Arqueología, Patrimonio y Arquitectura: protohistoria

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Academic career

Most of my academic career was focused on the archaeology of Northwestern Mediterranean societies' late Prehistory (Neolithic and Protohistory). More precisely my speciality is the study of ancient iconographic systems (rock art, pottery and stelae decorations) belonging to these societies. My first major research took place during my PhD (University of Nice). I studied one of the largest concentrations of rock art in Europe, with almost 20,000 figurative engravings, the Mount bego site[1]. At this time I applied descriptive, exploratory and confirmatory analysis performed on a geodatabase I created. This work was useful to perceive the *longue durée* of the site occupation and to disentangle the different iconographic layers. It led me to significantly improve my skills in GIS, databases and statistical analysis. These IT skills allowed me to join a department of Cartography (University of Bourgogne) where I levelled up my skills in GIS, databases and statistics and where I learned that these technics could be put together with computer programming and conducted entirely on open-source software. The following year, I joined the research laboratory ASM-CNRS (University of Montpellier) on a postdoctoral project (Labex Archimede) to deal with a well-known case of French Protohistory: the brief reintroduction of figurative art during the end of the Late Bronze Age. This postdoc led me to set up the root of an innovative method to record and analyse iconographic content through a geometric graph (network analysis). With colleagues, we published this method, as an open-source library, for the R scripting language[2]. I have drawn a synthesis of the protohistoric iconography in France[3], I also worked on a medieval rock-art site in the Spanish Central Pyrenean[4], on Iron Age rock art in the Italian Central Alps[5] and on Early Neolithic figurative bladelets in the Near East[6]. Iconography is my speciality, but most of the time I have worked outside this field of research since my computer skills allow me to work on very different periods, geographical areas or thematics. Among other things, I have worked on the spread of Neolithic, developing research and data papers alongside online interactive applications[7]. I have taken charge of the statistics of a very comprehensive study of

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[2]Huet, T., Pozo, J., & Alexander, C. (2021). Analysis of Prehistoric Iconography with the R package iconr. Journal of Open Source Software, 6(61), 3191.

[3]Thomas Huet (2018). Une revue de l'iconographie du début du Néolithique à la fin de l'âge du Bronze (ca. 5700-750 avant notre ère) en France. In La Protohistoire de la France (pp. 221–249). Hermann.

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[6]Ibañez, J., Muniz, J., Huet, T., Santana, J., Teira, L., Borrell, F., Rosillo, R., & Iriarte, E. (2020). Flint 'figurines' from the Early Neolithic site of Kharaysin, Jordan. Antiquity, 94(376), 880–899.

[7]Huet, T., Cubas, M., Gibaja, J., Oms, F., & Mazzucco, N. (2022). NeoNet Dataset. Radiocarbon Dates for the Late Mesolithic/Early Neolithic Transition in the North Central-Western Mediterranean Basin. Journal of Open Archaeology Data, 10(3), 1-8.; http://shinyserver.cfs.unipi.it:3838/C14/; Binder, D., Gomart, L., Huet, T., Kacar S., Maggi, R., Manen, C., Radi, G., Tozzi, N., & C. Panelli (2022). Le complexe de la Céramique imprimée de Méditerranée centrale

livestock management (from Late Neolithic to Late Antiquity) in Northeastern Spain[8], I am currently involved in the French ANR Itineris project on Italic metalwork techniques during the Early Iron Age, and I have worked on the spatial distribution of Latin epigraphy in Southern France[9]. I joined the University of Oxford, as a researcher and database manager, on Endangered Archaeology in the Middle East and North Africa (EAMENA) in October 2021. The EAMENA database gathers more than 300,000 records of cultural heritage places, information resources, etc. It is compliant with the highest standards of open science and FAIR data. This position has allowed me, among other things, to work from the server-side with international cultural heritage, multi-linguism, controlled vocabularies and ontologies.

Statement of need

After a division of Prehistory into tools-related industry periods, with Palaeolithic, Neolithic (stone *instrumentum*), and Copper Age, Bronze Age and Iron Age (metallic *instrumentum*), starts the Protohistory commonly accepted as the emergence of proto-state societies without (or a scarce use) of writing systems. Writing is the most rigorous semiographic. Before writing which signs the historical times, symbolic concerns of early societies were mostly accessible through paintings and engravings made on rock panels, stealae and ceramic. All these iconographic manifestations belong to the symbolic subsystem[10]. Unlike other sub-systems – like, for example, subsistence, technological or demographic – iconography is relatively disconnected from any determinism imposed by matter[11] and technical efficiency[12]. Displaying iconographical content offer great freedom of expression in the choice of themes, styles, technics and selected mediums. Even more, it is very much uncertain whether this iconographic content is meaningful *per se*, independently from its location, or whether it just signs the importance of a particular place (a landmark). Because of its great variability through time and space (space-dependent and time-dependent), the study of ancient iconography has been set apart from other subsystem studies, a majority of archaeologists consider that it is still lacking common standards, shared methods and consensus on how any interpretations can be drawn from the observed data. Archaeological research on ancient iconography often led to databases – or more likely to datasets – but these databases are often context-based and rarely interoperable one with another. Their use is then limited to a certain area or a certain period, complicating significantly the possibility to draw cross-cultural comparisons at a large scale and over the long term. Furthermore, issues appear about their long-term sustainability.

Research project

My research project is based on the observation that there is a need of common practice for the study of ancient iconography. To deal with its great variability my approach is to developped multi-scalar and multi-paradigm statistics to unveal the statistical regularities of large iconographic datasets. The developpment of this type of analysis would have been fruitless without efficient tools and a robust and iterative method. That is why I developped computer programming alongside with database management, statistical scripted routines, with a particular focus on geometrical (topological relationships, shape analysis) and geographical analysis (through spatial functions) to deal with the

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[11]Leroi-Gourhan, A. (1941). L'homme et la matiere: evolution et techniques (vol. 1). Albin Michel; Leroi-Gourhan, A. (1945). Milieu et techniques: evolution et techniques (vol. 2). Albin Michel.

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graphical units, their support, and the archaeological context where they belong. As my professional career, my project entangled two principal components:

- A: Development of the Interoperability Framework for Ancient Iconography (IFAI)
- B: Archaeology of Pre- and Protohistical societies semiographies

A. Development of the IFAI

Following the spread of the web and the use of digital cameras, both cultural heritage, art and architecture management and image recognition software have seen significant improvements in development thesauri (Getty AAT, Getty IA[13], Iconoclass[14]), metadata standards (EXIF, XMP[15]), high-resolution image sharing on the web with shared API, shared content (IIIF[16]), automated object/pattern/image recognition (e.g. Google Image), etc. These improvements not only concern the 2D images but also the 3D objects with the development of the new standard HTML5 and the base of the so-called web3D[17]. Indeed, most of the IT existing for 2D objects are promised to be available for 3D objects in a next future. At the same time, the international scientific community, and even more the European research community seek to promote open science (OS), to make data "as accessible as possible and as closed as necessary". The ARIADNEplus infrastructure aims to promote the use and sharing of controled vocabularies, good practices, iso-standards, etc.

This context of available open-source software, and open-source data, made possible the set up of an Interoperability Framework for Ancient Iconography (IFAI, working title) in the frame of the OS horizon.
Archaeologists are often unarmed to deal with concepts like FAIR data[18], linked open data (LOD[19]), data management plan (DMP[20]), unique identifiers[21]. If they understand them, they rarely have the skill and the time to implement them. On the other hand, computer scientists do not understand entirely practices in social sciences or are not able to highlight the relevant problematics in a research field. My computer skills and experience as an archaeologist will allow me to set up – or contribute significantly to set up – this IFAI. Indeed, I master R and Python programming languages. I am also able to work with any JavaScript scripts or file formats (JSON, GeoJSON). R is the most commonly used language in archaeology; its use is mostly for the front-end (user interface), Python is the most world widespread language; its use is mostly for the back-end (databases, servers, file/image manipulation). Finally, JavaScript is the language of the interactive web. Along with these programming languages, I master several database systems, including the first place of which Postgres/Postgis. Postgres is the core of the EAMENA database I manage. EAMENA itself is based on the open-source Arches database developed by the Getty Conservation Institute for the management of immovable cultural heritage. Arches is a geo-web NoSQL database (ie, semantic graph-based database). Arches is more a platform than a database since it offers a full-stack information system that integrates the iso-standard CIDOC-CRM, the Dublin Core vocabulary, the SKOS RDF data model, and a SPARQL endpoint, hosts an IIIF plugin, etc. Today Arches is used in several international projects hosted by the universities of Oxford, Cambridge, and the Max Planck Institute, among others. I will reuse part of this IT to developp the IFAI. My first step will be to set up a GitHub repository. GitHub is a leading web platform for developing computer applications and sharing source code offering all the facilities to comply with the FAIR principles (licences, 'how to cite', DOI versioning, contribution rules, Zenodo releases,

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triggered workflows, etc.). Nowadays, GitHub is the platform for any open-source collaborative IT project. This comprehensive platform is the first step before developing new technologies like Artificial Intelligence/Machine learning. Setting up, today, this IT to share common tools and methods will ensure our capacity to draw a global narrative about past societies' symbolic activities, and not narratives in competition one with another whether at the regional or national level. Indeed, all studied and published datasets will be made compliant with the FAIR policies, following the OS recommendations: "publish once and reuse often". In such a way, the heritage value of the past iconography will be shared through the international community[22] and preserved for future generations.

B: Archaeology of Pre- and Protohistical societies semiographies

While the IFAI represent the information technology, the archaeological knowlegde about semiographic systems will come from a wide survey of iconographic system of Western Asia (from Middle East to the Atlantic) during the later times of pre-writing societies. I already defined the way to analyse any object with a graphical content. These latters are the sum of individual graphical units. The artifact "graphical unit" has seven different dimensions: (i) its theme (eg., a horse, a human figure) which can be described in a hierachical thesaurus[23], (ii) its shape which is properly its geometry and can be manage with shape analysis, (iii) its topology (its relative location compared with other graphical units) which can be manage with the *iconr* package (see[24]), (iv) its technics (eg., paintings, painting with iron oxyds, engravings) which can also be manage with hierachical thesaurus and multifactorial analysis (for example, for the results of elemental analysis made with pXRF on paintings), (v) its support (eg., stelae, situla), (vi) its geographical location, and (vii) its chronology. The caracterization of a "graphical content" is then, the matrix calculation of these dimensions to measure the distances beetwen multiple pairwise of decorated objects. Of course not all these dimensions can be assess, and archaeological remains have numerous missing data, furthermore a lot of the graphical production of ancient periods have disappeared with their support (eg., carved wood, printed textile, skin tatoos). But this is the main limitation of any archaeological studies.

Today, my archives count drawings, photographs, bibliographic references, descriptions and geodatabase records of near 3,000 decorated objects with iconographic contents (rock panels, stelae, potteries, metallic vessels, etc.). These objects belong to a period sprawling from the Early Neolithic to the first Iron Age. The geographical area this database covers is mainly Spain, France and Italy. Graphical content is part of well-known series, among which: Levantine rock paintings, Macro-schematic rock paintings, Schematic rock art, Atlantic megalithism rock art, Atlantic cups-and-rings, Galician rock art, Rouergue stelae, Extremadura stelae, Lunigiana stelae, Situla Art. Alongside these decorated objects, my database records 7,700 graphical units and near 430 complete graphs, that is to say, the mapping of 430 semiographies (see[25]). I will subset this data and complete these subsets in compliance with the FAIR policies and semantic web (files' DOI, EXIF and XMP metadata of drawings and photographs, JSON manifests for IIIF, etc.). In parallel, I will set up a scripted routine to cast each dataset into open and interoperable formats (open data) and expose them on a server open to specialists (with different user permissions) for them to provide their expertise (quality control), complete the missing data, and collaborate to conclude the archaeological meaning of these iconographic contents. I already collaborated with colleagues from France (Megalithic art), Italy (Valcamonica art) and Spain (Warrior stelae, Levantine and Schematic art). I plan to work primarily on the Protohistory of these countries, starting with the so-called Warrior Stelae (es: *Estelas de Guerreros*) corpus belonging to the Late Bronze Age of Extremadura (southwestern Spain) for which I already have almost all the graphs (n

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[23]

[24]Huet, T., Pozo, J., & Alexander, C. (2021). Analysis of Prehistoric Iconography with the R package iconr. Journal of Open Source Software, 6(61), 3191.

[25]Huet, T., Pozo, J., & Alexander, C. (2021). Analysis of Prehistoric Iconography with the R package iconr. Journal of Open Source Software, 6(61), 3191.

= 122), as well as complete graphs of connected series: Alentejo stelae (South Portugal, n = 31), Headdress Diadem stelae (Western Spain, n = 34), among others. This ability to compare with precise statistical indices series conventionally studied separately will open the possibility to also compare earlier iconography (Atlantic cups-and-rings, Megalithism art) or later iconography (Orientalizing art, Late Iron Age). Therefore, this framework will cover enough graphical contents to be considered a milestone in modern archaeology.