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Disclaimer

This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.
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Abbreviations

WP: Work package
M: Month
UNIPI: Università di Pisa
UoY: University of York
UB: Universitat de Barcelona
UCO: Universitaet zu Koeln
TAU: Tel Aviv University
CNR: Consiglio Nazionale delle Ricerche
INERA: Inera srl
BARAKA: Baraka Arqueologos S.L.

Elements: Elements centro de gestio i difusio de patrimoni cultural
Executive summary

This document includes an overview of the project results towards the objective of the action in line with the structure of the Annex 1 to the Grant Agreement during the first reporting period from 1st June 2017 to 31st May 2018.

The objectives of ArchAIDE are to support the work of archaeologists with innovative computer-based tools, able to provide the user with features for the semi-automatic description and matching of potsherds over the huge existing ceramic catalogues. Indeed, pottery classification is of fundamental importance for the comprehension and dating of the archaeological contexts, and for understanding production, trade flows and social interactions, but it requires complex skills and it is a very time consuming activity, both for researchers and professionals.

These objectives will be achieved through the development of:

- an as-automatic-as-possible procedure to transform the paper catalogues in a digital description, to be used as a data pool for search and retrieval process;
- a tool that will support archaeologists in recognising potsherds during excavation and post excavation analysis, through an easy-to-use interface and efficient algorithms for search and retrieval of the visual/geometrical correspondences;
- an automatic procedure to derive a complete potsherd’s identity card by transforming the data collected into a formatted electronic document, printable or visual;
- a web-based real-time data visualization to improve access to archaeological heritage and generate new understanding;
- an open archive to allow the archival and re-use of archaeological data, transforming them into common heritage and permitting economic sustainability.

Currently, the project has ended its first year. Work Packages 1, 5, 6, 7, 8, 9, and 10 are currently active. WP3 and 4 are ended on M18. During the second year special effort were dedicated to WP5, 6, 7 and 10. After the review meeting it was necessary to start an Amendment procedure in order to deal with some of the question emerged during the first year of the project. In fact, it has become evident that the quantity and quality of data requested by WP6 should be wider than estimated. This means that together with the digitisation of paper catalogues, whose acquisition was at an advanced stage, we needed to take more pictures of potsherds. On the other hand, the work for developing the appearance based similarity training in WP6, was more complex than expected, and appeared more useful to separate the appearance based recognition from the shape based one, developing two different algorithms. Consequently, archaeological partners has spent a lot of their effort in taking photograph of real pottery sherds for training the algorithms to be developed in WP6. Among the various tasks completed, we can mention the more than 10,000 images of Montelupo’ Majolica collected by UNIPI, the conclusion of the work on the typology of medieval and postmedieval pottery found in Barcelona by UB, the continuous efforts made by BARAKA and ELEMENTS in finding potsherds of amphorae and Terra Sigillata from different archaeological excavation, the organisation of a huge photocampaign in Magdalensberg (that will start on M25) by UCO. This great amount of work permitted the development of WP6. First of all, the work was split into two main efforts - classification by appearance (i.e. the decorations) and by shape. As for the appearance-based recognition, the work was dedicated in developing an algorithm based on combining classic machine learning tools with neural networks that were trained on general image classification tasks. Following a testing phase on a
huge dataset of images, D6.1 was delivered on December 30, 2017, and later integrated in the ArchAIDE app, and classification is now available to archaeologists. Testbeds carried out at the beginning of WP8 enlightened that (a) the performance of the classification differs with different lighting conditions, and this can be improved by simulating further lighting conditions while training the system; (b) the recognition achieves better accuracy on the “common” classes, compared to more “rare” classes, and this can be fixed by giving a weight to each input in the training, to simulate an equal number of inputs from each class. As for shape-based recognition, we designed a system to produce “synthetic sherds” (3D shapes available on the computer) for training the system, starting with the pottery profiles that are extracted from the catalogues, using the work of CNR as part of WP4. After being trained and test on Amphorae synthetic sherds we delivered D6.2. The delivered algorithm was based on a standard convolutional neural network (CNN). Since we were training on large numbers of classes, we experimented with curriculum training (gradually introducing more classes during the training process) and custom loss functions, to make the network converge. As expected, when we started testing the system with real archaeological sherds for the first time, the system did not operate right away on actual sherds. Furthermore, as we trained the network on the sherds generated from the profile drawings, the classification was not robust enough to handle small variations that can be observed in sherds observed in practice. Both problems are currently being addressed in the research carried out by TAU, and are guiding the research going forward. Anyway, the results achieved by WP6 permitted to start the integration of recognition tools into the ArchAIDE app in WP7. Starting from the analysis carried on by the archaeologists, we produced mock-ups and demos of the mobile app to be presented to the stakeholders and receive early feedback on the user-experience and usability. The rest of the time, until now, has been spent in the development of the app. The current version of the Android App was presented at the ArchAIDE Workshop in Bonn (May 25th, 2018). Currently, the process for appearance-based recognition is totally integrated in the mobile app, whereas the process for shape-based recognition is not completely integrated but it already permits the extraction of the profile from potsherds’ images. All the work done, the encountered difficulties, and the results achieved were communicated and disseminated organising workshops and training days in the UK, Italy, Germany, and participating in national and international conferences. A special attention was dedicated in the updating of our exploitation plan, whose first draft was released at the end of the first year of the project. First of all, according to the request in the Review Report, the Exploitation Manager has been moved from CNR to INERA. In fact, the exploitation management requires particular attention from the SMEs involved in the consortium. Then, a continuous analysis of the possible exploitation strategies (from the commercialization of the tools to the re-use of the technologies in different application domains and the commercialization of the mobile app, etc.) was carried on. The result of the preliminary work and a better understanding of the potential market led us to foresee a promising approach: a free ArchAIDE mobile app as a vehicle to commercialize digitised versions of the pottery catalogues establishing a business relation with the copyright owners. From this point of view, ArchAIDE provides another important proof of concept by showing the potential of digitising paper catalogues in a way that demonstrates how their content can be actively re-used, allows ArchAIDE to open a discussion with publishers and other data providers around.
1. **Explanation of the work carried out by the beneficiaries and Overview of the progress**

Currently, the project has ended its first year. Work Packages 1, 5, 6, 7, 8, 9, and 10 are currently active. WPs 3 and 4 are ended on M18. Work Packages 1, 9, and 10, which started at the beginning of the project and will last during all the project lifetime, will be described after the technical activities developed during the second year of the project.

WP3 was completed on month 18. During the last 6 months, UoY coordinated with INERA on the changes required to database design, in particular, additional features for recording of geographical places (origin + distribution), associated with chronology and fabric were introduced into new database design, as well as the guidelines for the translation of chronologies expressed as strings to numerical values. The creation of multilingual vocabulary mappings of pottery characteristics was carried out by UoY, UB, UNIPI and UCO, together with the contribution of ArchAIDE Associates and implemented into the database to allow interoperable search. Mappings are available in English, German, Catalan, Spanish, Italian and French, but the work continues under the auspices of WP10 to create additional mappings in Polish, Portuguese and Dutch: information being provided by new ArchAIDE Associates. New vocabularies (implemented as local controlled vocabularies only) were created to describe key characteristics of vessel shape (rim, neck, shoulder, handle, body and base). These do not correspond to any current concepts within AAT or other SKOS, so have been implemented as local controlled vocabularies only. INERA has completed building the
reference database as well as the implementation of the multilingual vocabulary functionality. A database front-end has been constructed, allowing users to add new catalogues and types by hand or via JSON import. This front-end also allows users to edit or delete existing records. Deliverable D3.1 Final release of the database implementation was submitted at M18.

Also, WP4 (Technologies for digitisation of catalogues) was completed on month 18. Different solutions for OCR have been analysed by CNR, UNIPI, and INERA, and Tesseract set of tools was selected for the implementation in the context of the interface for database population. Two different implementations (created with the support of INERA) of the OCR-based tool have been proposed, one for assisted data-entry and one for automatic data-entry. The OCR tools, have been released in the Deliverable 4.1 “Final Version of the digitization system”, and are integrated into the Database front-end on the project website. An automatic application that is able to analyse a scanned version of the drawing and save the information in the context of a .svg file, has been implemented. In addition, a 3D representation of the drawing is created automatically by taking into account also the axis of revolution (indicated in the drawings as well). The application is currently able to extract both the body and the handles, and integrate the subparts in a single, continuous 3D model. The development of the drawing extraction tool is currently integrated with the work of task 6.2 (in collaboration with TAU), that aims at creating an automatic classification system based on shapes. Both the .svg files and the 3D models are used in the creation and training of the classification system.

At present, WP5 Population of the Database is in its 16th month of work. The main goal of this work package is to populate the database using the technologies developed in WP4. Upon agreement on pottery classes (Amphorae, Terra Sigillata, Medieval and Postmedieval pottery) for feeding the database, the digitisation of catalogues, and especially the taking of pictures of pottery sherds for training the algorithms to be developed in WP6 were carried on. Lists of the relevant types have been created and stored on the intranet. In these lists, information on the type and the amount of photos and drawings are given. A mapping tool was specially geared (“hard-coded”) for the CERAMALEX database. Using this tool, all relevant information has been extracted from the CERAMALEX database, reorganised according to the reference database layout and exported to a JSON formatted file. The JSON file was imported by INERA for populating the reference database. The Mapping Tool was delivered as D5.1 on month 20.

The Achievement of Milestone 4 First release of the populated database ready to be used in the development of WPs7 and 8 on month 14, permitted the implementation of WP7 and the start of WP8.

At present, WP6 is in its 20th month of work. WP6 is focused on providing the recognition and classification algorithms for ArchAIDE to enable the automatic classification of archaeological findings. The work is split into two main efforts - classification by appearance (i.e. the decorations) and by shape. For both efforts, the final goal is to produce a classification system, capable of ranking the relevance of different classes (by shape or by appearance) to the sherd in question. The system will then retrieve the description of those classes and display them to the archaeologist, sorted by the predicted relevance, for the archaeologist to make the final decision. As for the appearance-based recognition, the algorithm is based on combining classic machine learning tools with neural networks that were trained on general image classification tasks. Following a testing phase on a huge dataset of images, D6.1 was delivered on December 30, 2017, later integrated in the ArchAIDE app, and classification is now available to archaeologists. Testbeds carried out at the beginning of WP8 enlightened that (a) the performance of the classification differs with different
lighting conditions, and this can be improved by simulating further lighting conditions while training the system; (b) the recognition achieves better accuracy on the “common” classes, compared to more “rare” classes, and this can be fixed by giving a weight to each input in the training, to simulate an equal number of inputs from each class. As for shape-based recognition, we designed a system to produce “synthetic sherds” (3D shapes available on the computer) for training the system, starting with the pottery profiles that are extracted from the catalogues, using the work of CNR as part of WP4. After being trained and test on Amphorae’s synthetic sherds we delivered D6.2. The delivered algorithm was based on a standard convolutional neural network (CNN). Since we were training on large numbers of classes, we experimented with curriculum training (gradually introducing more classes during the training process) and custom loss functions, to make the network converge. As expected, when we started testing the system with real archaeological sherds for the first time, the system did not operate right away on actual sherds, and still requires adjustments to properly classify actual sherds. Among the issues observed, we suspect that the scaling process which scales all sherds to have the same image size, is causing a loss of vital information, as scale is indeed being used to differentiate between certain classes of pottery. Furthermore, as we trained the network on the sherds generated from the profile drawings, the classification was not robust enough to handle small variations that can be observed in sherds observed in practice. Both problems are currently being addressed in the research carried out by TAU, and are guiding the research going forward.

The achievement of Milestone 5 First software release for pairwise similarity between ceramics on month 16, permitted to start the integration of recognition tools into the ArchAIDE app in WP7.

At present, WP7 is in its 16th month of work. The goal of this WP is to design and implement a fully functional prototype of the ArchAIDE Mobile App and a desktop application allowing final user to access all the data. During 2017 the activities were focused on the implementation of the back-office tools for data management and APIs supporting data access from external applications (i.e. mobile app and desktop app). The results of the design and implementation activities carried on in the first year of WP7 are to web-based applications: Reference Database and Result Database. The Reference Database is populated with ceramic types, decoration types, and stamps to be used by archaeologist to classify their findings. The Result Database is devoted to store the data produced by the ArchAIDE final users i.e. their findings. In the last part of 2017 and beginning 2018 the main activity was the requirement analysis and User Experience for the mobile application. Starting from the analysis carried on by the archaeologists in the project (Task 7.1) we produced mock-ups and demos of the mobile app to be presented to the stakeholders and receive early feedback on the user-experience and usability. The rest of the time, until now, has been spent in the development of the app.

The achievement of Milestone 6 First version of the application ready to be tested in the field on month 21, permitted the beginning of WP8.

At present, WP8 is in its 2nd month of work. The goal of this WP is to create two testbeds related to different applications scenarios. Up to now, the testbeds have been carried out by UNIPI and UB on appearance-based recognition showing promising results.

At present, WP1 is in its 24th month of work. The main activities carried out were related to guarantee the correct implementation of the overall management, monitoring the project activities and organising face-to-face and remote meeting. Part of the effort were dedicated to carry out the Amendment procedure that was especially needed for the extension of WP5 up to M28 and for separating the appearance based
recognition from the shape based one, developing two different algorithms in WP6.

WP9 is in its 24th month of work. During this second year of the project, the main objective has been to maintain the communication channels built in the first year and increase their contents. Activities focused to show the work in progress of the project, through its work phases and its team at work, to involve a wider audience and enlarge the network of Associates and possible stakeholders. This phase is preparatory for the final year when it will be possible to show and test the prototype of the Application. To increase the “visual communication”, a new structure and a new graphic have been given in the video section of the website, creating a “Video Blog”. The Associates' page has been optimised to permit a better communication with the Associates themselves, through a dedicated “Forum” section, and to increase their visibility through personalised pages where (optionally) personal information and contacts are visible.

WP10 is in its 24th month of work. A special attention has been given with regard to open licensing, intellectual property rights and exploitation. As the project has progressed, it has become evident that the comparative data necessary to the implementation of the ArchAIDE database and app must be derived from a variety of sources, each with different advantages and restrictions. From this point of view, ArchAIDE provides another important proof of concept by showing the potential of digitising paper catalogues in a way that demonstrates how their content can be actively re-used, and allows ArchAIDE to open a discussion with publishers and other data providers around. In addition, ArchAIDE partners have embarked on significant photography campaigns to create new comparative data, the copyright for which will be held by the relevant project partners. These partners will deposit the new comparative data with UoY for archiving and dissemination. This will result in new, digital comparative data that will be freely and openly available. Furthermore, the multilingual vocabularies developed will be published from the UoY SPARQL endpoint, but will also be made freely available for download for re-use in other Linked Open Data projects focussed on archaeological pottery.

A great effort has been dedicated to dissemination. Four of the five training open days were successfully implemented during the second year of the project, and dissemination activities were carried on at the following conferences: STAG 2017 (Catania), EAA (Maastricht), EMAC (Bordeaux), Eurographics (Graz), ICDAR (Kyoto), EVA/MINERVA (Jerusalem), GARR 2017 (Venice), Colloquium in Digital Cultural Heritage (Cologne), Archeologia Quo Vadis (Catania), Glaze technology in the Western Mediterranean (Valencia), TourismA (Florence), and 3rd International Conference on Best Practices in World Heritage (Menorca). Early release of both mobile and desktop applications has been presented and demonstrated to stakeholders in various dissemination events organized by the project in York, Pisa and Bonn.
Table 1: List of Deliverables. In green Deliverable achieved at the due date. In Yellow Deliverable submitted with delay.

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<td>Other</td>
<td>Confidential, only for members of the consortium (including the Commission Services)</td>
<td>(20) JAN.2018</td>
</tr>
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<td>-----</td>
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<tr>
<td>D1.7</td>
<td>Progress report 2</td>
<td>WP1</td>
<td>UNIPI</td>
<td>Report</td>
<td>Public</td>
<td>(24) MAY 2018</td>
</tr>
<tr>
<td>D6.3</td>
<td>Unified similarity kernel, including tools for results refinement and visualization (software)</td>
<td>WP6</td>
<td>TAU</td>
<td>Other</td>
<td>Confidential, only for members of the consortium (including the Commission Services)</td>
<td>(28) SEPT.2018</td>
</tr>
<tr>
<td>D7.1</td>
<td>Data analysis and visualisation component (software)</td>
<td>WP7</td>
<td>INERA srl</td>
<td>Other</td>
<td>Confidential, only for members of the consortium (including the Commission Services)</td>
<td>(28) SEPT.2018</td>
</tr>
<tr>
<td>D7.2</td>
<td>Release of the final version of the mobile app (software) and the desktop front-end (software)</td>
<td>WP7</td>
<td>INERA srl</td>
<td>Other</td>
<td>Public</td>
<td>(32) JAN.2019</td>
</tr>
<tr>
<td>D10.3</td>
<td>Dissemination kit (final release)</td>
<td>WP10</td>
<td>UoY</td>
<td>Websites, patents filling, etc.</td>
<td>Public</td>
<td>(32) JAN.2019</td>
</tr>
<tr>
<td>D10.4</td>
<td>Web APIs for REST services</td>
<td>WP10</td>
<td>UoY</td>
<td>Other</td>
<td>Public</td>
<td>(32) JAN.2019</td>
</tr>
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<td>D9.3</td>
<td>Promotional video</td>
<td>WP9</td>
<td>UNIPI</td>
<td>Websites, patents filling, etc.</td>
<td>Public</td>
<td>(33) FEB.2019</td>
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</table>
1.1 Objectives

List the specific objectives for the project as described in section 1.1 of the DoA and described the work carried out during the reporting period towards the achievement of each listed objective. Provide clear and measurable details.

<table>
<thead>
<tr>
<th>Objective</th>
<th>Completion Criteria</th>
<th>Work carried out during the reporting period</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Enable scalable and cost-effective documentation of archaeological findings.</td>
<td>The demonstration of a hardware and software system prototype capable to quickly and semi-automatically acquire shape characteristics of archaeological findings (focusing on small scale artefacts and based on digital photography). Documentation will include text and visual representations and the production of drawings. The system front-end will run on a mobile device, to ensure easy use on-site.</td>
<td>During the second year of the project the work carried out in WP7 was focused on the mobile tools to be provided to final users. Particular attention was devoted to the integration of digital photography manipulation tools produced by CNR in Task 7.2. In particular, the first beta version of the mobile app, released in M21, now includes tools for: rotation, cropping, white balancing, scale definition and profile sketching. The images and information produced by the users thought the mentioned tools may be stored in the user database and eventually exported in various formats. M21 (early release) M32 (final release)</td>
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<tr>
<td>2. Enable digitization of current catalogues (by automatic processes), including the conversion from raster to digital conceptual models of the artefact classes defined in the catalogues.</td>
<td>The demonstration of a system prototype for the digitization of the catalogue and the production of conceptual models of the classes defined. This is a data acquisition campaign, which has to be completed in an early phase of the project (but requires some algorithmic design and implementation).</td>
<td>The work, in the second year of the project, was spent for the major part in finalising the digitisation tool, taking in account all the suggestions and improvements arisen during the initial testing. The tools have then been made usable for the data entry: the OCR Tools have been integrated in the Database frontend, and the drawing digitization tool now has a batch processing mode. The tools have been used to digitize the input catalogues chosen by the project. M16 (final release) M18 (evaluation)</td>
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<td>3. Enable on-the-field support to the archaeologist in the interpretation phase.</td>
<td>The demonstration of an enhanced version of the system running on mobile platforms, which will include also the component supporting the interpretation phase. Instruments for supporting the professional in the visual analysis of the finding, proposing possible matches (based on a search for shape-similarity run over a remote server storing the digital catalogue of classes, produced in Obj. 2).</td>
<td>The second year of the project the activities of WP7 was focused on the design of the mobile app sharing mock-up and early releases (since December 2017) within the project and with participants to the dissemination workshops. At the end of the second year was released the first beta version of the app. The work (tasks 7.4 and 7.5) related to data analysis and data visualisation started, the first results will be presented in June at the Centre for Digital Heritage meeting 2018. M21 (early release) M32 (final release) M32 (evaluation)</td>
</tr>
<tr>
<td>4. Enable the archival of all data produced on a remote archive, supporting also access through advanced presentation tools.</td>
<td>The demonstration of the complete version of the system running on mobile platforms, which will include the final component for data archival on remote repositories. The system will enable the archival of all data produced: textual data, raw images, models produced (2D drawings, 3D models), results of the interpretation phase, etc. These data will be accessible also via a standard web-based interface; it will provide also advanced visual presentation tools to enable the inspection of the media files.</td>
<td>During the second year of the project, it was carried out the evolution and consolidation of the Reference Database Management server: the central repository for all the data produced within the project. The ArchAIDE server was extended with a communication infrastructure supporting the store/retrieval requirements of the mobile app. As part of Task 7.6 it was developed a public interface allowing the browsing of the Reference Database including multimedia depictions and 3D models. The first release of public interface was published in M15. The official early release published in M21 was presented to an audience of archaeologists during the Training open day held in Pisa (M22).</td>
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<td>5. Enable reuse of all data collected and preserved in the open data repository</td>
<td>The realisation of an open data archival policy, which is able to provide long-term preservation and as wide as possible data reuse. The release of web APIs for REST services, in order to allow the creation of new applications and the possible economic exploitation of the data collected.</td>
<td>The second year centred on discussions around intellectual property rights and how best to implement the Data Management Plan (D10.2). Guidance was given on how to optimise the comparative data created by the project for open archiving and dissemination during the final year of the project, and the issues around economic exploitation.</td>
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<td>Month 32 (final release)</td>
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</tbody>
</table>
## 6. Evaluating the impact in real conditions

The objective and subjective evaluation of principal system components, performed by means of experiments and user studies developed in real working conditions.

The provision of a report outlining an assessment of the effectiveness of each tool component. This report will focus on the evaluation of both the system (functionalities provided) and its practical usability evaluated from an end-user point of view.

The second year was dedicated to the requirement analysis and User Experience for the mobile application. Starting from the analysis carried on by the archaeologists in the project (Task 7.1) we produced mock-ups and demos of the mobile app that have been presented during the “Training Open Days” (Task 10.3) held in Pisa, Italy, in Brighton, UK, and in Bonn, Germany to the stakeholders for receiving feedbacks on the user-experience and usability. The first steps of testbeds activity (Task 8.2) started on M22 for evaluating the impact in real working conditions of appearance-based recognition.

Month 32 (final release)

## 7. Establishing the conditions for a successful adoption and exploitation of project outcomes

Since the beginning of the project, a special attention will be addressed to public demonstrations, conferences and awareness rising of key actors in the field. This will include the live demonstration of the system in real excavation settings; the delivery of the tools to sample users even external to the consortium.

Setting-up of the dissemination and commercialisation network, including an attractive and regularly updated website and other communication means.

Active consideration of standardisation opportunities of the domain.

The second year of the project was characterised by intense dissemination activity and contact with project stakeholders. The goals and early results of the project were presented in events, conferences and dedicated workshops collecting feedback on both interest on potential results and exploitation strategy. Exploitation approaches was evaluated. The most promising being the combination of an open-source/open-data product with in-app purchase of digitised pottery catalogues, but any commercial exploitation of the catalogues will need to be the result of a partnership of the project with the copyright owners. If commercial exploitation is not possible with the copyright holders of the catalogues, it can still serve as a proof-of-concept model to show to copyright holders and encourage them to digitise their data for re-use, and potentially make that data open access in future.

Month 33 (final release)
1.2 Explanation of the work carried per WP

1.2.1 Work Package 1 – Management

UNIPI, CNR, TAU, UoY, UB, UCO, BARAKA, ELEMENTS, INERA

At present, WP1 is in its 24th month of work, and all the Tasks (all 3 led by UNIPI) are in progress as planned. The main objective of WP1 is to guarantee the correct implementation of the overall management, the monitoring of the project and its activities, and the achievement of the project objectives.

Task 1.1 Technical Management and Quality Control

Leader: UNIPI [other partners: CNR, TAU, UoY, UB, UCO, BARAKA, ELEMENTS, INERA]

Progress planned according to DoA

- Organisation of MTB physical Meetings.
- Organisation of MTB video-conference Meetings.
- Maintenance of the Project Risk Register.
- Monitoring of the Project activities.

Actual progress

- Organisation three General Meeting (in Brussel, Maastricht and in Bonn), a Technical Meeting in York, and five Skype call MTB Meetings:
  - The MTB Skype call of June 6th, 2017
  - The General Meeting of June 21st, 2017 in Brussels
  - The General Meeting of August 29th-30th in Maastricht
  - The Technical Meeting of December 6th, 2017 in York
  - The Skype MTB Skype call of January 15th, 2018
  - The MTB Skype call of February 15th, 2018
  - The MTB Skype call of March 20th, 2018
  - The MTB Skype call of May 16th, 2018
  - The General Meeting of May 23-24 in Bonn

- Maintenance of the Project Risk register
- Production of three Internal Periodic Reports

Task 1.2 Administrative/Financial Management and Reporting

Leader: UNIPI [other partners: CNR, TAU, UoY, UB, UCO, BARAKA, ELEMENTS, INERA]

Progress planned according to DoA

- Second transfer of the respective shares of the financial support to the partners.
- Monitoring of the resources employed by the Consortium.
- Administrative Management

Actual progress

- the Coordinator transferred the second tranche (September 2017) of the respective shares of the financial support received from the EC to all the partners at the beginning of the project.
• After the review meeting, it has been necessary to begin a new Amendment procedure that was submitted on June 6th, 2018. The Amendment was especially needed for:
  ○ Extension of WP5 up to M28
    As we continued the work on populating the database an end of WP5 in month 20 seems not useful. With the progress of the project, it has become evident that the quantity and quality of data requested by WP6 must be wider than estimated. On the other hand, the work for developing the appearance based similarity training in WP6, was more complex than expected. Therefore, we proposed an extension of WP5 up to month 28. The date of the deliverable of WP5 has not been affected by this extension as well as it has not affected the work on WP7 and 8. The proposed changes has not affected the total effort (in PM) by BARAKA, ELEMENTS. Also UCO’s total effort (in PM) has not been affected but their distribution of PM in WP1, 3, 4, 5 and 10. Therefore, it was necessary to slightly increase UCO’s PM in WP5 to carry out photo campaigns together with the other partners.
  ○ Changes in WP6
    After a deep survey of decoration data, it has appeared more useful to separate the appearance based recognition from the shape based one, developing two different algorithms. Furthermore, we were not able to submit D6.1 at the due date scheduled on M12. Consequently, we proposed to shift the due date of Deliverable D6.1 up to M19, whereas D6.2 has been submitted at the due date on M16. These changes has not affected the total effort (in PM) by TAU. MS5 has been released on 30th September as originally planned.
  ○ Minor changes
    - The creation of the newsletter has been skipped.
    - An internal change of personnel responsibilities occurred at CNR. Dr. Matteo Dellepiane took Dr.Roberto Scopigno’s place as ArchAIDE Unit Coordinator for CNR.
    - According to the request in the Review Report, the Exploitation Manager has been moved from CNR to INERA.
    - Deliverables D1.5 and D1.6 have been deleted for avoiding overlaps with the Final Periodic Reporting.

Task 1.3 Management of knowledge and IPR
Leader: UNIPI [other partners: CNR, TAU, UoY, UB, UCO, BARAKA, ELEMENTS, INERA]

Progress planned according to DoA

• Definition of Knowledge and Intellectual Property Right strategy

Actual progress

• Discussion at MTB level about the different option for the future exploitation of the project.
• Study of different scenarios.

1.2.2 Work Package 2 - Methodologies, specification and design

UNIPI, CNR, TAU, UoY, UB, UCO, BARAKA, ELEMENTS, INERA
WP2 has ended on month 8. The goal of this work package was to define a methodological approach for identifying, gathering and structuring the required data sources in order to design the project database, the data representation schemes, the algorithmic solutions for shape-based recognition/identification and, finally, the overall ICT system specifications.

1.2.3 Work Package 3 - Creation of the Application Database

UoY, UNIPI, CNR, UB, UCO, INERA

WP3 was completed on month 18. The objective of WP3 was to carry out the design (Task 3.1) and implementation (Task 3.3) of the database, based on the methodologies, specifications and planning carried out within WP2. It also included the development of multilingual vocabularies to be implemented into the database to allow interoperable searching.

Task 3.1: Database design
Leader: UoY [other partners: INERA, CNR, UCO]

Progress planned according to DoA
- Complete Database design
- Coordinate with INERA during implementation phase
- Respond to any necessary changes in database design during implementation by INERA

Actual progress
- Additional features for recording of geographical places (origin + distribution), associated with chronology and fabric were discussed at technical meetings and introduced into new database design.
- Guidelines for the translation of chronologies expressed as strings to numerical values were established.
- Coordinated with INERA on the changes required to database design.

Task 3.2: Incorporation of multilingual vocabularies
Leader: UoY [other partners: UB, UNIPI, UCO]

Progress planned according to DoA
- Coordinate creation of multilingual vocabulary mappings of pottery characteristics by UoY, UB, UNIPI and UCO, to be implemented into the database to allow interoperable search.

Actual progress
- Original mappings (English, German, Catalan, Spanish, Italian) delivered to INERA in JSON and CSV - implemented within the reference database.
- Additional mapping in French was created based on work provided by an ArchAIDE Associate - implemented within the reference database.
- Work continues under the auspices of WP10 to create additional mappings in Polish, Portuguese and Dutch: information being provided by new ArchAIDE Associates.
- New vocabularies were created to describe key characteristics of vessel shape (rim, neck, shoulder,...
handle, body and base). These do not correspond to any current concepts within AAT or other SKOS, so have been implemented as local controlled vocabularies only.

- INERA have added the ability to update and add mappings within the reference database interface.

**Task 3.3: Database implementation**

**Leader: INERA [other partners: UoY]**

**Progress planned according to DoA**

- INERA to implement the comparative database, based on the design completed by UoY.
- INERA to begin implementation of the multi-lingual vocabularies created in Task 3.2.
- UoY to work closely together INERA during implementation of the comparative database, and during the initial population of the database.

**Actual progress**

- INERA has completed building the reference database - incorporating edits required for a sophisticated recording of origin identified in 3.1. The database has been constructed in MySQL.
- The implementation of the multilingual vocabulary functionality has been completed: as noted in Task 3.2 this will allow additional languages to be incorporated, and new mappings between native terms and AAT concepts to be added by Associates.
- The database has been populated with a number of datasets from digital and paper sources, these include: UoY Amphora, Conspectus, Catalogo Medri, and Ceramica di Montelupo.
- A database front-end has been constructed, allowing users to add new catalogues and types by hand or via JSON import. This front-end also allows users to edit or delete existing records.

**Deliverables Completed:**

- **D3.1 Final release of the database implementation (M18)**

**1.2.4 Work Package 4 - Technologies for the digitization of catalogues**

**CNR, UNIPI, TAU, UCO, INERA**

WP4 has ended on month 18. The goal of this Work Package was to study and test technologies to transform the paper catalogues describing the pottery classes in a digitised version. The items to be taken into account in this digitisation effort are the ones defined in WP2. The goal here is to design a pipeline and the relative technologies to transform mostly printed content into a structured digital representation.

**Task 4.1: Technologies for the digitization of catalogues**

**Leader: CNR [other partners: INERA, UCO, UNIPI]**

**Progress planned according to DoA**

- Analysis of the selected paper catalogues.
- Testing of available OCR tools.
- Implementation of an ad-hoc solution.
Actual progress

- Different solutions for OCR have been analysed, in order to analyse flexibility, amount of languages supported, extendibility. The analysis was brought on by ISTI-CNR, UNIPI and INERA.
- Tesseract set of tools was selected for the implementation in the context of the interface for database population. It was selected since its JavaScript-based implementation made it easy to integrate in a web-interface, and due to the fact that several languages, including Italian, English, Spanish, and French, are supported.
- Two different implementation (created by ISTI-CNR, with the support of INERA) of the OCR-based tool have been proposed.
  - The first implementation is a basic OCR, aimed at assisted data entry in the database, for those catalogues that do not have a strong structure (i.e. where the description of ceramic types is just a text, where the various characteristics are described without following a scheme uniform for all types). The idea is to apply OCR at small chunks of text, and provide easy mapping on the database fields.
  - The second OCR implementation aims at those catalogues with a strong structure in the description of ceramic types (i.e. the description is structured in fields, coherent from one type to the other). The idea is to automatically fill the database structure by analysing the structure of the description. The “Conspectus” catalogue was selected to implement and test this second solution.
- The initial implementations of the OCR systems have been presented and discussed during the Pisa meeting in March 2017. Several issues related to the interface and data exchange have been discussed. All the partners took part in the discussion.
- The non-structured OCR tool aims at extracting the text from generic catalogues. After the first prototype has been tested, the tool has been integrated in the database as a helper for the assisted data ingestion. The OCR has a simple interface to select parts of an image of a digitized catalogue page, and transform the area in a text that can be directly fed to a field of the database. Similarly, the tool let the user select an area of the page containing a drawing, and automatically crops it and create an image that is ingested in the database as a “depiction” of the ceramic type. The tool has been and is currently used for the data entry in the database. The design and integration work was carried out by CNR, INERA and UNIPI.
- The advanced OCR implementation (that aims at automatically filling the database structure describing by analysing the structure of the description) is finished, and after testing, it has been used to ingest the whole “Conspectus” catalogue in the database. The scanned images of the catalogue have been fed to the OCR tool, that recognized the different text sections of the description, and parsed them accordingly, the resulting parsed data has then been packed into a JSON interexchange format, that has been ingested in the database, creating a new ceramic type for each entry in the catalogue. The work was carried out by CNR and INERA.
- The OCR tools, have been released in the Deliverable 4.1 “Final Version of the digitization system”, and are integrated in the Database front-end on the project website.
- A paper on this processing “From Paper to Web: Automatic Generation of a Web-Accessible 3D Repository of Pottery Types”, has been presented in the 15th Eurographics Workshops on Graphics and Cultural Heritage (EG GCH 2017), and published in its proceedings.
Task 4.2: Detection extraction and vectorialization of drawings from digitized pages
Leader: CNR [other partners: TAU, INERA]

Progress planned according to DoA

- Produce a vectorial representation of drawings.
- Build a tool to automatically extract the representation.

Actual progress

- The structure of the drawings in the context of several catalogues has been analysed, in order to select the geometrical features that can be reasonably extracted in all cases. This led to the definition of a set of features that include: internal and external profile of the body, internal and external profile of the handle (if present), rim and base points, scale factor, mouth radius. The analysis and selection was made by all the partners involved in the WP.
- An automatic application that is able to analyse a scanned version of the drawing has been implemented. The application (implemented by ISTI-CNR) is able to automatically extract the above mentioned features, and save the information in the context of an .svg file. In addition to the creation of the .svg structure, a 3D representation of the drawing is created automatically by taking into account also the axis of revolution (indicated in the drawings as well). The application is currently able to extract both the body and the handles, and integrate the subparts in a single, continuous 3D model.
- The development of the drawing extraction tool is currently integrated with the work of WP6.2 (in collaboration with TAU), that aims at creating an automatic classification system based on shapes. Both the .svg files and the 3D models will be used in the creation and training of the classification system.
- The semi-automatic tool for the extraction of geometric features from drawings has been presented and validated during the Pisa meeting in March 2017. All the partners took part in the discussion.
- The produced .svg annotated profiles and 3D models are also fed to the database, and associated to the corresponding ceramic type as a depiction. A custom 3D viewer has been added to the database page describing the ceramic type.
- After the initial prototype, the profile extraction has been tested and improved in a close collaboration with TAU. The tool has then been used to process all the available entries of the catalogues, and the results have been used by TAU as the input for the training of the profile classification engine.
- The code of the tool, based on the Matlab runtime, has been released in the Deliverable 4.1 “Final Version of the digitization system”, and is available on GitHub.
- A paper regarding the full pipeline for 3D reconstruction and virtual fragmentation of 3D models, “VASESKETCH: Automatic 3D Representation of Pottery from Paper Catalog Drawings”, has been presented in the 14th IAPR International Conference on Document Analysis and Recognition (ICDAR2017), and published in it proceedings.

Task 4.3: Preliminary validation of digitization technologies on sample datasets
Leader: CNR [other partners: UCO, UNIPI]

Progress planned according to DoA

- Test and validate the OCR tools.
- Test and validate the drawing digitization tool.

Actual progress

- Initial tests have been made on both the OCR (mainly on the “Conspectus” catalogue) and on the automatic digitization of drawings (mainly drawings coming from the ADS Amphorae database). This work has been supported by UNIPI and UCO.
- Both OCR have been finalized, and integrated in the database data-entry pages.
- The drawing digitization tool has been extensively tested with TAU, to provide a more uniform dataset for the training of the classification engine, resulting in various steps of fine tuning and additional refinement of the extracted profile data.
- Both the OCRs and drawing extraction tools have been used in the population of the database, processing the different catalogues that have been selected by the project as data source. Given the variability of the catalogues, few small tweakings have been carried out to the tools, to adapt them to the specificity of each single catalogue.

Deliverables Completed:

- D4.1 - Final Version of the digitization system (M18)

1.2.5 Work Package 5 – Population of the Database

UCO, UNIPI, CNR, UoY, UB, BARAKA, ELEMENTS

The main goal of this work package is to populate the newly designed database with data using the technologies developed in WP4. WP5 was subject to Amendment procedure, because of the fact that has become evident that the quantity and quality of data requested by WP6 must be wider than estimated. On the other hand, the work for developing the appearance based similarity training in WP6, was more complex than expected. Therefore, we proposed an extension of WP5 up to month 28.

Task 5.1: Search and selection of paper catalogues

Leader: UCO [other partners: UB, CNR, BARAKA, ELEMENTS, UNIPI]

The focus of the selection and scanning of paper catalogues lies on the relevant reference publications of Amphorae, Terra Sigillata (Hispanica, Italica and South Gaulish) as well as Majolica and, additionally, on the catalogues of pottery stamps used to provide more data information in order to fill the database and increase the data analysis and data visualisation possibilities, planned in T7.4 and T7.5.

Progress planned according to DoA

- Completion the definition of the types for each class of ceramic.
- Create lists of relevant types for ceramic test classes.
• Checking of data.
• Definition of a new typology as reference for Majolica products of Barcelona and València.

Actual progress

• The lists of relevant types for ceramic test classes have been created (Amphorae, TS Hispanica, TS Italica, TS South Gaulish, Majolica of Montelupo).
• The lists have been checked with pottery specialists and filled with data information about the presence of drawings, photos, 3D models, descriptive information.
• The lists have been also used to plan the photo campaigns and they have been shared with Associates.
• As for the Majolica products of Barcelona and València, a general accepted typological catalogue did not exist. For this reason, it was necessary to elaborate a typology in order to make the system working on the automatic classification of this pottery. UB worked on the collections of different institutions such as the Museu del Disseny de Barcelona, the Museu d’Història de la ciutat de Barcelona and the Museo Nacional de Cerámica y Artes Suntuarias “González Martí” of València, having the opportunity to draw and digitise more than 1299 complete vessels. The ongoing typological definition uses the Compositional EDMA (Euclidean Distance Matrix Analysis), a geometric morphometrics approach to approximate the form and/or shape of ceramics capturing their geometry. Results are still preliminary but promising because through this method it is also possible to establish the appearance of the mean shape form for a defined group through multidimensional scaling of its matrix of mean distances (completed by UB).

Task 5.2: Automatic digitization and OCR
Leader: UCO [other partners: UB, CNR, UNIPI]

Progress planned according to DoA

• Digitisation of the chosen paper catalogues.

Actual progress

• Two ways to get and transfer the information from the digitised catalogues into the database have been defined: (1) fully automatic for well-structured catalogues (e.g. Conspectus): through the OCR, defined parts of text are directly imported into the database; (2) semi-automatic for not well structured catalogues (e.g. Dragendorff): an OCR version of the catalogue is created and then the relevant text passages chosen and pasted into the dataset (completed by CNR).
• Digitised pages and drawings from the catalogues have been compared to the lists of types to fill the datasets (completed by UNIPI, UCO and UB).
• “Conspectus” catalogue has been processed and imported in the database; ceramic specialist of UNIPI has started the data control (completed by CNR and UNIPI)
• Concerning activities on pottery stamps: textual information from “Kenrick” catalogue book on Terra Sigillata stamps and from “Berti” catalogue for Majolica of Montelupo were imported semi-automatically into the database. The drawings of the stamps were extracted manually and then imported as well. Origins and occurs of the stamps have been automatically extracted to use them in T7.4 and T7.5. (Completed by UNIPI, CNR and UCO).
The discussion for defining appropriate search and retrieval of pottery stamps started during the GM in Bonn (May 2018).

Task 5.3: Database population
Leader: UCO [other partners: UB, UoY, UNIPI]

Progress planned according to DoA

- Data-entry.
- Definition of a directory structure for the intranet workspace and of guidelines for storing and file naming; structure and naming is important for the connection between stored data in the intranet and the actual reference database.

Actual progress

- All amphora types that are defined in the Amphora list are represented in the database (completed by UCO, UNIPI and UB).
- The Terra Sigillata Italica types defined by the Conspectus publication is represented with datasets (completed by UNIPI).
- The Majolica of Montelupo types are represented with datasets (completed by UNIPI).
- The consortium agreed on providing photos of sherd profiles for the training of the neural network. This task was not easy to establish in our workflow, because on the one hand we had to fulfil a defined number of sherds per type, and on the other hand, there were problems to find warehouses, museums and collections that were well structured and collaborative. This activity was carried on in the second year and it will end in the third (M28). Despite these problems the consortium managed to take several photos in:
  - **Italy**: Pisa, Montelupo Fiorentino, Ostia Antica, Roma, Perugia, Spoletino (completed by UNIPI);
  - **Spain**: Barcelona (completed by UB); Palma de Mallorca, Consell de Mallorca, Andratx, Son Mas archaeological site, Pollentia archaeological site (completed by Elements); Segobriga (Cuenca), Consorcio de Mérida, Museum of Ciudad Real (completed by BARAKA).

Currently we managed to take photos of:

- 66 Amphorae types with more than 10 sherds
- 58 TS types with more than 10 sherds
- 77 Majolica types with more than 20 sherds

In total more than **13,000** sherds were documented.

- UCO has planned a photo campaign of TS and amphorae to Magdalensberg (Austria) in June 2018.
- Photos of sherds have been organised and mapped in newly established data structure of the Intranet, using defined guidelines for storing and file naming (completed by UNIPI, UCO, UB, BARAKA and Elements)
UCO is establishing guidelines for data entry.
For better communication the WP5 partners have had regular skype meetings to foresee problems and talk about the progress.

Task 5.4: Normalisation of the CERAMALEX data on Hellenistic and Roman Pottery in Alexandria
Leader: UCO

Progress planned according to DoA

- Develop a generic mapping tool to map database fields of different source databases to the ArchAIDE reference database until month 20

Actual progress

- The first version of the mapping tool was specially geared (“hard-coded”) for the CERAMALEX database and did not cover any customisation possibilities for mapping other databases
- Using this version, all relevant information have been extracted from the CERAMALEX database, reorganised according to the reference database layout and exported to a JSON formatted file
- The JSON file was imported by inera for populating the reference database
- The following version of the mapping tool includes a mechanism to read a configuration file that contains the relevant mapping information. The tool itself was extended to a generic workflow
- D5.1 was delivered in month 20.

Deliverables Completed:

- D5.1 – Mapping tool (software) (M20)

Milestone Achieved

- MS4 - First release of the populated database ready to be used in the development of WPs7 and 8 (M14)

1.2.6 Work Package 6 - Shape and image-based similarity search and retrieval
Leader: TAU [other partners: UNIPI, CNR, INERA]

At present, WP6 is in its 20th month of work. WP6 is focused on providing the recognition and classification algorithms for ArchAIDE to enable the automatic classification of archaeological findings. The work is split into two main efforts - classification by appearance (i.e. the decorations) and by shape.

For both efforts, the final goal is to produce a classification system, capable of ranking the relevance of different classes (by shape or by appearance) to the sherd in question. The system will then retrieve the description of those classes and display them to the archaeologist, sorted by the predicted relevance, for
the archaeologist to make the final decision.

Combined with further narrowing down of classes by also filtering by location, century, fabric, and other known pieces of information (to be applied later, on top of WP6), we aim to produce a usable classification that greatly narrows the list of classes to be checked for each sherd.

**Task 6.1: Appearance-based search and retrieval over a database of shapes**  
**Leader:** TAU [other partners: CNR]

**Progress planned according to DoA**

- On month 12 (May 2017), D6.1 (Algorithms for pairwise similarity between ceramics based on appearance (software)) is to be delivered
  - This was later postponed to December 2017.

**Actual progress**

- A classified dataset of images portraying different decorations, was not properly available at the original delivery date for D6.1. Therefore, no algorithm could be developed or tested for the original delivery time (May 2017).
  - Furthermore, there was no archaeological definition of “what is a class”, thus preventing work on creating a classification engine.
- During June-August 2017, a first set of classified decoration images was made available, thanks to the work happening on other work packages.
  - Classes were based on decorations from the Majolica of Montelupo catalogue.
  - Each class had multiple samples available, with a total of 600+ samples from 23 classes.
- On August 2017, a first version of the algorithm was presented, tested on the initial dataset and showing more than 60% accuracy (accuracy is measured over all samples available, not as an average of per class accuracy):
  - The algorithm is based on combining classic machine learning tools with neural networks that were trained on general image classification tasks.
  - We use the features identified by a pre-trained neural network, and compute the score for each feature on the sherd images. We then take these feature vectors and train an SVM classifier (a classic machine learning tool) to classify those vectors into different classes.
  - Training a neural network from scratch on the number of inputs we have is not very feasible (as we need many more thousands of images, including from the “less common” classes). The adaption of an already trained network enables us to work with the current inputs we had, thus being an attractive solution for our current use case.
- The first version of the code for D6.1 was made on September 2017.
- On November 2017, a significantly larger set of images was delivered, thus enabling further training and testing of the algorithm.
- Following a testing phase on the new improved dataset, **D6.1 was delivered on December 30, 2017.**
  - All further details about the operation of the algorithm, and instructions about usage, are available in the deliverable report and the accompanying documentation.
- During 2018, D6.1 was already integrated in the ArchAIDE app, and **classification is now available to archaeologists.**
During May 2018, further places for improvement were identified thanks to usage of the algorithm, and will be implemented in the future. Some examples include:

- Robustness to lighting conditions - the performance of the classification differs with different lighting conditions, and this can be improved by simulating further lighting conditions while training the system.
- Better handling of “rare” classes - the data was trained on unbalanced data (i.e. some classes had more inputs than others), thus achieving better accuracy on the “common” classes, compared to more “rare” classes. This can be fixed by giving a weight to each input in the training, to simulate an equal number of inputs from each class.

**Task 6.2: Shape-based search and retrieval over a database of shapes**

Leader: TAU [other partners: CNR]

**Progress planned according to DoA**

- On month 16 (September 2017), D6.2 (Algorithms for pairwise similarity between ceramics based on shape and appearance (software)) is to be delivered.

**Actual progress**

- Given the very few sherds currently available for shape based classification, it is not feasible to build and train a classification system only using existing sherds.
- During the current work year, we designed a system to produce “synthetic sherds” (3D shapes available on the computer) for training the system.
  - To produce synthetic sherds, we start with the pottery profiles that are extracted from the catalogues, using the work of CNR as part of WP4.
  - We then remove the handle sections from the profiles (were such handles exist), to obtain a profile which when rotated, will produce the base shape of the vessel.
  - After reconstructing a 3D model as described above, we break the model into “random” sherds by “cutting” it using strategically placed 3D planes.
    - One plane is “vertical” (up to some random angle) to produce a fracture which resembles the original profile.
    - Further planes are randomly chosen to cut off parts from the top and bottom of the sherd at varying angles, to produce sherds that show different parts of the profile each time.
  - Each sherd has its main fracture projected into 2D by placing a virtual camera at the same orientation an archaeologist would look at the fracture.

- D6.2 was delivered on September 30, 2017 after being trained and test only on synthetic sherds (of Amphora pottery), as no real sherds was available in a format suitable for classification:
  - The delivered algorithm was based on a standard convolutional neural network (CNN).
  - Each sherd was fed into the neural network as a black-and-white image, by scaling each sherd individually to tightly fit into a 256x256 image:
    - CNNs typically require that all inputs will be of exactly the same size
  - The network was then trained to classify the input images into the different classes.
  - Since we were training on large numbers of classes, we experimented with curriculum...
training (gradually introducing more classes during the training process) and custom loss functions, to make the network converge:

- Full details are available in the report submitted with the deliverable

- In 2018, more sherds became available, to enable testing the system with real archaeological sherds for the first time.

- As expected, the system did not operate right away on actual sherds, and **still requires adjustments to properly classify actual sherds.**

- Making these adjustments is the main work **currently being carried out in TAU as part of WP6.**
  - Among the issues observed, we suspect that the scaling process which scales all sherds to have the same image size, is causing a loss of vital information, as scale is indeed being used to differentiate between certain classes of pottery:
    - Deciding on a fixed scale for all sherds is not feasible, since sherds greatly vary in size. Attempting to fix the scale would make most sherds appear in low resolution due to the big sherds that also have to be fit inside the image.
    - Furthermore, as we trained the network on the sherds generated from the profile drawings, the classification was not robust enough to handle small variations that can be observed in sherds observed in practice.
  - Both problems are currently being addressed in the research carried out by TAU, and are guiding the research going forward.

**Deliverables Completed:**

- D6.1 - Algorithms for pairwise similarity between ceramics based on appearance (software)
- D6.2 - Algorithms for pairwise similarity between ceramics based on shape (software)

**Milestone Completed:**

- MSS - First software release for pairwise similarity between ceramics (M16)

### 1.2.7 Work Package 7 - The mobile tool and Front-end Desktop Application

**INERA, UNIPI, CNR, UoY, UB, BARAKA, ELEMENTS**

At present, WP7 is in its 16th month of work. The goal of this WP is design and implement a fully functional prototype of the ArchAIDE Mobile App and a desktop application allowing final user to access all the data.

During 2017 the activities were focused on the implementation of the back-office tools for data management and APIs supporting data access from external applications (i.e. mobile app and desktop app). The results of the design and implementation activities carried on in the first year of WP7 are two web-based applications: Reference Database and Result Database. The Reference Database is populated with ceramic types, decoration types and stamps to be used by archaeologist to classify their findings. The Result Database is devoted to store the data produced by the ArchAIDE final users i.e. their findings.

In the last part of 2017 and beginning 2018, the main activity was the requirement analysis and User Experience for the mobile application. Starting from the analysis carried on by the archaeologists in the
project (Task 7.1) we produced mock-ups and demos of the mobile app to be presented to the stakeholders
and receive early feedbacks on the user-experience and usability.

The rest of the time, until now, has been spent in the development of the app. The current version of the
Android App was presented at the Archaide Workshop in Bonn (May 25, 2018).

Task 7.2: Implementation of the 2D acquisition and the 2D drafting components (mobile tool)
Leader: CNR [other partners: INERA]
Progress planned according to DoA
The goal here is the development of a library supporting the manipulation of 2D images. In particular, the
critical functionalities expected are:

- White balancing (manual, automatic)
- Scale identification (manual, automatic)
- Profile sketching (manual, automatic)

The library produced in this task will be subsequently integrated in the mobile app as part of the interactive
tool for the acquisition of information and manipulation of sherd images. The information acquired through
the library services (i.e. scale factor, profiles) will be used to classify the sherd inferring its shape.

Actual progress

- The task is complete and all the functionalities passed the alpha test phase.
- Expected functionalities are integrated in the current version of the app.
- CNR produced a C++ library (named Piccante) for image manipulation.
- INERA integrated functionalities of Piccante as part of the “Shape recognition” tool.
- The assessment of the app User-Experience led to the fine tuning of both Piccante and the app.

The current version of the app contains all the functionalities expected from Task 7.2 and will be integrated
with the Shape Recognition Neural Network as soon as it will be released.

Task 7.3: Implementation of the mobile application
Leader: INERA [other partners: CNR]
Progress planned according to DoA
The goal of this task is to produce a mobile application to be used by archaeologist to classify pottery
sherds. The original definition of the task was focused on what we now call “shape recognition” process.
Since the first analysis and design activities a more complex and functionalities rich definition of the mobile
app emerged. The recognition process originally though as monolithic now has been split in:

- Appearance recognition
  Applied to decorations, the appearance recognition tool tries to infer the decoration type of a
  sherd using only its image.
- Shape recognition
Given the scale ratio and the sketch of the internal/external profile of a sherd the system tries to infer its ceramic type (form).

- **Stamp advanced search**
  As it is too complex to recognize pottery stamps using their images (too many variations for a single stamp and too few samples for each variation) the project opted for an approach based on advanced search.

Appearance recognition and shape recognition will be distinct functions in the mobile app corresponding to distinct machine learning models.

Apart from recognition and search tools, in Task 7.1 and in early analysis stage of Task 7.3 it was identified the need for additional functionalities for the app:

- **User management**
  The mobile app may be used freely without any registration on the ArchAIDE server. At the same time users may want to register on ArchAIDE in order to save information about sherds and classification info.

- **Browsing of the Reference Database**
  The reference database i.e. types, decorations stamps, must be accessible from the mobile app in order to allow users to search and get complete descriptions including media.

- **Site/assemblage contexts**
  Registered users may create and manage Sites and Assemblages that will represents the contexts for the sherds they are working on. A site corresponds to a place (with geographic coordinates) and is the container for one or more assemblages (i.e. stratigraphic units, sherd grouping, etc.). An assemblage represents the context for a group of sherds defined, described and classified by the user.

- **Sherd editing**
  All the information and images about a sherd are collected in entity that is be saved on the ArchAIDE server.

While non registered users may use the recognition tools get classification info from images, the registered user are allowed to save all the information on a “Sherd object” for later inspection and use. All the info produced by registered users will be stored on the ArchAIDE server and will be available on both the mobile app and the desktop ArchAIDE application.

The following images are screenshots of the current version of the Android mobile app as it was presented at the ArchAIDE Bonn Workshop.
Actual progress

- Completed the UX design and functional specification of the mobile app
- Developed mock-up and demo versions of the app for evaluation
- Developed a complete API interface enabling the interaction of the mobile app with the Reference Database server
- Developed a complete API Interface enabling the interaction of the mobile app with the Result Database (database storing the registered users findings).
- Developed the API Interface to call the Appearance Recognition server
- Integrated the Piccante Library for image manipulation
- Developed an Android version of the mobile app including:
  - User sign-in
  - Reference database browsing
  - Site/Assemblage/Sherd Management
  - Appearance recognition tool
    - Image acquisition
    - Image manipulation (i.e. rotate, crop, etc.)
    - Automatic classification (Deep learning model integration as in D6.1)
    - Manual classification (i.e. search and comparison tool)
  - Shape recognition
Task 7.4: Data analysis
Leader: UNIPI [other partners: INERA, UB]

Progress planned according to DoA

The central achievement of this task is an exploratory statistical analysis of data related to pottery, mainly about size, density, geo-localisation and chronology. The task focuses on the following tools:

- Classification & Clustering techniques, to be used for understanding whether or not some features of the data may possess convenient classifications, suggesting meaningful interpretation of categories;
- Dimensionality reduction techniques, to be used in order to extract a small number of specific combination of features describing the greatest part of information and variability contained within the data;
- Spatial statistics, point pattern analysis and Kriging methods, mainly used in order to highlight the possible patterns within the spatial distribution of data;
- Predictive modelling techniques, to be applied for suggesting where to look for more data in order to get relevant gain of information, or optimal strategies to perform testing.

Actual progress

The aim of this task is to provide an exploratory analysis, followed by a forecast and a test phases, of the data from the ArchAIDE database. The database includes information such as the types and stamps of ceramics, dimensional information, geolocation, and chronology. The first phase of analysis has been carried out on the data related to Terra Sigillata Italica.

- **Explorative analysis** is to highlight statistical relationships and extract patterns from the available data. The main approach we followed in the first phase is the creation of networks (mathematical graphs), by linking the locations where Terra Sigillata Italica was produced and found. Main characteristics of data, including outliers, were identified starting from these networks. On the basis of the patterns exhibited by the data, 4 different temporal intervals were identified, showing qualitative different data. Exploratory analysis made it possible to correct some database compilation errors, incorrect localizations, and suggested the introduction of further database fields (e.g. a field related to the wholeness of finds).

- **Classification and clustering techniques** on networks identified the main clusters, i.e. communities. Communities were interpreted as commercial networks linking one or more production areas to preferred export locations. Moreover, by using the different temporal intervals, the evolution of production sites and main export areas, the increase and decrease of production, and the spheres
of influence of the major production poles across time were identified.

- **Dimensionality reduction techniques** were applied mainly to dimensional data, allowing to identify qualitatively different ceramics, based on different relationships between height, mouth radius, width, volume, area. Preliminary analysis seems to show that qualitatively different ceramics follow different paths.

- **Spatial statistics, point pattern analysis and Kriging methods** is being applied in order to disclose the spatial patterns exhibited by qualitative categories of ceramics identified on the basis of dimensional data. Spatial statistics is also being applied in order to investigate relationship between locations of ancient Roman legions and networks of origins/occurs of ceramics. Such analyses are ongoing.

Statistical analysis tools also supported evaluation of app performances on fixed (desktop and portable computers) and mobile devices (smartphones and tablets): based on these performances the critical issues and strengths of the first version were identified, see Task 8.2.

### Task 7.5: Data visualisation

**Leader:** UNIPI [other partners: CNR, INERA, UB, BARAKA, ELEMENTS]

**Progress planned according to DoA**

The results of the data analysis task will be made more understandable and easily explicable applying data visualisation techniques. Scope of this task is to implement a data visualization component that will be integrated in the desk front-end (Task 7.6). A web-based visualisation tools will be built following data visualization principles and good practices. Following these guidelines:

- We will classify the different data into types (categorial, ordinal, interval, ratio types).
- We will determine which visual attributes (shape, orientation, colors, texture, size, position, length, area, volume) represent data types most effectively, so giving rise to the visualization, according to the basic principle of assigning most efficient attributes.

Moreover:

- The process of building the visualisation will be made interactive, letting the user associating the different variables with the different attributes, at the same time explaining the principles above.
- The different relations within pottery production, trade flows, and social interactions, will be visualised applying the same principles, with graphs.
- The results of this task will be disseminated, together with those achieved in task 7.4, as deliverables D7.5 and D7.6.

### Actual progress

A natural completion of task 7.4 work was the production of static and interactive visualizations, which showed the networks created by ceramics finds across time. Specifically:

- We transformed available data and conveniently classified it into types (categorial, ordinal, interval, ratio types)
- We associated each data of interest to visual attributes - such as shape, orientation, colors, texture,
size, position, length, area, volume, in order to represent networks as effectively as possible.

- Based on the previous steps, we developed ceramics network visualizations, showing at the same time the locations of ceramic origins and occurs (with position), the quantity of different types or stamps (with area), the distance between each origin and its occurs (length of graph links), the chronology (on a variable which will make the visualization interactive), the community structures (with colouring).
- Visualisation showing the univariate and multivariate distributions of dimensional data were also produced, serving as exploratory visual analysis and as statistical consideration.

**Task 7.6: Implementation of the desktop front end**

Leader: INERA [other partners: CNR, UoY, UNIPI, BARAKA, ELEMENTS]

**Progress planned according to DoA**

The ArchAIDE desktop front-end is the web application published on the internet that will be used by archaeologists to access the Reference database, to use the data visualization tools and to enter their private area (only registered users) to access the data collected through the mobile app.

The images below are screenshot of the current version of the Reference Database browser, a core component of the ArchAIDE Desktop.

Type visualization 1: descriptive information and 3D model

Type visualization 2: Origin/Occurrences, depictions, drawings, references, etc.
Actual progress

- Completed the first draft of the application specs to be included in D7.2 due in month 32.
- Designed the Reference Database component of the Desktop app.
- Designed the Result Database component of the Desktop app (Registered users reserved area).
- Implemented the first version of the Result Database public interface.
- Implemented a first draft of the Result Database interface.
- Started the specification of the search and visualization tools.

1.2.8 Work Package 8 - Test and assessment of the overall system on application scenarios

At present, WP8 is in its 2nd month of work. The goal of this WP is to create two test beds related to different applications scenarios. On the one hand, it should have in mind that one type of final users will be archaeological small and medium sized enterprises (SME) involved in contract archaeology. On the other hand, the second type of end user would be Higher Education Institutions (HEI) and research centres.

Task 8.1: Archaeological testbeds (Archaeological SMEs)
Leader: BARAKA [other partners: ELEMENTS]

Progress planned according to DoA

- Test beds for assessing the designed tools for the 2D acquisition and the 2D drafting of the profile of sherds, as well as to prove the automatic classification of pottery on a number of real-cases scenarios from contract archaeological interventions. This task will be developed straight in the field with the actual constraints of contract archaeology.

Actual progress

- Up to now it has not be possible to perform this task due to the fact that the system it is only available for the recognition of Montelupo pottery appearance. From the two SME partners, ELEMENTS is the only one that might have some sherds of Montelupo pottery and during M25-26 it
is planned to test the system.

Task 8.2: Archaeological testbeds (HEI and Research Centres)
Leader: UNIPI [other partners: UB, CNR]

Progress planned according to DoA

- Test beds for assessing the designed tools for the 2D acquisition and the 2D drafting of the profile of sherds, as well as to prove the automatic classification of pottery on a number of real-case scenarios from research archaeological interventions. This task will be developed at the facilities of the HEI.

Actual progress

- Up to now, the system has been tested in two different scenarios.
  - UNIPI tested the tool both on desktop and on mobile devices. All the results presented are computed on the basis of the following data:
    * test on mobile app (sample: 100 different potsherds);
    * test on desktop app (sample: 400 different potsherds);
    * genres with associated number of photos available to train the app.

As for the desktop app:
  - the percentage of cases where right genre (i.e. the same as input) appeared in 5 outputs returned by the app was **77.9%**;
  - the percentage of cases where right genre (i.e. the same as input) appeared as the first in the 5 outputs returned by the app was: **42.5%**.

As for the mobile app:
  - the percentage of cases where right genre (i.e. the same as input) appeared in 5 outputs returned by the app was **33%**;
  - the percentage of cases where right genre (i.e. the same as input) appeared as the first in the 5 outputs returned by the app was **12.8%**.

Computing the difference between consecutive scores shown by the app results, we see that in the great majority of cases there are **not big score differences** between some results and others: most probably right results are not strongly suggested as opposed to probably wrong results.

Comparison of performances of the mobile app when repeating the recognition on the same object but changing location (so light and colors looks different to the camera). First attempts show the following:
  - the percentage of cases where right genre (i.e. the same as input) appeared in 5 outputs returned by the app was **17.9%**;
  - the percentage of cases where right genre (i.e. the same as input) appeared as the first in the 5 outputs returned by the app was **2.6%**.

When repeating the recognition, we have the following percentages (respectively **39.4%** and **17.3%**), indicating that different **environmental conditions play a big role** in the performances of the app.

Finally, **there seems to be no interesting relation** between the performances and the
number of photos available for each genre.
  - UB: in M23 was possible to test the system for the Montelupo appearance recognition with 15 sherds of the Museu d'Història de la Ciutat de Barcelona warehouse.

**Task 8.3: Final recommendation**
Leader: UB [other partners: UNIPI, BARAKA, ELEMENTS, CNR]

**Progress planned according to DoA**
- Results of tasks 8.1 and 8.2 will be evaluated and performance of devices and procedures will be assessing for real scenarios. Exhaustive documentation will provide the basis for real application forecast providing the basis for WP9 and 10.
- The results of this Task will be disseminated as deliverable D8.1

**Actual progress**
- Taking into account the first results after the UNIPI and the UB tests on Montelupo pottery, it has been possible to evaluate the system on actual sherds.
  - Different statistical treatments in order to determinate the systems accuracy have been performed.
  - It was possible to detect different answers of the system related to the light (inside/outside), between devices (smartphone/desktop) and type of photo uploads (photo taken through the app/photo taken by the smartphone and uploaded afterwards to the app).

**1.2.9 Work Package 9 - Communication/Public engagement/Innovation**

**UNIPI, CNR, TAU, UoY, UB, UCO, BARAKA, ELEMENTS, INERA**

At present, WP9 is in its 24th month of work, and all the Tasks are in progress as planned. The main objective of this WP is to communicate the implementation of the project, in order to maximise its impact beyond the project community.

**Task 9.1: Communication Management**
Leader: UNIPI [other partners: all]

**Progress planned according to DoA**
- Activities of communication management.
- Actions about media presence and relations.

**Actual progress**
- In the second year of the project, the main goal has been to maintain the communication channels built in the first year, and increase their contents. Activities focused to show the work in progress of the project, through its work phases and its team at work, and to involve a wider audience and enlarge the network of Associates and possible stakeholders has been carried out. This phase of work is preparatory to the final year when it will be possible to show and test the prototype of the Application. The adopted slogan for this phase has been: “Archaeo Revolution is coming”.
In February 2018, ArchAIDE project received the European Year of Cultural Heritage 2018 (EYCH) label. Label and hashtag (#EuropeForCulture) have been used in all communication activities following that date.

- Media presence: the activities carried out by the project have been disseminated attending to numerous conferences and seminars (see Task 10.4), but they have not had enough appeal to create new press releases and reach journals and/or magazines directed to the general public. There were two appearances in German papers:
  - Forschungsbroschüre 2017/18 - Philosophische Fakultät Universität zu Köln p.20-21 (http://phil-fak.uni-koeln.de/forschungsbroschüere.html)

A radio interview about ArchAIDE project has been made by Miguel Ángel Hervás of BARAKA in the program “Las Dos Miradas” in Radio Castilla-La Mancha, on 21 December 2017 (from 32:38”, 11 minutes long: postcast http://www.cmmedia.es/programas/radio/las-dos-miradas/podcasts/0_fs8mn9dz/)

Task 9.2: Promotional kit
Leader: UNIPI

Progress planned according to DoA

- Integration of the promotional kit.

Actual progress

- The Promotional kit released in the first year has been used during several communication and dissemination activities. A great success has had the USB drive shaped like an amphora; given that, the consortium decided to make a second order of this gadget deleting the production of
magnets.

- Other possible gadgets (such as customized pens, pins, t-shirts and postcards) have been designed, in order to have materials to distribute at the European Archaeological Fair during the 24th Annual Meeting of the European Association of Archaeologists in September 2018 and, at the CHNT and Visual Heritage Conference and Expo, scheduled on November 2018 in Wien. Evaluating the best impact and costs, the more adapted will be produced.

Pins and postcard:

![Image of postcard]

Postcards:

![Images of postcard]

After assessing the best impact and costs, the most suitable will be produced.
Task 9.3: Web communication
Leader: UNIPI [other partners: all]

Progress planned according to DoA

- Updating the website design.
- Population of the website with contents.
- Production contents of video communication.
- Communication by social media channels.

Actual progress

- The graphic design of the website (www.archaide.eu) has been updated:
  - the higher part of the home page has been changed inserting a random selection of images representative of the work in progress of the project;
  - to increase the “visual communication”, new structure and new graphic have been given to the video section, creating a “Video Blog”;
  - few small bugs have been fixed during the year (e.g. the inverse visualisation of the dates in the events section);
  - the Associates page has been optimize to permit a full communication with the Associates, through a dedicated “Forum” section, and increasing the visibility of them through personalized pages accessible from the public page where (optionally) personal information and contacts are visible.
- Since 1 June 2017 to 31 May 2018, the website engaged 3.414 users (6.428 sessions and 21.208 visualisation of pages) mainly from Italy, United Kingdom, Spain, Germany, France, Israel and Greece.
- The publication of the contents on the website has been carried out onto three sections: blog, news and events.
- A new calendar of publication of the website blog contents has been scheduled from 01.01.2018 to 30.10.2018.

Published contents:

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<td>Blog / Tim Evans</td>
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<td>19.06.2017</td>
<td>Review meeting</td>
<td>Events / Francesca Anichini</td>
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<td>EMAC 2017 (European Meeting on Ancient Ceramics)</td>
<td>Events / Francesca Anichini</td>
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<tr>
<td>03.07.2017</td>
<td>We’re looking for...</td>
<td>News / Francesca Anichini</td>
<td>UNIPI</td>
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<td>07.07.2017</td>
<td>We need you!!!</td>
<td>News / Francesca Anichini</td>
<td>UNIPI</td>
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<td>23.08.2017</td>
<td>ArchAIDE General Meeting</td>
<td>Events / Francesca Anichini</td>
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</tr>
<tr>
<td>05.09.2017</td>
<td>Working with Hispanic Terra Sigillata</td>
<td>Blog / Luis Alejandro García</td>
<td>BARAKA</td>
</tr>
<tr>
<td>11.09.2017</td>
<td>Training day in Spoletino (Italy)</td>
<td>Events / Francesca Anichini</td>
<td>UNIPI</td>
</tr>
<tr>
<td>11.09.2017</td>
<td>Training day in Spoletino excavation</td>
<td>News / Francesca Anichini</td>
<td>UNIPI</td>
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<tr>
<td>17.10.2017</td>
<td>Conference of Cultural Heritage and New Technologies (CHNT), Urban Archaeology and Integration</td>
<td>Events / Francesca Anichini</td>
<td>UNIPI</td>
</tr>
<tr>
<td>27.10.2017</td>
<td>Keeping your sherds under control: interesting way for generating virtual sherds from 3D models</td>
<td>Blog / Llorenç Villa</td>
<td>Elements</td>
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<td>02.11.2017</td>
<td>Information Extraction: Focusing on the essentials</td>
<td>Blog / Felix Kußmaul</td>
<td>UCO</td>
</tr>
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<td>07.11.2017</td>
<td>ArchAIDE discussion workshop York</td>
<td>Blog / Katie Green</td>
<td>UoY</td>
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<td>10.11.2017</td>
<td>EVA/Minerva Conference on the Digitisation of Cultural Heritage</td>
<td>Events / Francesca Anichini</td>
<td>UNIPI</td>
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<td>Venue</td>
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<tr>
<td>10.11.2017</td>
<td>GARR 2017 Conference</td>
<td></td>
<td>Events / Francesca Anichini</td>
</tr>
<tr>
<td>10.11.2017</td>
<td>Voglio fare l’archeologo...</td>
<td></td>
<td>Events / Francesca Anichini</td>
</tr>
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<td>04.12.2017</td>
<td>ArchAIDE Discussion Workshop</td>
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<td>Events / Francesca Anichini</td>
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<td>04.12.2017</td>
<td>Technical Meeting ArchAIDE project</td>
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<td>Events / Francesca Anichini</td>
</tr>
<tr>
<td>15.01.2018</td>
<td>Archeologia Quo Vadis?</td>
<td></td>
<td>Events / Francesca Anichini</td>
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<tr>
<td>30.01.2018</td>
<td>The development of a typology for majolica pottery of Barcelona and València</td>
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<td>Blog / Eva Miguel Gascón</td>
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<td>31.01.2018</td>
<td>ArchAIDE project in the International Workshop “Glaze Technology in the Western Mediterranean: Islamic and Christian traditions”</td>
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<td>News / Mireia Pinto Monte</td>
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<td>02.02.2018</td>
<td>ArchAIDE at the 19th International Congress of Classical Archaeology (AIAC2018)</td>
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<td>Events / Francesca Anichini</td>
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<td>02.02.2018</td>
<td>ArchAIDE workshop at the 19th International Congress of Classical Archaeology</td>
<td></td>
<td>News / Francesca Anichini</td>
</tr>
<tr>
<td>13.02.2018</td>
<td>ArchAIDE Discussion Workshop Italy</td>
<td></td>
<td>News / Francesca Anichini</td>
</tr>
<tr>
<td>13.02.2018</td>
<td>ArchAIDE at TourismA, Florence</td>
<td></td>
<td>News / Francesca Anichini</td>
</tr>
<tr>
<td>13.02.2018</td>
<td>ArchAIDE Discussion Workshop Italy</td>
<td></td>
<td>Events / Francesca Anichini</td>
</tr>
<tr>
<td>Date</td>
<td>Event</td>
<td>Creator</td>
<td>Institution</td>
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</tr>
<tr>
<td>14.03.2018</td>
<td>ArchAIDE discussion workshop York</td>
<td>Blog / Holly Wright</td>
<td>UoY</td>
</tr>
<tr>
<td>14.03.2018</td>
<td>Archaide Project advances: new phase of works</td>
<td>Blog / Luis Alejandro García</td>
<td>BARAKA</td>
</tr>
<tr>
<td>18.04.2018</td>
<td>ArchAIDE workshop at the Chartered Institute for Archaeologists annual conference</td>
<td>News / Francesca Anichini</td>
<td>UNIPI</td>
</tr>
<tr>
<td>18.04.2018</td>
<td>ArchAIDE workshop at the Chartered Institute for Archaeologists annual conference</td>
<td>Events / Francesca Anichini</td>
<td>UNIPI</td>
</tr>
<tr>
<td>27.04.2018</td>
<td>ArchAIDE at the 1st International Conference on Best Practices in World Heritage: Archeology</td>
<td>News / Francesca Anichini</td>
<td>UNIPI</td>
</tr>
<tr>
<td>27.04.2018</td>
<td>1st International Conference on Best Practices in World Heritage: Archeology</td>
<td>Events / Francesca Anichini</td>
<td>UNIPI</td>
</tr>
<tr>
<td>21.05.2018</td>
<td>ArchAIDE General Meeting in Bonn</td>
<td>Events / Francesca Anichini</td>
<td>UNIPI</td>
</tr>
<tr>
<td>28.05.2018</td>
<td>ArchAIDE at EAA2018</td>
<td>Event / Francesca Anichini</td>
<td>UNIPI</td>
</tr>
<tr>
<td>28.05.2018</td>
<td>ArchAIDE at annual meeting of the Centre for Digital Heritage</td>
<td>Event / Francesca Anichini</td>
<td>UNIPI</td>
</tr>
<tr>
<td>30.05.2018</td>
<td>ArchAIDE at the EAA2018!</td>
<td>News / Francesca Anichini</td>
<td>UNIPI</td>
</tr>
</tbody>
</table>

- **Social media communication:**
  - Two calendars of publication on the social media were planned (form 1.06.2017 to 31.12.2017, and from 1.01.2018 to 30.06.2018);
  - all partners are involved in creating two contents for month (completed by ALL partners). Contents for social media were designed describing the working phases and promoting events organized by ArchAIDE and where ArchAIDE attended;
  - two special campaigns of posts were made to engage the Associates and to involve the
archaeological audience to collaborate with the ArchAIDE team in the photo campaigns of Terra Sigillata and Montelupo. For these, special visual posts have been realised by Elements with animated gif and short videos.

- During the General Meeting in Bonn (May 2018), a new campaign of social communication about amphorae sherds has been planned, and it will take place in summer 2018.
- Periodical monitoring has been made using the standard social media metrics (insights, followers, “likes”, etc.). All the social networks (Facebook, Instagram and Twitter) maintain an increment:
  - Facebook and Twitter had an expected phase of impasse after the high-level increase of the first 18 months;
  - Instagram registered interesting numbers (+57.7% from the previous period) with good rate of interaction;
  - the YouTube channel, instead, had a decrease, despite the publication of new videos. To change this trend, UNIPI is working to review the SEO position of the ArchAIDE channel (since May 2018 started an activity to correct the video mapping and tagging) and to plan e-mail campaigns focused to promote the video products.

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<tbody>
<tr>
<td>FACEBOOK</td>
<td>Archaide project (@archaideproject)</td>
<td>132</td>
<td>Likes on the page: 1158</td>
<td>Likes on the page: 1527</td>
<td>+5.9%</td>
</tr>
<tr>
<td>TWITTER</td>
<td>@ArchAIDEproject</td>
<td>88</td>
<td>Followers: 258</td>
<td>Followers: 418</td>
<td>+9.7%</td>
</tr>
<tr>
<td>INSTAGRAM</td>
<td>@archaide_project</td>
<td>80</td>
<td>Followers: 296</td>
<td>Followers: 1006</td>
<td>+57.7%</td>
</tr>
<tr>
<td>YOUTUBE</td>
<td>ArchAIDE project</td>
<td>41</td>
<td>Visualisations (29.11.16-31.05.17) 1609</td>
<td>Visualisations (01.06.17 - 31.05.18) 807</td>
<td>-32.4%</td>
</tr>
</tbody>
</table>

- Video communication:

For the second phase of the video communication, 6 videos were planned in the Communication Plan: a) infographic about the functionality of the database; b) short partners’ interviews; c) short video about general meeting; d) campaign of “ironic clips”; e) infographic about the overall
functionality of the App; f) infographic about workshops. Following the plan, some small changes have been made to better describe the work in progress of the project. Ironic clips(d) have been postponed moving up the self-made clips; after the first testing self-video by CNR, it appeared clear that the activity of post-production of the self-made video was more time consuming than planned and it is possible to complete the overview of all the teams only in last year of the project. The infographic about the App (e) has been postponed to the third year and replaced with two short infographics dedicated to the photo campaigns and to the dissemination activity.

The activities have been carried out by UNIPI with the collaboration of UoY, UB, UCO and TAU for the self-made videos. All the video contents have been published on the web site (http://www.archaide.eu), the ArchAIDE YouTube channel (https://www.youtube.com/channel/UCbQxLfXGaGRtXlBuCqjkNNg), and the social networks.

Video:

- Infographic about the pre-review meeting and Review meeting in Brussels, on June 2017: “ArchAIDE review meeting in Brussels, June 2017” (https://youtu.be/xiG8vTAJ7xA)
- 5 clips (30-60 sec) with interviews to the partner have been shoted during the General Meeting on 7-8 March2017 in Pisa and publish in October 2017:
  - “We’re starting to see what we can really do - Holly Wright (ADS - University of York)” (https://youtu.be/VVTKHrMC1cM)
  - “The database itself is a strong result - Massimo Zallocco (INERA)” (https://youtu.be/SCqr2zOArGs)
  - “A complete database of pottery - Gabriele Gattiglia (MAPPA Lab - University of Pisa)” (https://youtu.be/jMfn_GHe06E)
  - “Archaeology is going to change a lot - Eva Miguel Gascòn (University of Barcelona)” (https://youtu.be/91NkEGx_zfc)
  - “A technology accessible to many many archaeologists - Barak Itkin (University of Tel Aviv)” (https://youtu.be/Hk9RF5YQqL4)
- Infographic (1.44”) to describe the ArchAIDE database: “Discovering ArchAIDE's database” (https://youtu.be/6qkPjkLZiF8)
- (Self-made) video, completed with infographic, dedicated to describe the University of Barcelona’ work on ceramics (2:20”): “Direct line with partners - University of Barcelona” (https://youtu.be/ngSSOn7BtVQ)
- (Self-made) video, completed with infographic, dedicated to describe the University of York’ work about dissemination activities (3:30”): “Direct line with partner - ADS University of York (UK)” (https://youtu.be/IWiXhs7XzbuU)
- Infographic (44 sec) with short description of the ceramic photo campaigns: “Amphorae, Terra Sigillata and Majolica of Montelupo photo campaigns” (https://youtu.be/A2RF3jw8PtM)
- Infographic (1:19”) with short description of dissemination activities: “Results for everyone! ArchAIDE’ dissemination activities”( https://youtu.be/fbXLrKVFHro)
- Video (3:38”), completed with infographic, about the 3 workshops realized in York, Pisa and Bonn: “ArchAIDE workshop around Europe”
Task 9.4 Multiplier events
Leader: UNIPI [other partners: all]

Progress planned according to DoA

- First multiplier event in York

Actual progress

- The first multiplier event has been organised on December 7, 2017 at the ADS-University of York, in York. The event has been organised as a Discussion Workshop to explain the aims of the project, to talk about the different activities carried on, to show the first release of the application on appearance-based recognition, and to collect feedback from the participants. 25 between professionals and academic attended the event; a real fruitful discussion was born around different issues and numerous feedback have been collected to improve the final product. A full transcription of the event in York, including the discussion, summation and slides, has been published on the website ([http://www.archaide.eu/blog/](http://www.archaide.eu/blog/)).

- The event has been considered a real success and the consortium decided to propose the same “format” to collect feedback also in the other countries (Italy, Germany, Spain):
  - the Italian workshop was held on March in Pisa;
  - the German workshop on May in Bonn,
  - and the Spanish workshop has been scheduled in autumn in Barcelona (see Task 10.3).

Task 9.5: Production of documentary video
Leader: UNIPI [other partners: all]

Progress planned according to DoA

- Progress creation of video contents

Actual progress

- All video contents have been produced to be used also in the documentary video.
- Self-made video by UoY and UB have been produced. Other 2 self-made video by TAU and UCO have been shoted and they are in post-production phase (completed by UNIPI with collaboration of UoY, UB, TAU, UCO).
- Several video shoot has been made: during the pre-review meeting in Brussels (adding also video shoot of the city); during the general meeting in Maastricht and during the presentation of the project at the EAA conference; during the technical meeting and the workshop in York; during the workshop in Pisa; during the workshop in Bonn; during the photo campaigns in Ostia, Perugia and Roma. Video contents will be processed to produce the final documentary video (completed by UNIPI).
1.2.10 Work Package 10 – Archiving and Dissemination

UoY, UNIPI, CNR, TAU, UB, UCO, BARAKA, ELEMENTS, INERA

The objective of WP10 is to archive, disseminate and promote the results of the project, specifically to the stakeholder communities defined in D10.1, to follow best-practice with regard to open data use and re-use and to make the project collaborative and transparent to researchers in the archaeological domain and beyond. This includes demonstrating the technologies developed through the project to the research community, and archiving and disseminating the comparative data online through the UoY archive.

Task 10.1: Data Management
Leader: UoY [other partners: UNIPI]

Progress planned according to DoA

- Task 10.1 is ongoing throughout the project and covers all aspects of advice and action with regard to data management. These will be set out in formal, online data management plan by M6 to conform with the Open Research Data Pilot (ORD) funded under Horizon 2020. This includes planning for the long-term archiving and disseminating by UoY of the comparative data generated by the project to be carried out during year three, and advising on aspects of copyright and dissemination. It also includes planning for the dissemination of Linked Open Data from the UoY SPARQL endpoint, to include resource discovery metadata for the ArchAIDE archive and the multilingual vocabularies created in Task 3.2.

Actual progress

- D10.2 Data management plan (https://dmponline.dcc.ac.uk/projects/archaide-horizon-2020-dmp), has informed the discussions carried out in year two of the project in preparation for archiving and dissemination in year three, including the comparative data generated by the project, and what is most appropriate to disseminate in the form of Linked Open Data.

Task 10.2: Data archiving
Leader: UoY [other partners: UNIPI, UB, INERA]

Progress planned according to DoA

- Planning and discussion will be carried out during the first two years of the project to understand what data can and should be archived and openly disseminated by UoY, including which data is appropriate for inclusion as Linked Open Data within the UoY triplestore and disseminated via the SPARQL endpoint.

Actual progress

- After considerable discussion over the first two years of the project, several conclusions have been reached. In addition to existing digital comparative collections, and digitising existing paper catalogues for the first time, ArchAIDE partners have embarked on significant photography campaigns to create new comparative data, the copyright for which will be held by the relevant
project partners. These partners will deposit the new comparative data with UoY for archiving and dissemination. This will result in new, digital comparative data that will be freely and openly available for re-use in perpetuity, representing a significant, sustainable output of the ArchAIDE project that will be of use irrespective of the direction of development for the ArchAIDE app and database. Any analogue comparative data which has been digitised by the project where the copyright holder chooses to sign a deposit license with UoY will also be eligible for archiving and dissemination in perpetuity with UoY during the final year of the project.

- Regarding Linked Open Data, it has been decided that resource discovery metadata for any comparative collections archived and disseminated by UoY will be created in RDF and published from the UoY SPARQL endpoint. The multilingual vocabularies developed in Task 3.2 will also be created using Simple Knowledge Organisation System (SKOS) RDF and will be published from the UoY SPARQL endpoint, but will also be made freely available for download for re-use in other Linked Open Data projects focussed on archaeological pottery. This will represent another significant, sustainable output of the ArchAIDE project, irrespective of the direction of development for the ArchAIDE app and database.

**Task 10.3: Demonstration to the research community**
Leader: UNIPI [other partners: CNR, TAU, UNIPI, UB, UCO, INERA, BARAKA, ELEMENTS]

**Progress planned according to DoA**

- Organise and begin to implement five training open days with content of interest to students and researchers in archaeology, ICT and related disciplines.
- Begin discussions about a final conference to report the final results of the ArchAIDE project.

**Actual progress**

- Four of the five training open days were successfully implemented during the second year of the project and the final workshop will be organised during the third year. These include:
  - Training open day in Spoletino, Italy, 14-15 September 2017 (Organised by UNIPI and CNR)
  - Training open day in Pisa, Italy, 23 March 2018 (Organised by UNIPI)
  - Training open day in Brighton, UK, 17 April 2018 (Organised by UoY)
  - Training open day in Bonn, Germany, 25 May 2018 (Organised by UCO)
  - Training open day in Barcelona, Spain, *date to be confirmed* (Organised by UB)
- It was decided that the final conference will be held in Pisa in late March/early April of 2019.

**Task 10.4: Dissemination and promotion**
Leader: UoY [other partners: CNR, TAU, UNIPI, UB, UCO, INERA, BARAKA, ELEMENTS]

**Progress planned according to DoA**

- Carry out dissemination and promotion activities according to the stakeholder communities defined within D10.1 Dissemination Plan, using the communication outlets created within WP9, access to other, related projects, and beyond. These will include materials and information sharing for use by the training open days (Task 10.3) and the multiplier events (Task 9.4). These will include posters, and social media posts, which are accessible/available for download via social media and
the ArchAIDE website. An easy to digest document will be prepared to present the intermediate results of the project by M18. In addition to the training open days, ArchAIDE will disseminate information about the project via conferences and journals.

**Actual progress**

- Easy to read datasheet was produced by M18 for download from the ArchAIDE website, and printed for distribution at training open days and other dissemination events. It will be updated by M32 to reflect the final prototype.
- Discussions took place about what to include in the dissemination kit, bringing together all dissemination information about the project.
- In order to facilitate greater interaction with dissemination stakeholders, it was decided to implement ArchAIDE Associates. This included the creation of an online form so that stakeholders could register their areas of interest and potential participation within the project, and the creation of a shared online workspace where Associates can interact with partners and with each other. Within the first two years 56 Associates have signed up from around the world, with varied interests and areas of expertise. Some have participated in helping to extend the multilingual vocabularies with new languages or in taking photos to populate the comparative collections.

![Associates' countries map.](image)

- During the first two years of ArchAIDE, the following dissemination activities were carried out by individual partners:
<table>
<thead>
<tr>
<th>Activity</th>
<th>Type</th>
<th>Date</th>
<th>Partners</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STAG Catania 2017</strong></td>
<td>Paper at Smart Tools and Applications in Graphics conference</td>
<td>11-12 September 2017</td>
<td>CNR</td>
<td>Presented ArchAIDE to around 40 graphics app specialists</td>
</tr>
<tr>
<td><strong>EAA Maastricht</strong></td>
<td>Session and papers at European Archaeology conference</td>
<td>30 Aug - 3 Sept 2017</td>
<td>Session: UoY, UNIPI Papers: UoY, UCO, TAU, CNR</td>
<td>Organised session on automation in artefact recognition, including papers from several ArchAIDE partners for around 30 archaeologists and artefact specialists</td>
</tr>
<tr>
<td><strong>EMAC Bordeaux</strong></td>
<td>Conference paper at European meeting on ancient ceramics</td>
<td>6-9 September 2017</td>
<td>UB</td>
<td>Presented ArchAIDE to around 200 pottery specialists</td>
</tr>
<tr>
<td><strong>Eurographics Graz</strong></td>
<td>Conference paper at workshop on graphics and digital heritage</td>
<td>27-29 September 2017</td>
<td>CNR</td>
<td>Presented ArchAIDE to about 60 people, majority IT Specialist, some from archeology and museum curation</td>
</tr>
<tr>
<td><strong>ICDAR Kyoto</strong></td>
<td>Conference paper at International conference on document analysis and recognition</td>
<td>9-15 November 2017</td>
<td>CNR, TAU</td>
<td>Presented ArchAIDE to around 25 people, mostly IT specialists</td>
</tr>
<tr>
<td><strong>EVA/MINERVA Jerusalem</strong></td>
<td>Workshop at international Conference for Professionals in Cultural Heritage</td>
<td>13-14 November 2017</td>
<td>UNIPI</td>
<td>Presented ArchAIDE to around 30 cultural heritage specialists</td>
</tr>
<tr>
<td><strong>GARR 2017 Venice</strong></td>
<td>Conference paper at international research data conference</td>
<td>15-17 November 2017</td>
<td>UNIPI</td>
<td>Presented ArchAIDE to around 150 ICT professionals</td>
</tr>
<tr>
<td>Event</td>
<td>Format</td>
<td>Date</td>
<td>Location</td>
<td>Notes</td>
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</tr>
<tr>
<td>Voglio fare l’ARCHEOLOGO...incontri di orientamento alla professione in Pisa</td>
<td>Workshop at information day</td>
<td>17 November</td>
<td>UNIPI</td>
<td>Presented ArchAIDE to around 50 students, including PhD students</td>
</tr>
<tr>
<td>Colloquium in Digital Cultural Heritage Cologne</td>
<td>Presentation in International Colloquium</td>
<td>22 November 2017</td>
<td>UCO</td>
<td>Presented ArchAIDE to around 40 people including faculty and students</td>
</tr>
<tr>
<td>Archeologia, quo vadis? International workshop in Catania</td>
<td>Presentation in international workshop</td>
<td>18 January 2018</td>
<td>UNIPI</td>
<td>Presented ArchAIDE to around 130 people: academic, institutional (archaeologists employed in Ministry of CH), professionals and students</td>
</tr>
<tr>
<td>Glaze technology in the Western Mediterranean Valencia</td>
<td>Organised international workshop</td>
<td>25 January 2018</td>
<td>UB</td>
<td>Presented ArchAIDE to around 50 people, mostly archaeologists (professional and researchers) along with geologists, physicists and students (PhD and masters)</td>
</tr>
<tr>
<td>TourismA Florence</td>
<td>Presentation international archaeology exhibition</td>
<td>22-24 February 2018</td>
<td>UNIPI</td>
<td>Presented ArchAIDE to about 100 people, mostly archaeologists (professional and academic), and students</td>
</tr>
<tr>
<td>3rd International Conference on Best Practices in World Heritage Menorca</td>
<td>Paper at international cultural heritage conference</td>
<td>2-5 May 2018</td>
<td>ELEMENTS, UNIPI, UoY</td>
<td>Presented ArchAIDE to around 55 people, mainly archaeologists some from South America, Mexico, Peru, Columbia (professional and academic), and students</td>
</tr>
</tbody>
</table>

**Task 10.5: Demonstration activity oriented to the market**

*Leader: INERA [other partners: UNIPI, CNR, BARAKA, ELEMENTS]*
Progress planned according to DoA

- Planned presentation and demonstration meetings up to M32

Actual progress

- Participation in expos and fairs has been scheduled for September 2018 at the European Archaeological Fair in Barcelona and in November 2018 at the Expo of the Visual Heritage in Wien and the Expo at EUROMED in Cyprus. The consortium is evaluating other opportunities for the early months of 2019.

Task 10.6: Exploitation
Leader: INERA [other partners: CNR, UNIPI, BARAKA, ELEMENTS]

Progress planned according to DoA

- First draft of D10.5 issued in M13 (1st year review)
- Planning and discussions of exploitation and issues around copyright and intellectual property rights.

Actual progress

- During the first and second year of the project exploitation strategies were analysed and discussed, ranging from the commercialisation of the tools, re-use of the technologies in different application domains, commercialisation of the mobile app and many more. The result of the preliminary work and a better understanding of the potential market has led the project to a promising approach: a free ArchAIDE mobile app as a vehicle to commercialise digitised versions of the pottery catalogues. The idea is to show copyright holders the added value of digitising paper catalogues, as they can then be used dynamically in a digital environment like the ArchAIDE app. The work of the copyright holders can then be shown how their work becomes more accessible, and more useful than in a traditional paper publication. While the long-term goal for archaeological data is to be open access, for those copyright holders who are not able to do so, a commercial exploitation model will be developed. ArchAIDE app users will be able to buy a specific catalogue (i.e. Conspectus) from the app itself as an “in-app purchase”, the proceeds of which are paid to the copyright holder for use of their resource. For a user, buying a catalogue means having the possibility to browse and search the types contained in it and display all the available information, including multimedia object and eventually 3D models generated by ArchAIDE team. Whether any copyright holders choose to participate or not, this exploitation model will serve as a strong proof-of-concept for making paper catalogues more useful and accessible, within a commercial environment.
- New business plan under construction
- Presentation to the pottery catalogue publishers planned for M28 (EAA 5-8 Sept. 2018 Barcelona).
## 1.3 Impact

We consider the information on how ArchAIDE project will contribute to the expected impacts still relevant.

<table>
<thead>
<tr>
<th>Expected Impacts</th>
<th>Project Contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stimulate new research perspectives for the humanities and social science communities, promote further the use of digital cultural heritage allowing its reinterpretation towards the development of a new shared culture in Europe.</td>
<td>ArchAIDE allows the creation of new archaeological data that will be made available both through the interactive app (supporting data access and visualization) and published as open data in a section of the UoY archaeological repository. In this way, the large amount of data produced by the ArchAIDE System will be available to the archaeological community as a whole, and it will help to broaden the horizons both of archaeological research (new typological studies about archaeological pottery, trade flows and their economic impact, geographical diffusion, etc.), and of all those related areas (educational, touristic, entrepreneurial, etc.) that draw on open archaeological data to produce derivatives content such as storytelling, educational tools, etc. Moreover you must consider that pottery was produced in all historical ages and in all geographic areas, therefore the data produced by ArchAIDE have not chronological or spatial limits and they can be used by a wide range of users.</td>
</tr>
<tr>
<td>Provide innovative and creative methods for approaching cultural assets and generate applications and services to access and exploit the rich and diverse European digital cultural heritage in a sustainable way.</td>
<td>The project is based upon the current methodology used by archaeologists for recognising and describing potsherds, but it proposes a simplification of their work. This will allow a wide use of the ArchAIDE system as it does not require any additional proficiency beyond the skills already possessed by professionals or scholars. Moreover, this new approach will reduce significantly the costs of archaeological practice and, at the same time, it will greatly reduce the time of publication of the documentation, which will more quickly become part of our, both digital and material, cultural heritage. Moreover, the availability of open archaeological data always updated and enriched allow the use of the data themselves or aggregated with other digital contents, for the development of digital applications on cultural heritage. In fact, the data produced by ArchAIDE can generate an ecological data recycle, which would make the initial investment more sustainable and profitable.</td>
</tr>
<tr>
<td>Foster collaboration between those with primary expertise in the interpretation of cultural data and researchers with complementary expertise in digital and interactive frameworks.</td>
<td>The collaboration between archaeologists, as primary experts in the interpretation of cultural data, mathematicians and ICT scientists will be definitely strengthened by the complementarity with which these figures will be framed in the organization of the project. The proposed project is by its nature a multidisciplinary effort, originated by specific archaeological requirements and applying innovative ICT methodologies and algorithms to design a new innovative process based on mobile interface and sophisticated data processing and archival approaches. We expect that this experience, in addition to direct cooperation to achieve the goals set by the project, will foster both new interdisciplinary research, and the emergence of competitive start-ups.</td>
</tr>
</tbody>
</table>
2. Update of the plan for exploitation and dissemination of result

There has been considerable discussion during the first two years of the project with regard to open licensing and intellectual property rights. As the project has progressed it has become evident that the comparative data necessary to implement the ArchAIDE database and app must be derived from a variety of sources, each with different advantages and restrictions. Comparative data (data which is meant to show typical pottery types and characteristics, against which pottery to be identified by the user is compared) is often useful only if it is considered authoritative. For example, the online comparative collection *Roman Amphorae: A digital resource*, held by UoY, receives around 18,000-20,000 unique page views every month from around the world, showing it is broadly held to be useful, and is therefore authoritative. An analogue equivalent might be a particular comparative paper catalogue for Majolica of Montelupo that is accepted by specialists in that pottery type as a required citation in any peer-reviewed paper, and is also therefore considered authoritative.

In the first example, while the data creators retain copyright, the comparative collection is already freely and openly disseminated online via a deposit agreement between copyright holder and UoY, and can therefore be incorporated into the ArchAIDE database and used within the app without needing to derive further permissions from the copyright holders (as long as ArchAIDE abides by the appropriate terms and conditions of use). This is not the case for the paper catalogue described in the second example, where conversion into a dynamic digital resource was never envisioned. While useful tools to help digitise the authoritative paper catalogues necessary to show the technical proof of concept of the ArchAIDE app have been developed by CNR, this does not mean the ArchAIDE project necessarily now holds copyright to the newly digitised, remixed data (although the metadata created as part of this process by the ArchAIDE project can be argued to be new data, for which the project can claim copyright).

Whether this data can be made available outside the proof of concept would need to be negotiated with each copyright holder, which represents a major logistical and (potentially) financial difficulty. This becomes even more complicated if the ArchAIDE app is monetised in any way. The issue cannot of course be solved by ArchAIDE, but instead provides another important proof of concept opportunity by the project. By showing the potential of digitising paper catalogues in a way that demonstrates how their content can be actively re-used, allows ArchAIDE to open a discussion with publishers and other data providers around the importance of making their resources available in new ways with a concrete example (seeing their data in use within the app), furthering the long-term discourse around making research data open and accessible.

3. Deviations from Annex 1 and Annex 2

All the deviations were made taking into the consideration the Amendment procedure agreed after the first year review meeting. In particular as described in D1.4 they take into consideration the following aspects:

1. Extension of WP5 up to M28
As we continue the work on populating the database an end of WP5 in month 20 seems not useful. With the progress of the project, it has become evident that the quantity and quality of data requested by WP6 must be wider than estimated. On the other hand, the work for developing the appearance based similarity training in WP6, was more complex than expected. Therefore, we proposed an extension of WP5 up to month 28. The date of the deliverable of WP5 has not been affected by this extension as well as it has not affected the work on WP7 and 8. The proposed changes has not affected the total effort (in PM) by BARAKA, ELEMENTS. Also UCO’s total effort (in PM) has not been affected, but their distribution of PM in WP1, 3, 4, 5 and 10. Therefore, it was necessary to increase UCO’s PM in WP5 for carrying out photo campaigns together with the other partners.

2. Changes in WP6

After a deep survey of decoration data, it appears more useful to separate the appearance based recognition from the shape based one, developing two different algorithms. Furthermore, we were not able to submit D6.1 at the due date scheduled on M12. Due to the lack of training data we were not able to train neural network classifiers on real pottery data. The problem is related to the state of the art in the medieval and post-medieval archaeological pottery studies. Instead, we trained generic similarity networks on auxiliary tasks and concentrated on task 6.2 (shape based matching). Consequently, we proposed to shift the due date of Deliverable D6.1 up to M19, whereas D6.2 was submitted at the due date in M16. These changes have not affected the total effort (in PM) by TAU. MS5 has been released on 30th September as originally planned.

3. Minor changes

- The creation of the newsletter has been skipped. During the first year, it has been decided to use a faster and more friendly way of communication through social media and blogs.
- An internal change of personnel responsibilities occurred at CNR. Dr. Matteo Dellepiane tooks Dr.Roberto Scopigno’s place as ArchAIDE Unit Coordinator for CNR.
- According to the request in the Review Report, the Exploitation Manager has been moved from CNR to INERA.
- Deliverables D1.5 and D1.6 have been deleted for avoiding overlaps with the Final Periodic Reporting.

3.1 Tasks

<table>
<thead>
<tr>
<th>Task 9.2</th>
<th>DoA</th>
<th>Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>“The project logo will be trademarked at the EU Office for harmonization in the Internal Market, in order to franchise the ArchAIDE innovation results, and to permit business exploitation”</td>
<td>The project logo has been created and the different possibility for trademarking it have been studied. At the moment, only UNIPI is interested in trademarking it. Consequently, UNIPI, as coordinator, decided to postpone the trademarking until the applicable commercial categories will be clearer.</td>
<td></td>
</tr>
</tbody>
</table>
Conclusion

This document includes an overview of the project results towards the objective of the action in line with the structure of the Annex 1 to the Grant Agreement during the first reporting period from 1st June 2017 to 31st May 2018, including a summary of exploitable results and an explanation about how they can/will be exploited.

Currently, the project has ended its second year. The maximum efforts were spent in Work Packages 5, 6, 7, 9 and 10. Our first priority was to take as many pictures as possible in order to feed the neural network, in fact, during the first year it has become evident that the quantity and quality of data requested by WP6 should have been wider than estimated. Consequently, the archaeological partners were able to collect more than 13000 images, especially in Italy and Spain, whereas new photo campaigns has been organised on June in Austria.

The second priority was to train and to improve the neural network. For this reason, we decided to split our activity into two main efforts - classification by appearance (i.e. the decorations) and by shape. As for the appearance-based recognition, the work was dedicated in developing an algorithm based on combining classic machine learning tools with neural networks that were trained on general image classification tasks. Following a testing phase on a huge dataset of images, the appearance based recognition algorithm was delivered, and later integrated in the ArchAIDE app, and classification is now available to archaeologists. As for shape-based recognition, we designed a system to produce “synthetic sherds” (3D shapes available on the computer) for training the system, starting with the pottery profiles that are extracted from the catalogues. The delivered algorithm was based on a standard convolutional neural network (CNN). Since we were training on large numbers of classes, we experimented with curriculum training (gradually introducing more classes during the training process) and custom loss functions, to make the network converge. As expected, when we started testing the system with real archaeological sherds for the first time, the system did not operate right away on actual sherds. Furthermore, as we trained the network on the sherds generated from the profile drawings, the classification was not robust enough to handle small variations that can be observed in sherds observed in practice. Both problems are currently being addressed in the research, and are guiding the research going forward.

The third priority was the integration of recognition tools into the ArchAIDE app. Currently, the process for appearance-based recognition is totally integrated in the mobile app, whereas the process for shape-based recognition is not completely integrated but it already permits the extraction of the profile from potsherds’ images.

The last priority was related to communication, dissemination and exploitation. Workshops and training days in the UK, Italy, Germany has been organised for showing and testing the ArchAIDE app and its functionality, and for receiving feedbacks from ArchAIDE’ stakeholders. Finally, a special attention was dedicated in the updating of our exploitation plan, through a continuous analysis of the possible exploitation strategies: from the commercialization of the tools to the re-use of the technologies in different application domains and the commercialization of the mobile app.
ANNEXES
An EC H2020 project

Call Reflective 6, RIA (Research and Innovation Action)

Duration: **36 months**

Project Started on June 1\(^{st}\), 2016 and end on May 31\(^{st}\) 2019
ArchAIDE Partners

Archaeological Automatic Interpretation and Documentation of Ceramics

Archaeologists, mathematicians and ICT scientists are involved in the project.
ArchAIDE aims to support the classification and interpretation work of the archaeologists with innovative computer-based tools, able to provide the user with features for matching of each discovered sherd over the huge existing ceramic catalogues.
The vast majority of the finds that come back to light during the archaeological excavations are fragments of pottery ...

Pottery breaks, but does not deteriorate until disappearing as wood, textiles, food, papyrus ...
From the Neolithic, pottery was used in a number of **daily activities**: for eating and drinking, for cooking, for enlightening, and for storing. Pottery is an extraordinary window open on the past. It allows to:
- date the archaeological contexts;
- understand the dynamics of production and trade flows;
- understand the social interactions.
It is reasonable to estimate that **80 or 90%** of the time and energy of an archaeologist it is spent in the quantification of excavation finds.

Unfortunately, **quantification requires**:

- complex skills and since it is heavily dependent on human inspection and interpretation it is a very time consuming activity;
- a boundless bibliography, fragmented and incoherent, whose consultation is long and fatiguing also when is available a well furnished library ...
Analysis of sherds:
(a) the identification of the ceramic class, the specialist looks at:
• surface treatment,
• the decoration
• the fabric
(b) identification of the form type:
• looks into the ceramic class paper catalogues for the specific form;
• analyses the section of the potsherd and its profile;
• makes a comparison with the published vessels (hundreds of pages and drawings)
We want to innovate the archaeological practice, introducing a modern computer-aided approach. But we want to keep as much as possible unchanged the overall methodology, to ensure easy adaptation and impact in the archaeology domain.
ArchAIDE
Archaeological Automatic Interpretation and Documentation of Ceramics

The pipeline

1. Discovery of a new sherd
2. Production of initial documentation (2D images, drawing, text)
3. Automatic search over the digital catalogue
4. Validation of the Automatic Classification
5. Production of the digital Sherd Description File
[catalogues]

[Digitisation]
ArchAIDE
Archaeological Automatic Interpretation and Documentation of cEramics

Roman Amphorae

Maiolica

Terra Sigillata
- Implement tools to digitize the catalogues of the pottery classes selected by the project
- Populate the database structure of the reference typologies
- Analyse and extract information from reference drawings (and the images taken on-site)
- Provide input to the search-and-retrieval block
Analysing the catalogues

Strong variability in textual parts: from very structured to totally unstructured
(Assisted) manual and automatic text digitisation
From drawings digitisation to 3D models
[database]
Database design

The database is designed to:

• Hold images, shape models and descriptive data from the pottery collections

• Allow the recognition technologies developed to be applied

• Incorporate data from users
• Database capable of holding spatial geometries (polygon and point) for existing terms, or of creating additional features
• Principally uses country (Geonames), but also Pleiades and Getty thesauri for particular places (ancient towns).
Multilingual vocabularies

• Allows a conceptual and linguistical mapping.
• Different recording traditions may not only use different words, but different levels of granularity.
• Quite often, no direct match between very specific terms used across countries.
• The mapping to AAT ‘neutral’ terms allows us to widen searches outside of direct string matching.
ArchAIDE
Archaeological Automatic Interpretation and Documentation of cEramics

Database implementation
image recognition

DEEP LEARNING

appearance and shape based similarity search and retrieval
Appearance based recognition

- Decorations

- Stamps
Following a discussion with the archaeologists, a methodology was defined on how the data should be classified.

1. The user annotates a profile on a picture
2. The shape is extracted from the annotation
3. This shape is used for finding similar profiles, and ranking them by relevance

Ranking of pottery classes by relevance
The main steps of building the system are:

- Extracting pottery profiles obtained from catalogues
- Reconstructing 3D models of the pottery from the profiles
- Generating a database of synthetic sherds for each class
- Extracting the fracture shapes from the sherds
- Training a neural-network to learn classifying sherds by their fractures
[ArchAIDE System]

https://www.flickr.com/photos/wwarby/
ArchAIDE
Archaeological Automatic Interpretation and Documentation of Ceramics
ArchAIDE
Archaeological Automatic Interpretation and Documentation of Ceramics

Genere 56. Nodo orientale evoluto
Tra le decorazioni maggiormente

Genere 45. Compendiario della "famiglia bleu"
Questo processo riguarda

Il genere 19 è caratterizzato
da una decorazione che viene

Genere 54. Spirali arancio
Poche sono le novità elaborate

Genere 56. Nodo orientale evoluto
Genere 54. Spirali arancio
Poche sono le novità elaborate localmente negli anni 30-40

Genere 16. Imitazione della foglia valenzana
Questa tipologia di decoro deriva

Genere 33. Grottesche
Ben sappiamo come ad iniziare dai d'ultimi anni del XV secolo

Genere 15. Bleu Robbiano
Negli scarichi delle fornaci
<table>
<thead>
<tr>
<th>Genere 19. Settori puntinati.</th>
<th>Il genere 19 è caratterizzato da una decorazione che viene</th>
<th>32</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genere 26. Fasci con ovali e tonti.</td>
<td>Il genere 26, nella fase ancora</td>
<td>32</td>
</tr>
<tr>
<td>Genere 26. Fasci con ovali e tonti.</td>
<td>Il genere 26, nella fase ancora</td>
<td>64</td>
</tr>
<tr>
<td>Genere 53.3. Estenuazione nastri spezzati</td>
<td>Nel corso della seconda metà</td>
<td>35</td>
</tr>
<tr>
<td>Genere 54. Spirali arancio</td>
<td>Poche sono le novità elaborate localmente neli anni 30-40</td>
<td>35</td>
</tr>
<tr>
<td>Genere 50. Piatti pseudobaccellati</td>
<td>Il genere 38 si colloca tra le</td>
<td>31</td>
</tr>
<tr>
<td>Genere 38. Piatti baccellati</td>
<td>Il genere 38 si colloca tra le</td>
<td>34</td>
</tr>
</tbody>
</table>
Genere 5. Stile orientale
Il decoro si sviluppa per via delle decorazioni e delle figure

Genere 45. Deriva da una piccola foglia bleu
Questo processo di lavorazione si chiama

Genere 11. Lustro Metallico
La decorazione a lustro metallico si divide in 3 gruppi:

Genere 34. Fascia con bleu graffito.
Il genere 34 è detto fascia “con

Genere 29. Armi e scudi
Tra Quattrocento e Cinquecento i vasi di Montelupo elaborarono
Palazzo Scotto, Pisa

Region
Tuscany (Italy)

Latitude
43.71299

Longitude
10.407614

Assemblages

NEW ASSEMBLAGE
<table>
<thead>
<tr>
<th>Name</th>
<th>York</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
<td>UK</td>
</tr>
<tr>
<td>Region</td>
<td>Yorkshire</td>
</tr>
<tr>
<td>Latitude</td>
<td></td>
</tr>
<tr>
<td>Longitude</td>
<td></td>
</tr>
</tbody>
</table>

SAVE
ArchAIDE
Archaeological Automatic Interpretation and Documentation of Ceramics
Code

sherd1

Class Type

Amphorae
Terra Sigillata
Maiolica di Montelupo

Form

Assemblage

York / 1000

Type

Part

Note

ADD MEDIA

SAVE
<table>
<thead>
<tr>
<th>Code</th>
<th>sherd1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Type</td>
<td>Terra Sigillata</td>
</tr>
</tbody>
</table>

**Form**
- flagon
- cup
- jar
- beaker
- dish
- mortaria
- plate
- pot
- baking pan
- cookware
- casserole
<table>
<thead>
<tr>
<th>Code</th>
<th>sherd1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Type</td>
<td>Terra Sigillata</td>
</tr>
<tr>
<td>Form</td>
<td>bowl</td>
</tr>
<tr>
<td>Assemblage</td>
<td>York / 1000</td>
</tr>
<tr>
<td>Type</td>
<td></td>
</tr>
<tr>
<td>Part</td>
<td></td>
</tr>
<tr>
<td>Note</td>
<td></td>
</tr>
</tbody>
</table>
sherd1

Type
Conspectus form 27.1 (null)

Stamp

Decoration

Form
bowl

Part

Ceramic Class
Terra Sigillata

Note
Amphorae

Maiolica di Montelupo

Terra Sigillata
Conspectus form 24.1

Class 1

Comment

Conical cup as forms 22 and 23, with incurving rim, treated in various ways, including rouletting and appliqued decoration. Rim-fragments may not always bedistinguishable from Form 15.

Distinctive features

Vertical convex rim, curving smoothly inwards from the line of the wall, from which it is marked off by a fine groove; groove inside and/or outside at lip. Rouletting and/or applied decoration.

References

54.1.1 Haltern 1645a. Italien. 54.2.1 Gubbio 131 Abb.27,3. Italien. 54.3.1 Luni I Taf.64,4. Italien.
Africana 2A Grande

Comments

Principal contributor: Michel Bonifay and Simon Keay

Distinctive features

This is a fairly large cylindrical amphora, classified by Panella (1973) as a subtype of the 'Africana grande' type of Zevi & Tchernia (1969). The rim is thickened, with an almond profile, rounded on the outer face and generally marked by a small stepped undercut on the lower face (2A con gradino), at the junction with the short and quite cylindrical neck. The ribbon-in-section handles, with an ear-shaped profile, are larger than those of the Africana 1 type. The body is also taller and more globular with a medium-sized solid and tronco-conical spike. The neck (and rarely the handle) is occasionally stamped with the initials of a tria nomina in relief letters within a cartouche. There are no place names on this type.
ArchAIDE
Archaeological Automatic Interpretation and Documentation of Ceramics
Genere 25. Nasti

Definition

Tra le decorazioni della prima fase rinascimentale sviluppata nei più importanti centri di fabbrica italiani il motivo del “nastro” assume com’è noto, un ruolo di primo piano. Il termine “nastro” intende definire un’archeggiatura posta a contornare il centro delle forme aperte composte da una serie di segmenti paralleli tra di loro che vengono a disegnare una linea spezzata; essendo parzialmente campiti nel loro sviluppo lineare, il motivo così definito sembra in effetti voler imitare l’aspetto di un nastro, che viene ad incorniciare con le sue volute appuntite i decori centrali.

I materiali di scavo di Montelupo mostrano, con eccellente dovizia di particolari, il percorso formale di questo genere a partire da una versione più semplice e incentrata sulla rappresentazione di una sola corona nastriforme, corrente nel settore compreso tra il bordo e la cerchiatura del centro dei piatti laddove si collocano i motivi “principalì”.

Questa tipologia di decoro risulta correlata dai seguenti gruppi e sottogruppi: gruppo 25.1 (sottogruppi: 25.1.1; 25.1.2); gruppo 25.2; gruppo 25.3.
[Data preservation]
ArchAIDE partecipates in the **Open Research Data Pilot**. The data created will be preserved and disseminated online, and made freely available for use and re-use.
We created a Data Management Plan (DMP), following Guidelines on FAIR Data Management in Horizon 2020.

The DMP is a living document – periodically reviewed and edited to reflect changes in the project.

The DMP covers work in holding the data in perpetuity:

- Open Access
- Interoperability (Open formats, metadata)

At the end of the project, all data within the Reference database (catalogue data, images, models etc), and a subset of data from the Results database will be available within ADS archive:

- Accompanied by rich metadata permitting wide array of re-use
- Potential for use of object-level data within the ADS Linked Data store
- Visibility of ArchAIDE archive via European aggregators (e.g. ARIADNE)
[Data Visualisation]

[Distribution Map]

[Data analysis]

https://www.flickr.com/photos/wwwworks/
[Selection of test bed cases]
[Thank you for your attention]

www.archaide.eu

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement N.693548

The views and opinions expressed in this presentation are the sole responsibility of the authors and do not necessarily reflect the views of the European Commission.
Populating the Reference Database
Photographing Collections
Bonn, 25th of May 2018
Akademisches Kunstmuseum

XIX. AIAC 2018
Population of the database

Goals:

• population of the newly designed database
• establish import workflows
• creation of a mapping tool for an import process

After the first phase of the project:

• Focus on collecting training data for the neural network in TelAviv.
• Focus on collecting drawings of the types for the creation of 3D-Models
Pottery classes

- Amphorae
  - Terra Sigillata Hispanica
  - Terra Sigillata Italica
  - Terra Sigillata South Gaulish

- Majolica
  - Terra Sigillata Italica Stamps

Shape based approach

Image based approach
Structure of WP5 workspace

WP5/
Documents/

Paper catalogues/
Amphorae/ [catalogue scans]
TS/ [catalogue scans]
Majolica/ [catalogue scans]
Stamps/ [catalogue scans]
Bibliography [documents-pdf]

Photos/

Amphorae/ [subfolders]/ [photos]
Terra Sigillata Hispanica/ [subfolders]/ [photos]
Terra Sigillata Italica/ [subfolders]/ [photos]
Terra Sigillata South gaulish/ [subfolders]/ [photos]
Majolica/ [subfolders]/ [photos]
Stamps [photos] [extracted drawings]
Stamps identified/ [subfolders]/ [photos]
Stamps - revision required [subfolders]/ [photos]
Intranet structure

293 types of amphorae
61 types of TSH
339 types of TSI
104 types of TSSG

86 decorative types of Majolica di Montelupo
more than 10,000 extracted stamp drawings (Kenrick)
Development of a typology of Majolica from Barcelona

Museu del Disseny de Barcelona

<table>
<thead>
<tr>
<th>SEGLE XVI</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Table of Majolica from Barcelona" /></td>
</tr>
</tbody>
</table>
Digitising and Photographing

- ArchAIDE DB
- User input
- Digitized catalogues
- ADS CERMALEX

Flowchart:
- User input flows to ArchAIDE DB, which then flows to digitized catalogues and ADS CERMALEX.
Roman Amphorae: a digital resource
University of Southampton, 2005 (updated 2014)

Keay 59

Distinctive Features
This amphora seems to be a precursor of the amphora Keay type 8A (Bonifay, 2004). It is characterised by a flanged rim with squared section directly prolonging the tall and cylindrical neck. The latter present a finger impression on his internal face at the upper attachment of the handles, which have a small triangular profile and an elliptical section. The body is perfectly cylindrical, gently rounded at he base, terminating in a filled, cylindrical spike with a flat bottom.

See characteristics

Date Range
End of the fourth and first half of the fifth centuries AD.
Search: [4th century AD] [5th century AD]

Origin
Origin seems to be the same as that of the Keay 8B type, production of which is attested to in southern Byzacena, perhaps at lunca (?) (Bonifay, 2004).
Search: [North Africa] [Tunisia]

Distribution
Distributed in small quantities in the western Mediterranean (Catalunya, southern France and Italy). It is also attested in the eastern Mediterranean (Egypt: unpublished). Most of the complete examples come from Catalunya (Keay, 1984). An example from Arles is well dated in a context of the beginning of the fifth century AD (Congès & Leguilloux, 1991). An example from Rome seems to be late in date (Whitehouse et alii, 1982).
Search: [Eastern Mediterranean] [France] [Italy] [North West Europe] [Spain] [Western Mediterranean]
Keay 59
Amphorae

Distinctive Features: This amphora seems to be a precursor of the amphora Keay type 8A (Bonifay, 2004). It is characterised by a flanged rim with squared section directly prolonging the tall and cylindrical neck. The latter present a finger impression on his internal face at the upper attachment of the handles, which have a small triangular profile and an elliptical section. The body is perfectly cylindrical, gently rounded at the base, terminating in a filled, cylindrical spike with a flat bottom.

Period Text: End of the fourth and first half of the fifth centuries AD.

Primary Function: Transport
Forms: amphorae
ArchAIDE DB

dataimport

user input

digitized catalogues

ADS CERMALEX
Form 22  Conical cup with concave and normally finely moulded vertical rim

Konische Schale mit gekerbt und meist sehr profilierter Stellung

Coppa tronconica o con parete leggermente concava e orlo verticale convesso-concavo

Coupe tronconique à rebord vertical, concave, généralement finement moulée

Cup with conical body and concave vertical rim bounded above and below by convex mouldings which are usually rouletted; the floor may be curved, flat or beconical and there is considerable variety in the height of the foot, which sometimes bears a groove on the outer face. On the exterior, the wall rises directly from the lines of the foot. See Haltern 794 for a cup of this form in which the wall meets the floor outside the line of the foot. Counterpart to the plate Form 18.

22.1: External and internal rim-mouldings as Subform 18.2. The axis of the rim is vertical and it rises from the wall at an angle but without any break. Occasional applied double spirals.

22.2: Distinguished from the preceding by the fact that the axis of the rim slopes outwards, more or less continuing the line of the wall; this feature is also regularly associated with a slightly convex body, curved floor and externally grooved foot. Sometimes also a narrow band of rouletting on the lower part of the wall (as on 224.1.1).

22.3: The central element of the rim is flat on the outer face rather than concave, and the lower convex moulding projects downwards to form a marked overhang where it joins the wall.

22.4: Rim as Subform 22.1 but compressed and inclined inwards.

22.5: Outer face of rim as Subform 21.1, inner face composed of a single convex element marked off at lip and at junction with body by grooves. Occasional applied double spirals.

22.6: Similar to Subform 22.5 but with all details reduced to a minimum.

Production

Probably made in all the principal centres of TS production, though very few are certainly from Arzoa. Some regional trends are apparent despite much overlap. Very large cups (diam. 18–20 cm., as 22.1.1) may have been produced only by the Alesina workshops at Pisa; otherwise there are two standard sizes with diam. 12–14 cm. and 7.5–9 cm., respectively. Subform 22.2 seems to be exclusive to Puteoli and Subform 22.3 was apparently produced only by T. Malissa Fortenotus at Lyon (though the same workshop produced more conventional examples of the form). The output of the Padova factories adheres to the main elements of the form, but is generally simpler and more geometric in execution and always without applied decoration (see Subform 22.6).

Date

Present at Oberaden and Rodgen in greater quantities than the plate Form 18 and probably therefore introduced a little earlier, i.e. during the second decade B.C. Also attested at Dangastetien. The relative quantities of the various forms found at Haltern suggests that for a while cups of Form 22 were being produced and used alongside plates of Form 12. It is possible that the form was first invented at Puteoli. Chronological development cannot be rigidly defined, but there is typically more variety at first, as the form evolves towards Form 23 the curved floor and the internal divisions of the rim disappear, probably around the end of the Augustan period. A few low forms become regular, and applied double spirals appear before the abandonment of Haltern; the transition to Form 23 is probably complete before the end of the reign of Tiberius.

References

22.2.1 Kartberg K 772/24. unpublished. Stamp: SARVNER, A.C. 2137. Italy.
22.2.2 Haltern 1212. Stamp: SEX AFR, O.C. 91. Italy.
22.2.3 Haltern 1040. Stamp: IESCINOS, O.C. 1719. Puteoli.
22.4.1 Dangasteit 52/14. Stamp: PRB/WMV, O.C. 1397. Italy.
22.5.2 Kartberg K 772/24, unpublished. Anepigraphic stamp: O.C. 2562. Italy.

Other forms

22.1 Not separately listed.
22.2 Aschburg, Berenic, Coimbriga, Norremon, Orona, Puteoli.
22.3 Canavon, Norremon, Tongeren.
22.4 Aschburg, Coimbriga, Norremon, Papillon.
22.5 Not separately listed.
22.6 Angera, Bologna, Luni, Pellostia.

Concordance

22.3: Mazzeo 12C.
22.5: Mazzeo 12B. – Berenic (RSO) 3. – Hayes 16A. – Oberaden 7. – Rodgen 9C.

Also: Halter 9. – Goudelain 37. – Pueci 258. – Barocelli 10. – (Ruttering 3).

Note: Halter 9 is not sufficiently clearly defined to be attributed to any specific subform.

P.M.K.
Examples of digitized catalogues

- **AAVV**, Concpectus Formarum Terrae Sigillatae italicco modo confectae
- **Berti**, Storia delle Ceramica di Montelupo (4 Volumes)
- **Dragendorff**, Terra Sigillata
- **Fornaciari**, La sostanza delle Forme: Morfologia e cronotipologia della Maiolica di Montelupo Fiorentino
- **Gempeler**, Elephantine X, Die Keramik römischer bis früharabischer Zeit
- **Hayes**, Late Roman Pottery
- **Medri**, Terra sigillata tardo italica decorate
- **Medri**, Terra sigillata tardo italica decorate
- **Medri**, Terra sigillata tardo italica decorate
- **Mayet**, Les Céramiques Sigellées Hispaniques
DEMO
Photo campaigns to get data for the verification of the neural network

The trained neural network needs sherds to verify the results out of synthetic-sherds-training.

UNIPI, UB, Baraka and Elements carried out campaigns to gather photos.

Guidelines for the workflow had to be established to get the best possible results.
DOCUMENTATION OF CERAMICS FOR THE DATABASE POPULATION (PHOTOS OF THE MUHBA COLLECTION AND ARQUB DATABASE)
DOCUMENTATION OF CERAMICS FOR THE DATABASE POPULATION (PHOTOS OF COLLECTIONS IN ITALY)
DOCUMENTATION OF CERAMICS FOR THE DATABASE POPULATION (PHOTOS OF COLLECTION IN MAGDALENSBERG)
Tasks for the future

- Population of the database with textual and pictorial information
- Evaluation of the results of the neural network
- Connection of database to the mobile application
This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement N.693548

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