Work Package 2: Laying the Foundations for AUTOMATA

From September 2024 to April 2025, the AUTOMATA consortium carried out Work Package 2 (WP2). This phase brought together all partners to review existing practices, define methodologies, and set the stage for the project's future developments.

Objectives

The goal of WP2 was to review current practices, protocols, and technologies for digitising cultural heritage artefacts, and to design a methodological framework for gathering and structuring data. This framework now underpins the project's next steps: designing the robotic system, creating 3D models, integrating physico-chemical data, and defining the ICT architecture.

How archaeologists work today

To understand what was needed, WP2 began with a simple but crucial question: *how do archaeologists currently work with ceramics and lithic artefacts, and what challenges do they face?*

Traditional procedures involve washing, numbering, reassembling fragments, drawing, and classifying artefacts. These are essential but time-consuming, manual activities. In recent years, digital tools have opened new possibilities. Techniques such as 3D modelling capture an artefact's shape, texture, and morphology, while miniaturised spectrometers provide precise elemental and molecular data without damaging the object.

Challenges

Within WP2, partners reviewed the state of the art and combined their expertise to explore how automation, AI, and robotics could support and improve archaeological work. Alongside technology, the team also examined political, legal, and ethical challenges.

Digitisation practices vary across regions. In some countries, images can only be shared under licences such as CC-BY-ND-NC for research and non-commercial use. In others, 3D models require authorisation and may fall under stricter licences. While AUTOMATA's archaeometric data will be openly shared under a CC-BY licence, embedding these data into 3D models requires careful consideration of local rules.

Ethics and responsible data use

Ethics are central to AUTOMATA. Each stage of digitisation, from selecting artefacts to distributing digital files, raises potential concerns around manipulation, bias, access, or authenticity. AUTOMATA follows the ethical principles of AI defined by the High-Level Expert Group on Artificial Intelligence (HLEG, 2019): autonomy, non-maleficence, beneficence, justice, and explicability.

Another reflection concerns data reuse. Even when datasets are open, derivative models may become private property, raising questions about equity. AUTOMATA addresses this by promoting responsible data sharing that protects both heritage and stakeholders' interests.

Selecting tools and protocols

After reviewing methods, WP2 defined the functional specifications of the AUTOMATA system and selected the most suitable tools. Photogrammetry was chosen as the main 3D recording protocol. It is cost-effective, widely used in archaeology, adaptable, produces high-quality textures, and performs well with translucent materials.

To complement imaging, WP2 integrated a range of portable, non-destructive spectrometers: hyperspectral imaging (HSI) cameras, portable X-ray fluorescence (pXRF), and handheld Raman devices. These will enable precise, non-invasive chemical characterisation of artefacts.

Designed for mobility

Portability was a design priority. The AUTOMATA system is conceived as a movable digitisation unit, able to travel between museums, storage facilities, and archaeological centres. It will be compact enough to pass through standard doors and elevators, with dimensions fine-tuned during the prototyping phase.

Looking ahead

Through WP2, AUTOMATA has laid the foundation for a system that is technologically advanced, ethically responsible, and aligned with real archaeological practice. The next step is to move into prototyping and testing, bringing us closer to a portable, innovative tool for the future of cultural heritage.

Curious to know more? All the reports on the work done so far are available here
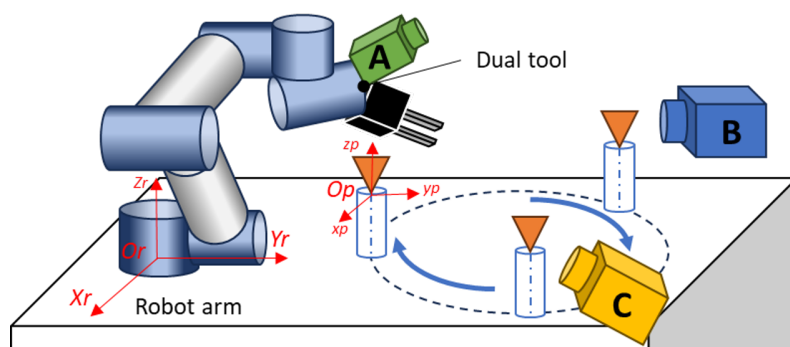
Fig.1 Work cell layout

Schematic view of the AUTOMATA work cell, showing the robotic arm and data acquisition systems (A–C). The robotic arm, equipped with a dual-tool gripper, handles artefacts and moves them between analysis stations: A) 3D/HSI acquisition, B) portable XRF, and C) handheld Raman spectroscopy. The process starts with a 3D/HSI scan, which also indicates whether further analyses are needed, before transferring the artefact sequentially to the other stations.
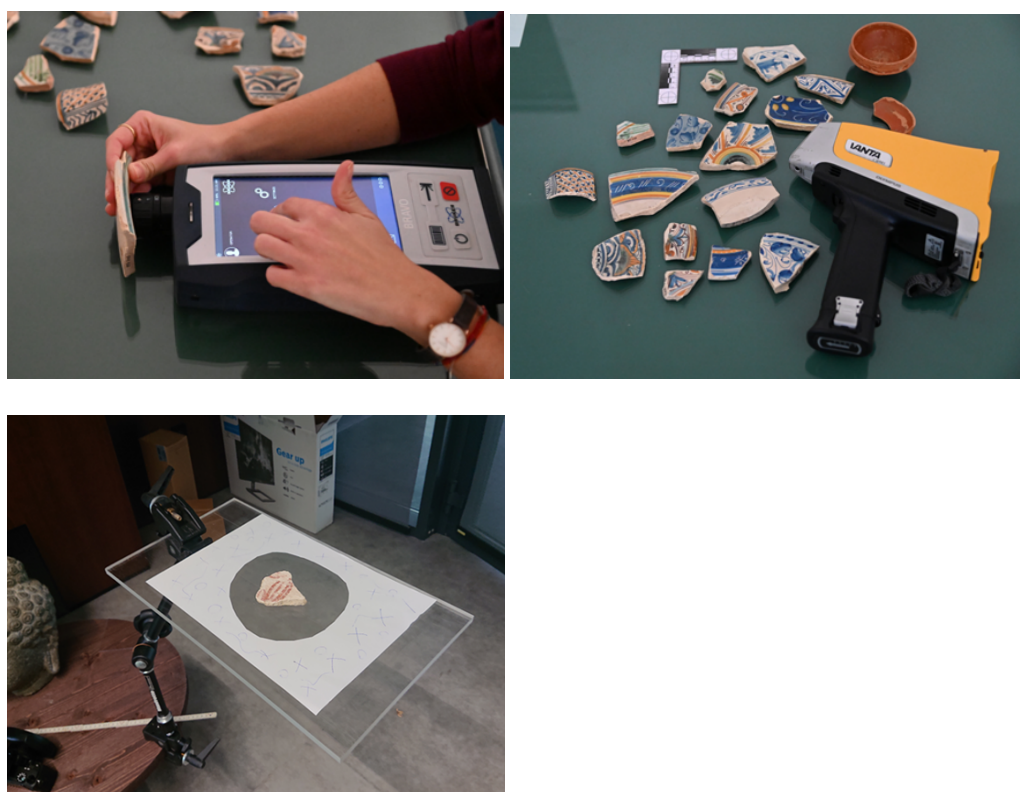

Fig.2 Testing activities.
Top: analyses carried out at the LAD (Archaeometry and Diagnostic Laboratory), University of Pisa, using the Bruker Bravo handheld Raman spectrometer and the Olympus Vanta pXRF.
Bottom: photogrammetry setup tested at the Archeovision laboratory, Université Bordeaux Montaigne.