in this strategy in the Relevant Educational Institutes
4. Develop digital tools for integration of archaeological heritage in School Curricula
5. Use a well-planned documentation system with established standards and formal languages
6. Follow the F-A-I-R principle (Findable, Accessible, Interoperable and Reusable)
7. Prepare and follow a clear Communication Strategy
8. Foster the use of digital technologies in museums
9. Support open-access digital data and publications
10. Include a diverse team of experts
11. Clear any copyrights
12. Engage on Social Media platforms

PRIORITY LIST FOR SLOVAK PARTNERS OF THE DANUBE ´S ARCHAEOLOGICAL ELANDSCAPES PROJECT



1. Support the development of sound National Guidelines for cultural heritage sector
2. Use a multidisciplinary approach by integrating archaeological, technical and social aspects
3. Foster the use of digital technologies in museums
4. Prepare and follow a clear Communication Strategy
5. Include a diverse team of experts
6. Integrate education on points raised in this strategy in the Relevant Educational Institutes
7. Follow the F-A-I-R principle (Findable, Accessible, Interoperable and Reusable)
8. Use a well-planned documentation system with established standards and formal languages
9. Develop digital tools for integration of archaeological heritage in School Curricula
10. Support open-access digital data and publications
11. Clear any copyrights
12. Engage on Social Media platforms

PRIORITY LIST FOR SLOVENIAN PARTNERS OF THE DANUBE ´S ARCHAEOLOGICAL ELANDSCAPES PROJECT



1. Support the development of sound National Guidelines for cultural heritage sector
2. Use a multidisciplinary approach by integrating archaeological, technical and social aspects
3. Include a diverse team of experts
4. Use a well-planned documentation system with established standards and formal languages
5. Foster the use of digital technologies in museums
6. Develop digital tools for integration of archaeological heritage in School Curricula
7. Integrate education on points raised in this strategy in the Relevant Educational Institutes
8. Prepare and follow a clear Communication Strategy
9. Support open-access digital data and publications
10. Clear any copyrights
11. Follow the F-A-I-R principle (Findable, Accessible, Interoperable and Reusable)
12. Engage on Social Media platforms

IMAGES AND GRAPHICS

Figure 1

Partner Institutions of the Danube's archaeological eLandscapes Project

Figure 2

Digital archaeological landscape of Kaptol (Croatia).
©Miroslav Vuković - Lupercal d.o.o.

Figure 3

Correlation between the strategic approach to digital visualisation and the three aspects of the strategy

Figure 4

Challenges chapter 4

Figure 5

Challenges chapter 5

Figure 6

Interlink between Strategy 21 and Danube's
Archaeological eLandscapes project

Figure 7

Relationships between the different aspects of the visualisation process and their impact on the composition of the virtual 3D visualisation.
(Lužnik-Jancsary, PhD Thesis, in progress)

Figure 8

Virtual visualisation workflow. (Lužnik-Jancsary, PhD Thesis, in progress)

Figure 9

ARIADNE Reference Model (ARIADNE RM)
<https://www.semanticscholar.org/paper/Mapping-archaeological-databases-to-CIDOC-CRM-Doerr-Theodoridou/d31bacb148de1d7c7fec0ecf506fa1e499acb078> Fig.1

Figure 10

Europeana digital storytelling tips. Title: "Seven tips for digital storytelling with cultural heritage", Creator: Maggy Szyndkielewska, Date: 2021, Institution: Europeana Foundation, Country: Netherlands, CC BY-SA

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