

IT APPLICATIONS TO ARCHAEOLOGY AND THE OA DIAMOND JOURNALS' CHALLENGE. ENHANCING ACCESS AND REUSE OF TEXTUAL AND VISUAL RESOURCES

1. INTRODUCTION

In recent years there have been increasing efforts by policy makers to promote Open Science, both at the theoretical and at the practical level, so that best practices and recommendations on Open Access (OA) to research data and publications have often turned into rules and mandates¹. The OA publishing landscape is varied, comprising diverse strategies and approaches to ensure its sustainability. In this, the economic aspect is pivotal, especially for the so-called 'gold road' of OA. This consists of two different models: the APC-based model (where APC stands for Article Processing Charges), requiring fees from the authors for publication, and the 'diamond OA' model, with free publication for both authors and readers².

«Archeologia e Calcolatori» (<http://www.archcalc.cnr.it/>) has been an OA diamond journal since the beginning of its online publication in 2005, long before this label was coined (MOSCATI 2009, 2018). This article presents the latest operational choices made in the valorisation and accessibility of the journal's resources to the benefit of the research community in IT applications in archaeology and discusses the new solutions we are experimenting to enhance the journal's archive, in line with the FAIR principles³. It focuses on two aspects: the provision of open visual resources – images and 3D models – in addition to the articles' full texts on the journal's website, and the management, enrichment, and provision of descriptive metadata of the journal's resources, in view of their reuse by service providers and inclusion in e-infrastructures, above all OpenAIRE, the Open Access Infrastructure for Research in Europe (<https://www.openaire.eu/>).

¹ See for instance the EU's Open Science policy (https://ec.europa.eu/info/research-and-innovation/strategy/strategy-2020-2024/our-digital-future/open-science_en). For an overview of the history of the adoption of Open Science policies at the national levels, with a focus on France, see DACOS 2019. Italy recently included its first 'Piano nazionale per la scienza aperta' in the latest *Programma Nazionale per la Ricerca 2021-2027* (<https://www.mur.gov.it/sites/default/files/2021-01/Pnr2021-27.pdf>).

² For an overview of OA principles and practices in the Humanities, see the recent contribution by SALUCCI and CINOTTI (2021, postprint). For a study of the OA journals in the archaeological sector, see CARVALE, PIERGROSSI 2012, 2015. These articles also provide useful explanations of terminology and concepts related to OA publishing. For Open Science in archaeology, see MARWICK *et al.* 2017.

³ The acronym FAIR stands for 'Findable, Accessible, Interoperable, Reusable'. FAIR principles, first codified in 2016, are guidelines for the production and dissemination of digital resources, aiming at improving their accessibility and reusability (WILKINSON *et al.* 2016, 2019). On FAIR principles in archaeology, see lastly PIERGROSSI 2020 (with references).

This paper is an opportunity to describe and assess the relevance of those initiatives within the digital archaeology disciplinary domain (HUGGETT 2015), in the light of the Open Science recommendations, and to map the current position of the journal against the landscape of the OA diamond publishing model. In particular, the possibilities that this paradigm offers in terms of research and development will be shown. We will then draw conclusions, based on this discussion, in section 4.

I.R., N.P.

2. FROM DATABASES TO INFRASTRUCTURES: CUSTOM SOLUTIONS FOR FAIR LITERATURE RESOURCES

2.1 «Archeologia e Calcolatori» and the early provision of metadata via an OAI gateway

Since 2005, «Archeologia e Calcolatori» has been providing online the PDF files for the published versions of journal articles through its official website. This was motivated by a pioneering adoption of OA principles, as promoted in the early 2000s by the Open Archives Initiative (OAI) (LAGOZE, VAN DE SOMPEL 2001). Along with the PDF files, «Archeologia e Calcolatori» also provided metadata about publications using open formats – namely, the *oai_dc* metadata format based on Dublin Core terms – and interoperable standards, so that harvesting and aggregation services could have access to them. This was accomplished through a static OAI repository gateway (provided as a service by Ghent University, in Belgium) that served metadata via the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH), using an XML file generated by the journal (BARCHESI 2005, 2019).

However, this solution meant that «Archeologia e Calcolatori» as a data provider was directly tied to a third-party service. Furthermore, the metadata generation process was indeed ‘static’ from the journal’s side, since the data were compiled into a single XML file, which was then used by the gateway. The XML document itself was generated by extracting data from a Microsoft Access database, which was therefore dependent on proprietary software.

With the substantial evolution of web technologies and the widespread adoption of open-source solutions, «Archeologia e Calcolatori» migrated from the static gateway provider to a custom implementation of OAI requirements for metadata provision, which proved particularly useful when Ghent University stopped offering its service. Therefore, a dedicated data provider repository⁴, compliant with OAI-PMH 2 specifications and designed around the new relational database, was developed.

⁴ The repository is available at http://www.archcalc.cnr.it/oai/aec_oaipmh2.php?verb=Identify.

2.2 Relational database and development of a standalone OAI-PMH data provider

One of the central steps in the restructuring and renovation of the underlying technology that supports «Archeologia e Calcolatori» was the design and implementation of a relational database to hold data on journal resources. As detailed by Salvatore FIORINO (2019), a conceptual model was defined to represent publications (Article entities) so that their relationships with authors, volumes, etc. would be clearer and more manageable. This resulted in the development of an Entity-Relationship model and, consequently, a logical and physical implementation of the database using an open-source Database Management System (DBMS), MySQL. This is in line with the general approach to move from proprietary to open solutions, which informs the journal's policy in its entirety. This database was then populated so that data about publication resources were properly distributed over the respective entities.

The significance of this restructuring of the data model – and its implementation – lies (among other things) in the fact that it became a necessary foundation for the development of the new data provider repository. Indeed, the repository dynamically generates the proper XML response to the various OAI-PMH requests (verbs and related parameters) by retrieving relevant data from the underlying database. To perform this task, it first processes the incoming HTTP request by parsing the query parameters according to the rules defined by the protocol. If the request is valid, it calls the relevant procedure, structures the data according to the requested metadata format, and returns the generated XML to the harvester (or, generally, the client that sent the request). If the request is not valid and does not comply with the protocol, the repository returns the appropriate error response, still in XML format.

The repository is structured as shown in Fig. 1. It exposes 4 different sets to allow selective harvesting based on resource type and category. Sets are the main option provided by the protocol to filter available resources, so harvesters like OpenAIRE rely on them to gather only the metadata they intend to, depending on the context. For instance, the *openaire* set was added to be compliant with OpenAIRE requirements for automated metadata harvesting, as detailed in paragraph 2.3.

Another important piece of information exposed by the repository is the datestamp of individual records (not to be confused with the publication date, which is part of the Dublin Core metadata set). The datestamp reflects either the creation date of the record or the date when it was last modified. This allows harvesters to only gather metadata for newly created resources or existing resources that were updated with respect to the latest harvesting, a process known as incremental harvesting (VAN DE SOMPEL

Verb	Description
<i>Identify</i>	Information about the repository itself (name, base URL etc.)
<i>ListSets</i>	The list of available sets for selective harvesting
<i>ListMetadataFormats</i>	The list of metadata formats exposed by the repository
<i>ListRecords</i>	The list of all records available in the repository, including metadata for each record. Metadata for a single record can be retrieved through the respective <i>GetRecord</i> request URL
<i>ListIdentifiers</i>	The list of only the identifiers of all available records, not the metadata. The corresponding <i>GetRecord</i> request URL is also exposed for each identifier

Fig. 1 – OAI-PMH verbs implemented by the repository.

OAI Record: oai:www.archcalc.cnr.it/oai/arc_oaipmh2.php:816

OAI Record Header

OAI Identifier: oai:www.archcalc.cnr.it/oai/arc_oaipmh2.php:816 [oai_dc/](#) [formats](#)

Datestamp: 2011-04-29

setSpec: S.A. [Identifiers](#) [Records](#)

setSpec: openaire [Identifiers](#) [Records](#)

Simple Dublin Core Metadata (dc)

Title: Dati culturaltha.it, un progetto pilota dedicato ai dati aperti e a Linked Open Data

Author or Creator: D. Giorgio, Sara

Right Management: info:eu-repo/semantics/openAccess

Right Management: <https://creativecommons.org/licenses/by-nc-nd/4.0/>

Other Contributor: Serforan, Mirella

Other Contributor: Leoni, Giorgia

Abstract: The pilot project dati.culturaltha.it started in 2011 to build up a Linked Open Data (LOD) Service that will progressively make available open data sets from the web-portal Culturaltha, the Italian national aggregator for European. The application, online since 2011 (<http://dati.culturaltha.it/>), was designed to allow the resources aggregated by Culturaltha to be available into large semantic networks after exposing, sharing and connecting data according to LOD principles. Culturaltha is the Portal of Italian Culture managed by the Istituto Centrale per il Catalogo Unico (ICCU), in which are involved cultural institutions - museums, archives and libraries - from national, regional and local levels. Metadata aggregated by Culturaltha, encoded according to the XML schema POCO Dublin Core Application Profile (PCO APL), were mapped into two different RDF schemas: the European Data Model (EDM) and the CIDOC Conceptual Reference Model (CIDOC-CRM). In particular, the OWL implementation named Erlangen CRM was chosen for implementing the mapping. RDF triples mapped into Erlangen CRM were then enriched with links to URIs identifying instances of internationally established RDF resources for geographic names and authority files for personal and corporate names, such as GeoNames and Virtual International Authority File (VIAF).

Date: 2011

Language: ita

Resource Type: info:eu-repo/semantics/bookPart

Resource Type: info:eu-repo/semantics/publishedVersion

Publisher: CNR - Istituto di Scienze del Patrimonio Culturale

Publisher: Edizioni All'Insegna del Gallo

Resource Identifier: http://www.archcalc.cnr.it/supplements/01_sup.php?id=oss:http://www.archcalc.cnr.it/supplements/A_C_oss_Archive_sup.xml:816

Resource Identifier: http://www.archcalc.cnr.it/index/Suppl_7.11_Db%20Governo.pdf

Format: application/pdf

Source: Archeologia e Calcolatori, Supplemento 7. Il SITAR nella Rete della ricerca italiana. Verso la conoscenza archeologica condivisa. Atti del III Convegno (Roma, Museo Nazionale Romano, 23-24 maggio 2013)

Source: ISSN: 2185-202X

Source: ISBN: 9788878146259

Subject and Keywords: <http://id.loc.gov/authorities/subjects/sh5006507>

Subject and Keywords: <http://id.loc.gov/authorities/subjects/sh89003285>

Subject and Keywords: Multimedia and web tools

Subject and Keywords: Cultural Resource Management

Fig. 2 – Example record from «Archeologia e Calcolatori»’s repository.

et al. 2004). Therefore, the repository implements the ‘until’ and ‘from’ parameters defined by the protocol to enable this process. Fig. 2 shows an example record from the repository, in its presentation as an HTML page on the web.

In the transition from the static XML file to the repository, there was a problem to be solved to ensure that compatibility with the previous system was preserved. In fact, the repository includes – in the metadata for each

record – a URL to directly retrieve the related full text in PDF format. The full texts are hosted on «Archeologia e Calcolatori»'s website, and the URL schema that the website uses to visualize metadata on a web page depends on the record's ID in the static XML. However, when data was transferred to the relational database, the IDs of individual records changed and – in general – were no longer aligned with the XML. Therefore, a new column was added to the database table for article records to create a 'mapping' between old and new IDs. This was then used to generate the correct PDF URL for each record in the repository.

N.P.

2.3 Aligning «Archeologia e Calcolatori» metadata to the OpenAIRE Guidelines

While the static XML files already served the records' integration by aggregators such as *CulturaItalia*⁵ (PIERGROSSI, ROSSI 2019) and *Europeana*⁶ (CARVALE, PIERGROSSI, ROSSI in print)⁷, the restructuring of «Archeologia e Calcolatori»'s repository was an opportunity to reconsider the description of the journal's resources metadata for their aggregation by other service providers, in particular by OpenAIRE (BAGLIONI *et al.* 2019). This task was facilitated by the fact that all resources were already described according to the Dublin Core Metadata Initiative (DCMI) specifications⁸, being *oai_dc* the metadata format also required by OpenAIRE.

The alignment process to the *OpenAIRE Guidelines for Literature Repositories v3*⁹, the latest operative version by summer 2020, consisted in the addition of a few metadata to «Archeologia e Calcolatori» records and in the mapping of domain-relevant attributes to standard vocabularies and encoding rules (see Fig. 3).

Compared to the previous DCMI elements set (see BARCHESI 2005, Tab. 1), the repository records were basically enriched by two `dc:rights` for the Access Level and the License Condition, and two `dc:type` for the Publication Type and the Publication Version. Further elements were added or multiplied in order to provide the most complete description of the

⁵ http://www.culturaitalia.it/opencms/opencms/system/modules/culturaitalia/templates/ricerca.jsp?searchType=&submitButton=&language=it&cat=indice&facetUnlimited=categoria_3_facet&facetUnlimited=categoria_2_facet&searchMode=on&q=archeologia+e+calcolatori&__meta_descSource_1_facet=Archeologia+e+Calcolatori.

⁶ <https://classic.europeana.eu/portal/it/search?q=istituto+di+scienze+del+patrimonio+culturale>; http://www.culturaitalia.it/opencms/it/contenuti/focus/Europeana_Archaeology__risorse_digitali_accessibili_e_riutilizzabili_sul_patrimonio_archeologico.html?language=it&tematica=Tipologia&selected=2.

⁷ The abstract of the paper, given at the Archaeofoss 2020 conference, is available in BOGDANI *et al.* 2020.

⁸ <https://www.dublincore.org/specifications/dublin-core/dcmi-terms/>.

⁹ https://guidelines.openaire.eu/en/latest/literature/index_guidelines-lit_v3.html.

```

<record>
  <header>
    <identifier>oai:www.archcalc.cnr.it/oai/aec_oaipmh2.php:1120</identifier>
    <timestamp>2021-04-29</timestamp>
    <setSpec>J:A</setSpec>
    <setSpec>openaire</setSpec>
  </header>
  <metadata>
    <oai_dc:dc xmlns:oai_dc="http://www.openarchives.org/OAI/2.0/oai_dc/"
      xmlns:dc="http://purl.org/dc/elements/1.1/"
      xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
      xsi:schemaLocation="http://www.openarchives.org/OAI/2.0/oai_dc/
        http://www.openarchives.org/OAI/2.0/oai_dc.xsd">
      <dc:title>
        Use and reuse of spatial and quantitative data in archaeology: from 3D survey to serious
        game at Phaistos (Crete)
      </dc:title>
      <dc:creator>Buscemi, Francesca</dc:creator>
      <dc:creator>Militello, Pietro Maria</dc:creator>
      <dc:creator>Santagati, Cettina</dc:creator>
      <dc:creator>Figuera, Marianna</dc:creator>
      <dc:creator>D'Agostino, Graziana</dc:creator>
      <dc:creator>AIELLO, Damiano Antonino Angelo</dc:creator>
      <dc:rights>info:eu-repo/semantics/openAccess</dc:rights>
      <dc:rights>https://creativecommons.org/licenses/by-nc-nd/4.0/</dc:rights>
      <dc:description>
        The article presents the results of a wider research carried out by a multidisciplinary
        group (archaeologists and engineers) of the University and the CNR-ISPC of Catania
        in the South-Western Quarter of the Minoan Palace of Phaistos (Crete).
        The article focuses on two digital survey campaigns carried out respectively in 2014,
        laser scanning, and 2019, Structure from Motion. Starting from the point cloud by
        laser scanner, the most recent, low cost and user-friendly photogrammetric tools
        (GoPro camera and software Agisoft Metashape) have been used during the 2019 campaign
        in order to update and to improve the previous dataset, which was used as a grid for
        georeferencing and scaling the new virtual model. Special attention was addressed to the
        comparison of the two datasets and to the reuse of the first one for georeferencing
        and scaling the second one. Furthermore, the research has been focused on the opportunity
        to exploit the obtained virtual model both for scientific purposes and for the outreach.
        The lack of accessibility of the South-Western Quarter of Phaistos Palace to the visitors
        attributes a special interest to this output. The virtual environment thus realized
        constituted an ideal starting point for the development of an educational fruition project
        based on a Serious Game approach. The cooperation of archaeologists and engineers in the
        development of the Phaistos game ensures a gaming experience not only pleasant but also
        provided with a strong educational profile.
      </dc:description>
      <dc:date>2020</dc:date>
      <dc:language>eng</dc:language>
      <dc:type>info:eu-repo/semantics/article</dc:type>
      <dc:type>info:eu-repo/semantics/publishedVersion</dc:type>
      <dc:publisher>CNR - Istituto di Scienze del Patrimonio Culturale</dc:publisher>
      <dc:publisher>Edizioni All'Insegna del Giglio</dc:publisher>
      <dc:identifier>
        http://www.archcalc.cnr.it/journal/id.php?id=oai:www.archcalc.cnr.it/journal/A_C_oai_Archive.xml:1120
      </dc:identifier>
      <dc:identifier>Info:doi:10.19282/ac.31.1.2020.09</dc:identifier>
      <dc:identifier>
        http://www.archcalc.cnr.it/indice/PDF31.1/09_Buscemi_et_al.pdf
      </dc:identifier>
      <dc:format>application/pdf</dc:format>
      <dc:source>Archeologia e Calcolatori 31.1</dc:source>
      <dc:source>ISSN: 1120-6861</dc:source>
      <dc:subject>http://id.loc.gov/authorities/subjects/sh85006507</dc:subject>
      <dc:subject>http://id.loc.gov/authorities/subjects/sh89003285</dc:subject>
      <dc:subject>Virtual Reality and 3D Modelling</dc:subject>
      <dc:subject>Survey and excavations</dc:subject>
    </oai_dc:dc>
  </metadata>
</record>

```

Fig. 3 – XML record from «Archeologia e Calcolatori»'s repository, compliant with the *OpenAIRE Guidelines for Literature Repositories v3*.

publication record, such as `dc:contributor` to recognise the role of the editors of the Supplements' volumes¹⁰. This goes in the same direction as the request of DOIs for the monographic issues of the journal («Archeologia e Calcolatori. Supplements» series; see PIERGROSSI, ROSSI 2019), because of the relevance of acknowledging curatorship of books in the Humanities and Social Sciences. Moreover, the `dc:relation` element for the description of the Project Identifier was implemented to capture and transmit to OpenAIRE information regarding relevant funding leading to the publication described. The `dc:relation` element for the Dataset Reference was also added to link the publication with underlying research data¹¹.

Further optional or recommended metadata listed in the OpenAIRE Guidelines are not applicable, e.g., the Embargo End Date (because the journal's publications have no embargo), or are not applicable yet, e.g. the Publication Reference and the Coverage, but might be implemented in the future, especially as the journal is planning to provide HTML versions of the articles on its website. Moreover, interesting results already achieved in the annotation of information contained in the articles full texts can be extracted and further exploited to this purpose (e.g. spatial annotation: see CANTONE, CARVALE 2019).

Some metadata were aligned to the terms of the standard vocabularies in use by OpenAIRE, i.e. the *info:eu-repo* vocabularies for Access Level, Publication Type and Publication Version¹², the IANA MIME Types list¹³ for Format, the ISO 639-3¹⁴ for Language. The two main disciplinary fields of the journal are described in `dc:subject` elements, according to the Library of Congress Subject Headings¹⁵ (LCSH) vocabulary, which is one of the encoding schemes maintained by the DCMI¹⁶. Thus, Archaeology¹⁷ and Computer Science¹⁸ add to the domain-specific concepts that had been classified based on the journals' interests. These describe both the archaeological field and the IT application field the resource is concerned with (see MOSCATI 1999 and more recently CARVALE, CECCARELLI 2019).

¹⁰ The example above lacks this element because it is taken from the Journal Articles set.

¹¹ The issue of preserving and linking digital data in archaeology is topical; see recently RICHARDS *et al.* 2021, with references, and the «Journal of Open Archaeology Data» as an example of this data-centric approach in digital publishing.

¹² <https://wiki.surfnet.nl/display/standards/info-eu-repo>.

¹³ <http://www.iana.org/assignments/media-types/media-types.xhtml>.

¹⁴ <https://iso639-3.sil.org/>.

¹⁵ <https://id.loc.gov/authorities/subjects.html>.

¹⁶ <https://www.dublincore.org/specifications/dublin-core/dcmi-terms/#http://purl.org/dc/terms/LCSH>.

¹⁷ <https://id.loc.gov/authorities/subjects/sh85006507.html>.

¹⁸ <https://id.loc.gov/authorities/subjects/sh89003285.html>.

2.4 «Archeologia e Calcolatori» as an OpenAIRE data provider: contributions to the disciplinary community

After positive compatibility tests of the repository on the Provide Dashboard¹⁹ (Fig. 4) and registration as an OpenAIRE data provider, by summer 2020 «Archeologia e Calcolatori» landed on OpenAIRE Explore with nearly a thousand resources of scientific literature²⁰. In agreement with the OpenAIRE support staff, the records metadata were soon added with links to the full texts of the articles in a `dc:identifier` element to allow OpenAIRE to access the resources for text mining, in order to enable their full services (i.e. extracting bibliographic references, project information and links to other resources, computing subject classifications, etc.).

Finally, «Archeologia e Calcolatori» was integrated within the OpenAIRE *Digital Humanities and Cultural Heritage* (DHCH) community²¹, adding its nearly 971 open-access articles, in addition to 111 metadata-only records corresponding to the articles of older issues, whose full texts are in the process of being uploaded²².

The research domain of IT applications to archaeology and cultural heritage is well represented in OpenAIRE²³. The DHCH community aggregates contents from journals such as «Internet Archaeology» (709 OA publications), «Journal on Computing and Cultural Heritage» (91 OA and 175 restricted-access publications), «Frontiers in Digital Humanities» (89 OA publications), and «Digital Applications in Archaeology and Cultural Heritage» (38 OA, 111 restricted- and 1 embargoed-access publications)²⁴.

Other journals are indexed in OpenAIRE but are not currently listed as content providers in the DHCH community, though it aggregates a good number of their articles: «Virtual Archaeology Review», contributing 398 OA publications²⁵, and «Studies in Digital Heritage», with its 86 OA publications²⁶, in particular, represent the OA diamond publishing model in this research domain together with «Archeologia e Calcolatori».

¹⁹ <https://provide.openaire.eu/>.

²⁰ https://explore.openaire.eu/search/dataprovider?datasourceId=openaire____:f3a35cc23d629e74e8d5fe0d8bca1684.

²¹ https://dh-ch.openaire.eu/search/dataprovider?datasourceId=openaire____:f3a35cc23d629e74e8d5fe0d8bca1684.

²² The numbers reported in this article date to June 2021.

²³ For an up-to-date overview of the journals operating in this sector, see MOSCATI 2019b, 23-25.

²⁴ Their respective webpages in the DHCH Community can be accessed from the list of content providers (<https://dh-ch.openaire.eu/search/find/dataproviders?size=50>).

²⁵ <https://explore.openaire.eu/search/dataprovider?datasourceId=doajarticles::1ccd0d954512fbc65588259717859622>.

²⁶ <https://explore.openaire.eu/search/dataprovider?datasourceId=doajarticles::b9f0f74d7ce28ff8a491b08bd682635>.

Due to «Archeologia e Calcolatori»'s long-standing adhesion to the OAI, the journal has opted for directly providing contents to OpenAIRE via its own repository, despite being indexed in DOAJ. This ensures immediate updatability, because when a new indexing is launched by OpenAIRE, the added or modified records of the database, exposed in the repository with a new datestamp, are automatically ingested by OpenAIRE by means of incremental harvesting. Moreover, the flexibility derived by the autonomous management of an OAI-PMH repository allows the journal to experiment with new solutions for the enhancement of descriptive metadata, as we will exemplify below.

2.5 Latest updates: enriching metadata

After several months of content provision to OpenAIRE, we were told by the OpenAIRE staff that the *Guidelines for Literature Repository Managers v4*³⁰ had become operational. With a view to keeping pace with the progress of research infrastructures, we are implementing the provision of literature records also according to these latest Guidelines, which require the use of two richer metadata formats: *oai_datacite* and *oai_openaire*³¹. Those schemas allow encoding references to vocabularies and authoritative lists as attributes of the elements.

For instance, annotation of the authors' information can be enriched with references to registries of people such as ORCID, encoded in the sub-properties of `datacite:creator`, e.g.:

```
<datacite:creators>
  <datacite:creator>
    <datacite:creatorName>
      Buscemi, Francesca
    </datacite:creatorName>
    <datacite:affiliation>
      Istituto di Scienze del
      Patrimonio Culturale - CNR
    </datacite:affiliation>
    <datacite:nameIdentifier nameIdentifierScheme=
      "ORCID" schemeURI="http://orcid.org">
      0000-0003-4886-656X
    </datacite:nameIdentifier>
  </datacite:creator>
</datacite:creators>.
```

³⁰ <https://openaire-guidelines-for-literature-repository-managers.readthedocs.io/en/v4.0.0/>.

³¹ The repository will continue providing records in the *oai_dc* format, since it is a basic requirement for a repository to be a valid OAI-PMH data provider and allows interoperability with a larger set of initiatives.

Terms of the COAR vocabularies (<https://vocabularies.coar-repositories.org/>) are referred to describe the genre of the resource, e.g.:

```
<oire:resourceType resourceTypeGeneral="literature"
uri="http://purl.org/coar/resource_type/c_6501">journal
article</oire:resourceType>
```

and to provide information on its accessibility, e.g.:

```
<datacite:rights rightsURI="http://purl.org/coar/
access_right/c_abf2">open access</datacite:rights>.
```

A further advantage is the possibility of encoding the type of resource version, that is its status in the publication process, e.g.:

```
<oire:version uri="http://purl.org/coar/version/
c_970fb48d4fbd8a85">VoR</oire:version>
```

and the location of the file of the resource, with declaration of the associated rights, e.g.:

```
<oire:file accessRightsURI="http://purl.org/coar/access_
right/c_abf2" mimeType="application/pdf" objectType=
"fulltext">http://www.archcalc.cnr.it/indice/
PDF31.1/09_Buscemi_et_al.pdf</oire:file>.
```

The upgrade of the journal's repository to the latest Guidelines will prove especially relevant as archives of different resource types and datasets of varied contents are getting more and more interconnected. Even within the journal's own archive, the richer semantics of some elements, such as the `datacite:relatedIdentifier`, allow for a more accurate description of the relations among the bibliographic resources (articles, volumes, series), and between the latter and additional digital objects, as described in the next section of this article. These updates to the repository will of course leverage the automatic generation of XML records from the database detailed above.

I.R.

3. BEYOND LITERATURE: OPEN ACCESS TO JOURNALS' NON-TEXTUAL CONTENTS

3.1 *Open visual resources and metadata*

During the restructuring process of the database and the repository, «Archeologia e Calcolatori»'s editorial board decided to take advantage of the customisation possibilities of its own archival system to enhance not only the journal's textual resources, but also its non-textual digital contents. The objective was manifold.

Firstly, in the wake of «Archeologia e Calcolatori»'s contribution to the studies on digital and multimedia publishing in the archaeological domain

since the journal's earliest issues³², the aim was to facilitate the reader in the web fruition of the articles' visual content, which is instrumental in supporting the understanding of the archaeological and technological topics discussed. In addition to the still images corresponding to the articles' figures, other kinds of visual resources described in the publications are taken into consideration, such as the 3D models.

Secondly, the ideals informing the journal's policies called for the extension of the FAIR approach to those digital objects, not only allowing their full-size download and reuse, but also providing their description. This means considering the visual objects not just as supplementary materials embedded or attached to a publication's full text, but as independent resources, to be exposed as standalone metadata records in an archive for harvesting, while preserving the indissoluble relation with the literature sources which they belong to. As such, those visual resources, including photographs but also charts, drawings, etc., were to be assigned descriptive metadata, in order to foster discoverability of cultural and scientific contents.

The flexibility of the journal's archival system allowed to fulfil the above-mentioned requirements by simply extending the current database model and repository sets and implementing the website to present the visual resources in dedicated web pages, thus guaranteeing a comprehensive approach to the scientific product.

I.R.

3.2 Database extension and presentation on the website

To implement the new requirements for visual resources, as mentioned above, some specific changes to the database were needed. First, a conceptual model was drafted to integrate the new entities within the existing schema, creating an appropriate correspondence between metadata and database columns. The model defines two new entities, two one-to-many relationships and three many-to-many relationships (Fig. 5).

The entities represent data pertaining to images and 3D models, while the relationships are needed to properly refer each image and 3D model to their respective article and authors, and to reflect the interrelation between the visual resources themselves³³. In addition to information needed to expose metadata, the database tables contain values related to the presentation of

³² See the list of about 120 publications, retrievable through a search on the archive's content by the 'Multimedia and web tools' classification heading (<http://www.archcalc.cnr.it/pages/search.php>), spanning from the earliest volumes of the journal until the most recent study on the evolution of electronic publishing in the archaeological research from 1955 until today, by FROMAGEOT-LANIEPCE (2019).

³³ An image – as a figure within an article – can picture one or more 3D models. A 3D model can be source of several images.

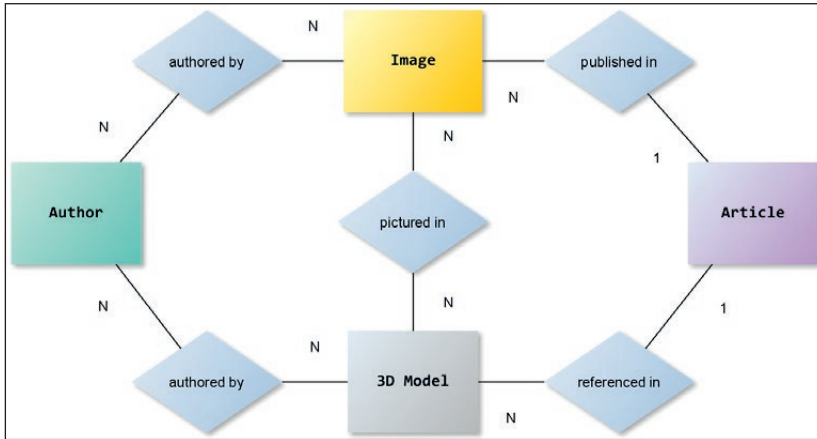


Fig. 5 – «Archeologia e Calcolatori» Entity-Relationship model for visual resources in the database.

the visual resources on the journal's website. To accomplish this goal, specific adaptations of the website were required, so that images and 3D models could be presented through dedicated web pages, showing both metadata in a human-readable format and media previews, along with direct file downloads (where possible).

3.3 Images

Virtually every article in «Archeologia e Calcolatori» contains several figures, many of which can be of general interest in their own right, as they reflect a substantial part of the authors' work. Therefore, an appropriate presentation of these resources on the website was deemed necessary. A preliminary step in this direction was the adaptation of the existing web page presenting metadata of individual articles to include information on related images and 3D models, where applicable.

These additions required changes to the way this dynamic page is generated on the website. In fact, this was previously accomplished by extracting metadata from the static XML file generated for the OAI gateway, as mentioned in paragraph 2.1. However, this approach was not suitable to represent relational data, since images and 3D models are separated entities, connected to the articles via relationships. Therefore, the dynamic generation of article pages was updated to retrieve all data, including relations, from the new database, and display them according to a modified template.

For the sake of example, we chose the article BUSCEMI *et al.* 2020, published in «Archeologia e Calcolatori» 31.1, as a case study to show the



Archeologia e Calcolatori

CNR - DIPARTIMENTO SCIENZE UMANE E SOCIALI - PATRIMONIO CULTURALE
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 JOURNAL ESTABLISHED BY: Mauro Cristofari and Riccardo Franzosini - EDITOR: Paola Moscati

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Authors	Buscemi F., Miletto P., Santagati C., Figuera M., D'Agostina G., Aiello D.
Title	Use and reuse of spatial and quantitative data in archaeology from 3D survey to serious game at Phaistos (Crete)
Volume	Archeologia e Calcolatori 31.1
Year	2023
Pages	199-212
DOI	https://doi.org/10.19282/ae.31.1.2020.09
Full text	PDF
Publisher	CNR - Istituto di Scienze del Patrimonio Culturale
Publisher	Edizioni All'Insegna del Gallo
Subject	Virtual Reality and 3D Modelling
Subject	Survey and excavations
Abstract	The article presents the results of a wider research carried out by a multidisciplinary group (archaeologists and engineers) of the University and the CNR-ISPC of Catania in the South-Western Quarter of the Minoan Palace at Phaistos (Crete). The article focuses on two digital survey campaigns carried out respectively in 2024, laser scanning, and 2019, Structure from Motion. Starting from the point cloud by laser scanner, the most recent, low cost and user-friendly photogrammetric tools (Globe camera and software Agisoft Metashape) have been used during the 2019 campaign in order to update and to improve the previous dataset, which was used as a grid for georeferencing and scaling the new virtual model. Special attention was addressed to the comparison of the two datasets and to the reuse of the first one for georeferencing and scaling the second one. Furthermore, the research has been focused on the opportunity to exploit the obtained virtual model both for scientific purposes and for the outreach. The lack of accessibility of the South-Western Quarter of Phaistos Palace to the visitors attributes a specific interest to this output. The virtual environment thus realized constituted an ideal starting point for the development of an educational fruition project based on a Serious Game approach. The cooperation of archaeologists and engineers in the development of the Phaistos game ensures a gaming experience not only pleasant but also provided with a strong educational profile.
Language	English
License	CC BY-NC-ND 4.0
Related images	
Related 3D models	
Q&A-PHM Record	http://www.archaeol.com/it/naiaaeq_sagpmh2.php?1120

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Automatic Zoom

of outreach among scholars has grown considerably with the widespread implementation of new tools provided by digital technology. The second is how the digital revolution has driven new quality standards in terms of surveying and post-excavation activity, as well as the recording of discoveries and information in active databases.

While the development of highly accessible tools and software has undoubtedly facilitated progress and change, new challenges have arisen regarding first of all the efficiency and reliability of acquired data, and of the resulting communicated information. This is especially true for prolonged excavations involving even several generations of archaeologists. A new archaeological project may well be planned from the onset according to a clear and organic strategy (from survey through to excavation and data storage up to communication), but sites that have been subject to excavation for a century or more suffer certain intrinsic difficulties. These include inconsistent and possibly unpublished documents, drawings and photographs that do not meet current standards, missing and unrecoverable data, and established narratives that stubbornly resist re-evaluation (MILETTO 2019).

With these provisos in mind, a 2014 project centred on the Phaistos Palace was submitted to the Greek Ministry of Culture (CARINCI, MILETTO 2015) by the Universities of Catania and Venice. The "Beyond the Palace" project called for new soundings aiming at clarifying the relationship between the Palace and surrounding houses, as well as three further lines of research: the reorganization of all preceding documentation, and the digitization and

<p>Editorial address: "Archeologia e Calcolatori", IIS - Istituto di Scienze del Patrimonio Culturale del CNR, (Sede di Roma), Via Salaria Km 29,300 c.a. 10 - 00156 Montebellano (Roma) - Italy Tel. +39 06 90572402 / 79027127 E-mail: redazione.aac@ispc.cnr.it</p>	<p>Software ISPC: Edizioni All'Insegna del Gallo s.r.l., Via Aringo Bello 50/52, 50019 Sesto Fiorentino (FI) - ITALY Tel. +39 055 4543675 E-mail: redazione@insegnaalgallo.it</p>	<p>Publishers and Distribution: Edizioni All'Insegna del Gallo s.r.l., Via Aringo Bello 50/52, 50019 Sesto Fiorentino (FI) - ITALY Tel. +39 055 4543675 E-mail: redazione@insegnaalgallo.it</p>
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Fig. 6 – New web page for the presentation of «Archeologia e Calcolatori»'s article data.

results of these adaptations (the same article used for the example records in section 2). The article contains 11 figures, which were all uploaded to the database with the corresponding metadata. It also references a 3D model, described in paragraph 3.4. The results are shown in Fig. 6.

A new field named 'Related figures' was added in the page, where the thumbnails of all related images are displayed in a row. The thumbnails are linked to the corresponding presentation page for each image. This page displays the resource's metadata, links to any related 3D models, and a preview of the image itself, which can also be downloaded in full resolution (Fig. 7).

The screenshot displays the website for 'Archeologia e Calcolatori'. The header features the journal's logo and affiliation with the CNR Dipartimento Scienze Umane e Sociali, Patrimonio Culturale. The main content area shows an article titled 'Reverse modeling process of the amphora n. inv. F3479H12551 (from Level 1976, tax. 696)'. Below the article metadata, there is a 'Preview' section with three images of a 3D model of an amphora: a textured 3D view, a white wireframe, and a textured 2D image. The page also includes a sidebar with navigation links, a 'Software ISPC' section, and contact information for the editorial office and publishers.

Fig. 7 – Presentation of image data in «Archeologia e Calcolatori»'s website (BUSCEMI *et al.* 2020, fig. 9).

3.4 3D models

The integration of 3D models in «Archeologia e Calcolatori»'s website is perhaps the most interesting aspect of the restructuring related to visual resources.

Some journals in the domain of digital technologies and archaeology have been doing this using different solutions. For example, «Digital Applications in Archaeology and Cultural Heritage»³⁴ provides previews of images and videos of 3D models, and allows downloading high resolution images and 3D files, along with supplementary materials. The pioneering «Internet Archaeology»³⁵, instead, in addition to image galleries with full previews, also displays interactive previews of 3D models, with an embedded web viewer (RICHARDS, WINTERS 2015)³⁶. The Deutsches Archäologisches Institut (DAI) has developed a tool called DAI Journal Viewer through which article metadata and figures are provided in a contextual presentation along with

³⁴ <https://www.journals.elsevier.com/digital-applications-in-archaeology-and-cultural-heritage/>.

³⁵ <https://www.intarch.ac.uk/>.

³⁶ See also the presentation 'Internet Archaeology – Open Access, Sharing Data' by the journal's editor Judith Winters at the colloquium *Actualité de l'Open Access en archéologie française* (23rd-24th of March 2017: <https://www.inrap.fr/internet-archaeology-open-access-sharing-data-13177>).

written text³⁷. 3D models can be viewed via links to an external interactive viewer, hosted on the institute's Arachne platform (<https://arachne.dainst.org/>). Other journals, such as «Open Archaeology»³⁸, rely on third party services – typically Sketchfab – to provide access to 3D models.

«Archeologia e Calcolatori»'s approach, in addition to web preview and downloads, also provides fully annotated and linked metadata for visual resources, including 3D models, which are therefore treated on the par with publications. To accomplish this, a suitable web 3D viewer was required, possibly with simple embedding and interactive features, and minimal impact in terms of changes to the underlying source code. The tool chosen as fitting for this purpose is the ATON 3.0 framework, developed and maintained within CNR-ISPC by Bruno Fanini³⁹.

ATON is an open-source, web-based software framework (distributed under the GPL-3.0 license) to build and deploy interactive and collaborative 3D applications targeting cultural heritage (FANINI *et al.* 2021). ATON's 3D rendering components run in any modern web browser, thus not requiring any additional installation from users.

The main service that deploys ATON web applications can be installed and configured on a self-managed server with a dedicated domain name. The 3D scenes processed and deployed by ATON – via its front-end – can be then embedded in any web page using an *iframe* HTML element, that the application can generate automatically. In «Archeologia e Calcolatori»'s case, a standalone instance of ATON was installed on a virtual machine hosted by the CNR, referenced by the domain aton.archcalc.cnr.it.

Since ATON assigns each 3D scene with a unique identifier, this can be used to automatically generate the URL that serves the scene itself (since the identifier is a parameter within the full URL). This mechanism was leveraged to dynamically extract from the database the ATON identifier related to each 3D model presented on «Archeologia e Calcolatori»'s website. Thus, the *iframe* embedded in the page renders the appropriate scene for the model itself based on the identifier. As in the case of images, the scene is included as an interactive preview in the web page, along with the model's metadata and related resources. The scene rendering employs a specific User Interface (UI) profile, that displays a set of interactive tools as buttons in a menu. The tools are: full screen mode, Virtual Reality mode, screenshot, measurement, and environment options. The result is shown in Fig. 8.

³⁷ <https://www.dainst.org/en/-/digital-publishing-award-2020-fur-archaologischen-anzeiger-und-dai-journal-viewer>.

³⁸ <https://www.degruyter.com/journal/key/OPAR/html>.

³⁹ <https://doi.org/10.5281/zenodo.4618387>.

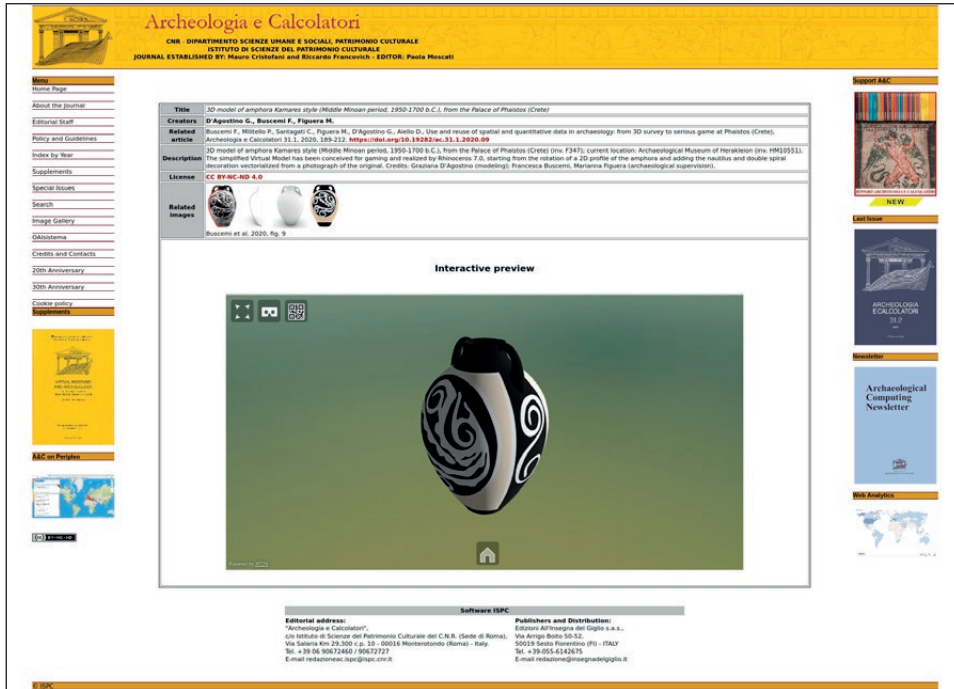


Fig. 8 – Web presentation of a 3D model, described in BUSCEMI *et al.* 2020.

In addition to visualization on the website, the models' files can be downloaded in GLTF or OBJ format, with a CC BY-NC-ND 4.0 (or less restrictive) license. The fact that «Archeologia e Calcolatori» provides this integrated access to resources – that is, full metadata annotation, media previews and downloads, all within the same user context – while also exposing direct links between related content, is perhaps its distinguishing factor compared to similar journals in the same domain.

N.P.

3.5 Repository implementation

As introduced in paragraph 3.1, a basic aspect of the valorisation of the visual resources is their description through interoperable metadata. Relevant images' and 3D models' information is stored in the respective tables of the database or can be inferred via the relationships between them. It comprises information on title, creator(s), bibliographic source (when the image is reused from a previous publication), publication date, publisher, description, identifiers, access rights, license condition, format, subjects, related «Archeologia

e Calcolatori»'s article, and related image(s) or 3D model(s) (for 3D model or Image records respectively).

It is beyond the current scope of the journal to encode technical (e.g. EXIF) metadata of the articles' images, all the more so as these do not solely or primarily consist of photographs, thus excluding, for instance, the thorough adoption of the IPCT Photo Metadata standard (<https://iptc.org/standards/photo-metadata/iptc-standard/>). As for the 3D models, relevant metadata can be embedded in the GLTF files that are available for fruition and download from the journal's website.

Descriptive metadata will be exposed in the journal's OAI-PMH repository to allow harvesting and reuse. In addition to the unqualified *oai_dc*, other formats are being considered for harvesting by aggregators of literature and cultural resources. The current implementation aims at compatibility with the *OpenAIRE Guidelines for Data Archives*⁴⁰, which adopt the DataCite Metadata Schema v3.1, with minor adjustments⁴¹. Image and 3D model records, identified via their URL, will feature some specific properties such as creator, title, size, format, rights, and description, and draw others from the related Article record, such as publisher, publicationYear, date, and the basic subjects list.

Providing the Image and 3D model records according to the *OpenAIRE Guidelines for Data Archives* allows their harvesting by OpenAIRE and mutual linking with the relevant literature records, also expressing the type of relation. In fact, the `datacite:relatedIdentifier` elements encode not only the machine-readable identifier of the connected resource, but also the semantics of this relation. For instance, referring to the case-study presented in this article, the record of the Image entitled 'Buscemi et al. 2020, fig. 9' can be related to the record of the article it belongs to, by a `relatedIdentifier` element having the attributes `relatedIdentifierType="DOI"` and `relationType="IsPartOf"`. Viceversa, the Article record (see paragraph 2.5) can be related to this and to the other Image records describing its figures through the same element, having the attributes `relatedIdentifierType="URL"` and `relationType="HasPart"`, and containing the relevant URL. The same applies to the relation between the Article and the 3D model records, having just a different `relationType` property, as the Article "Documents" the 3D model (and conversely the 3D model "IsDocumentedBy" the Article). An additional relation links the Image with any 3D model it is extracted from (`relationType="IsDerivedFrom"`), and conversely a 3D model with any Image deriving from it (`relationType="IsSourceOf"`).

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⁴⁰ <https://guidelines.openaire.eu/en/latest/data/index.html>.

⁴¹ https://guidelines.openaire.eu/en/latest/data/use_of_datacite.html; https://guidelines.openaire.eu/en/latest/data/application_profile.html.

4. «WE STILL HAVE THE FREEDOM TO EXPERIMENT»⁴²

From June 2020 to February 2021, a large-scale survey on scientific journals was carried out under the impulse of cOAlition S⁴³ to study the landscape of OA diamond journals (BOSMAN *et al.* 2021). Keeping the latter as a constant term of comparison, the initiative aimed at gaining a better understanding of the variety, scope, and impact of OA diamond journals in various disciplines and regions, of their compliance with Plan S requirements⁴⁴, of the operational challenges those journals face, and of their economic sustainability.

None of the three abovementioned OA diamond journals in the field of IT applications to archaeology and cultural heritage (see 2.4) was included in this survey. Nonetheless, the main results of this research appear to be compatible with our experience.

As an OA diamond journal, the editorial process and the implementation and maintenance of the digital assets and tools heavily depend on the voluntary commitment of its board and staff, referring only copy-editing, printing, and distribution of the paper journal to the commercial publisher (BOSMAN *et al.* 2021, 8, 90-91). OA diamond journals that are independent from publishing platforms are often tied to the legacy of their pioneering experience in terms of data management and digital tools, and have to face on their own the obsolescence of software and the evolving landscape of the best practices in scientific publishing. To achieve this goal, they need to constantly apply internal efforts, often aided by the support provided by the academic and research institutions they usually are a part of⁴⁵. At the same time, the autonomy of OA diamond journals grants them flexibility and the freedom to experiment, which journals bound to external platforms may not enjoy, so that the former appear to adapt to change more easily and even promote it (BOSMAN *et al.* 2021, 89).

By building an open-access archive of the textual and visual resources of a journal counting more than 30 years of publication, «Archeologia e Calcolatori» aims at providing the scientific community with a powerful tool in the research

⁴² BOSMAN *et al.* 2021, 89.

⁴³ <https://www.coalition-s.org/>.

⁴⁴ Relevant Plan S requirements for journals are: publishing content under Creative Commons licenses, with authors retaining copyright; a full Open Access model should be applied (no 'hybrid models'); no fees are required from authors and researchers (if applicable, any fees should be covered by funders and should be transparent). For more details, see <https://www.coalition-s.org/addendum-to-the-coalition-s-guidance-on-the-implementation-of-plan-s/principles-and-implementation/>.

⁴⁵ One of the recommendations to funders and infrastructures, based on the results of the abovementioned survey into the OA diamond landscape, is precisely to improve access to formatting tools and services for OA journals, such as those a number of infrastructures already provide, e.g. AmeliCA (<http://ameli.ca.org/>), PKP (<https://www.coalition-publi.ca/>), Metopes (<http://www.metopes.fr/>) and OpenEdition (<https://www.openedition.org/>), with its open-source publishing software Lodel (BECERRIL *et al.* 2021, 20). As a case study of the advantages of archaeological publishing on OpenEdition Journals, see RENAULT *et al.* 2020.

field of IT applications to archaeology, especially relevant for the study of the history of the discipline. The reader will benefit from the availability of full-size images and 3D models displayed in an embedded web viewer. In addition to this, «Archeologia e Calcolatori» follows a completely open and ‘linked’ approach, by providing interoperable metadata for all resources – both full annotations of individual records and their relations with other records – as well as contextual downloads of related files, thus facilitating reuse under the terms defined by the relevant Creative Commons licenses. Data provision to aggregators of scientific and cultural content ensures that the journal’s resources will be more and more interconnected and discoverable, thus feeding a virtuous cycle.

The CNR and its Institute of Heritage Science have been active players in e-infrastructures such as CLARIN⁴⁶, DARIAH⁴⁷, E-RIHS⁴⁸, OpenAIRE and, more recently, SSHOC⁴⁹, which will create the Social Sciences and Humanities area of the European Open Science Cloud (EOSC: HRUŠÁK *et al.* 2020)⁵⁰. Institutional support has been essential in sustaining «Archeologia e Calcolatori»’s ‘OA diamond’ approach through time, and in opening the way for its integration into this digital ecosystem. The engagement towards this publishing model will be even more fundamental as Open Science has been rapidly turning into reality, and the OA diamond paradigm has proved to be the fairest one, making research sharable for all, based on excellence alone, regardless of economic considerations, and preserving the freedom to experiment new ways to provide accessible resources.

I.R., N.P.

Acknowledgements

We would like to express our gratitude to Emma Lazzeri (CNR-ISTI) for facilitating «Archeologia e Calcolatori»’s approach to the OpenAIRE infrastructure, and the OpenAIRE staff, especially in the person of Amelie Christine Bäcker, for their kind and constant advice. We would also like to thank our colleagues Bruno Fanini, who supported us in the integration of ATON within «Archeologia e Calcolatori»’s website, and Francesca Buscemi, who kindly provided the 3D model used for testing the new features of «Archeologia e Calcolatori»’s database, repository and website. This research work has been supported by the CNR-ISPC project DSU.AD017.108 ‘Innovazione Patrimonio Culturale’.

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⁴⁶ <https://www.clarin.eu/>.

⁴⁷ <https://www.dariah.eu/>.

⁴⁸ <http://www.e-rihs.eu/>.

⁴⁹ <https://sshopencloud.eu/>.

⁵⁰ <https://eosc-portal.eu/>.

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ABSTRACT

Open Science best practices and policies have been increasingly promoted and adopted in Europe and worldwide to extend public availability of research data and publications, according to FAIR principles. In this context, the so-called 'Diamond Open Access' model is particularly relevant since it entails provision of scientific content entirely free of charge, both for authors and readers. The journal «Archeologia e Calcolatori» adopted this model at a very early stage, when – in 2005 – it started publishing online full-text PDFs and metadata of its articles according to recognised standards, as an Open Archives Initiative data provider. This paper addresses the evolution of «Archeologia e Calcolatori» in the context of scientific publishing in the disciplinary domain of IT applications to archaeology. It focuses on the updates of its OAI-PMH repository, which led to the journal's inclusion in OpenAIRE as a data provider, and on mapping its current position in the OA Diamond landscape. The paper also illustrates recent implementations of «Archeologia e Calcolatori»'s website to provide full access to visual and interactive resources, such as images and 3D models, related to its publications, and to relevant metadata, structured according to OpenAIRE's most recent guidelines. The combined, contextual provision of full texts, visual and interactive resources, and structured metadata – including full annotations and relations – turns out to be a pioneering publishing service in the domain of IT applications to archaeology.

