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PYARCHINIT AT CASTELSEPRIO: PROGRESSIVE ADOPTION OF AN INTEGRATED MANAGING SYSTEM FOR ARCHAEOLOGICAL FIELD DATA

1. Introduction

This paper explores the adoption of pyArchInit as a tool for managing field data in the investigation of Casa Torre, Castelseprio (VA) (La Salvia *et al.* 2022). The topic will be tackled from a teaching/training perspective, focused on a small team of students and in the framework of a research/training excavation. The use of digital tools for the management of archaeological field data is nowadays a standard practice. Being primarily spatial and alphanumeric data, GIS has a long tradition of being used for mapping and/or recording archaeological evidence and many proprietary and open applications have been built for this purpose (such as iDig, Archtools, OpenDig and many others, see Doneus *et al.* 2022; Psarros, Stamatopoulos, Anagnostopoulos 2022). In the last two decades, the needs of archaeologists shifted from simple 2D shapes and simple local databases, to 3D imaging, LiDAR, UAS imagery as well as multiuser remote databases, Big Data analysis and so on.

M.M.

2. The context of Casa Piccoli (Castelseprio, Va) between research, training and public archaeology

The use of traditional documentation systems (i.e. paper) has long since begun to show its operational limits. We all know that archaeology produces an enormous amount of evidence that often has to be translated into a written record, the compilation of which, besides being time-consuming and laborious, is frequently subject to a high percentage of inhomogeneity and errors. Fully mastering such a wealth of information generally turns into an arduous, if not impossible task, especially when it has to be fully processed (to transform it into a historiographical model). On the contrary, the use of the IT tool allows for a much more effective and versatile archaeological record's archive. Moreover, it makes it possible to implement strict quality controls at the data entry level and to perform a wide range of analyses at the interpretation stage (statistical, spatial, logical, data managing), providing new opportunities for achieving greater flexibility than the paper-based record. It is precisely these two aspects, on both the managerial and the

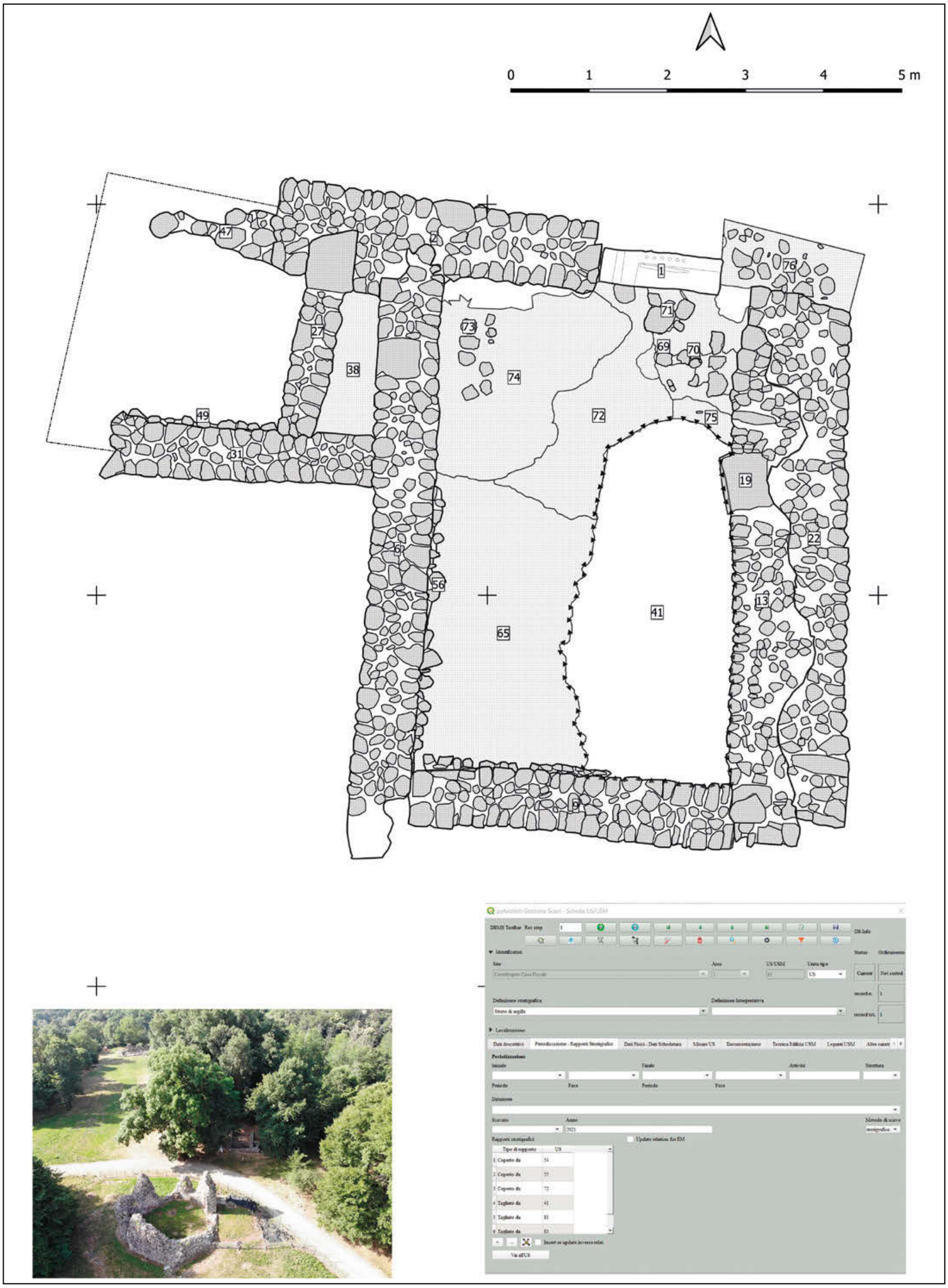

Fig. 1 – Excavation at Casa Piccoli, Castelseprio: pyArchInit US vectors and database.

analytical level, that most clearly are showing the qualitative increase that digital technology has brought to archaeological research.

This is particularly true in cases such as that of Casa Piccoli excavation (Fig. 1), where the need to document a complex stratification (early medieval layers, features of dismantled metal workshops) has to be combined with that to build a record appropriate to both didactic-formative and dissemination aspects (i.e. Public Archaeology), the site being located within an Archaeological Park. Digital archaeology and data management are fundamental and mandatory to have a continuous overview of the investigation area; to update the data and be able to query it, facilitating the data validation process; for cross-referencing data; for creating an open and public scientific and scholarly environment. However, in order for technology to truly assume a transformative role within the research project, it deserves to be used with awareness and full knowledge of the real capabilities of the tools.

The researcher should be able to choose for the most suitable type of hardware and software environment, depending on the purposes of the research project, the shape of information that has to be supported and the type of processing data that is to be implemented. Above all, it is necessary for the archaeologist to be able to determine how the information and the analyses of the data are to be managed by the computer. The tool-building process, in fact, has to be centered on the elaboration of a data modelling process: this represents, in the analysis of an IT solution, the moment of closest involvement of the archaeologist's own "cognitive process". The accuracy of the information recorded and the possibility of producing knowledge through the use of digital technology largely depends on it. In fact, if archaeology still stands in the field of Humanities, aiming to increase historical knowledge through the use of material evidence, information technology applied to archaeology should be understood as a set of methodological and technical tools only for the elaboration of historical models.

The possibilities offered by digital technology are perfectly suited to the purpose: they allow large quantities of data to be managed, disseminated and shared. Such a possibility opens up entirely new perspectives in the field of archaeological research, potentially making a vast collection of information available to the entire scientific community, online and in real time. The benefits deriving from this approach range from the search for comparisons to the contextualisation of data, from the possibilities of performing quantitative analyses to cross-checking the quality of information and processing and managing data (Fronza, Nardini, Valenti 2009; Montagnetti, Mandolesi 2019).

V.L.S.

3. pyArchInit in practice: a 3-year program

In the choice of a digital tool for recording the archaeological evidence in our excavation, there were some requirements to be met. The first requirement was related to the Italian law on research excavations. The archaeological excavation at Casa Piccoli, Castelseprio is carried out under the license of the Ministry of Cultural Heritage (ref. 631/ 23-05-2022). Current regulations from the Ministry of Cultural Heritage require the delivery of the site plans and topographic position in a vector format, specifically shapefiles SHP, Geopackage GPKG or DXF. Therefore there was a need of GIS software, at least for the final delivery of documentation. The second requirement was to be open (open as open source archaeology and open archaeology: Wilson, Edwards 2015; Marwick 2017) and integrated with the tools we already use, specifically QGIS. The "openess" affects not only the data but also the students involved in the excavation.

Being a university training excavation, it is aimed at teaching students the necessary skills to work in the field. The batch of students working in our excavation is highly trained (4-6 months of previous experience with fieldwork), already exposed to GIS use, even if in a very basic form. This training aspect is very important when you take into consideration which tool or software will be used in a research/training excavation. Two topics, in particular, were crucial in our choice. The first topic is the restricted amount of time available to students for training and practicing the tool/software. Students are usually trained on the go during the excavation or, more rarely, just after the excavation when the lab activities take place. Due to deadlines, exams and courses, the time dedicated for these activities is always short. A second and perhaps even more important topic is sustainability. Training in excavations and lab activities is fundamental to develop skills for the job market. When a student graduates in Archaeology, he is supposed to know not only how to dig or how to correctly draw a potsherd, but also how to manage digital archaeological data, like site plans, aerial photographs, drawings, 3D models and so on.

Therefore we argue that teaching through FLOSS software (such as QGIS and pyArchInit) is ethically correct as they are available for everybody to use and economically sustainable in the framework of soon-to-be professionals. PyArchInit met all the requirements we had, being FLOSS software and specific for the digital management of an excavation. The software, developed since 2009 by L. Mandolesi and E. Cocca (Mandolesi 2009; Mandolesi, Cocca 2013; Montagnetti, Mandolesi 2019; Mandolesi, Montagnetti, Pickel 2022) is a plugin for QGIS, meaning that there was no need for an external software and the main commands were already

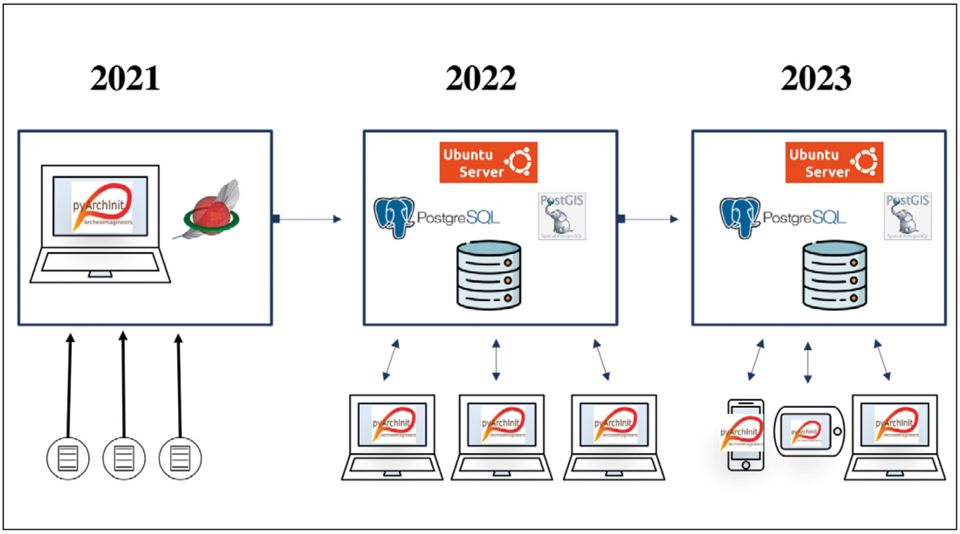

Fig. 2 – Graphical schema of the 3-year implementation program.

known by the students. Quoting the developers, in fact, «pyArchInit has been created by archaeologists, and it caters to specific archeology needs. It provides dedicated tools that allow archaeologists to upload and check all the digital survey information taken and all the alphanumeric documentation (paperwork) produced during an archaeological project» (Montagnetti, Mandolesi 2019, 32). PyArchInit includes a range of features, such as the ability to create detailed site reports, generate maps and plans of excavation sites, and manage artifacts. One of the key advantages of pyArchInit is its ability to handle large amounts of data efficiently and accurately. Also, being integrated in QGIS, it works in an environment which provides a powerful tool for digitizing vector data and georeferencing raster plans, as well as a database tool to manage Stratigraphic Unit sheets, etc. One issue that has been personally faced with the software is its learning curve, which may require many hours of application especially if one tries to master the software all at once.

Building on previous experience in using the software, it was planned to implement it with a gradual transition from a traditional full paper documentation to a fully digital one (Fig. 2). There was no previous documentation to acquire, since the excavation started from scratch; this gave us also the opportunity to gradually increase the complexity of the infrastructure in use, shifting from local to remote. This was meant not only to understand the capabilities offered by the software but also to evaluate in person how difficult and how much expensive it is. This former aspect should not be taken lightly from the point of view of a soon-to-be professional. The implementation program covers the years 2021-2023 (Tab. 1).

	Nr. of Students	Focus	Activities
2021	6 (MA candidates with preliminary training)	Local; Spatialite; Data Recording; Single user, tasks divided by team	Paper documentation on field, Digital in lab
2022	7(6MA candidates + 1 Postgraduate)	Server; Remote; Data Recording, Elaborating; Multi-User; task shared by team	Paper and Digital documentation on field
2023	10 (foreseen)	Resolve Issues; Raster Data; Mobile	Workflow setup Mobile data entry

Tab. 1 – 3-years implementation program.

For 2021 excavation a new project was created on a main machine with a local, single user Spatialite database. During the archaeological investigation, paper stratigraphic unit sheets (SUs) were used to record data and UAV pictures and Structure from Motion of Casa Piccoli to survey archaeological features. Later in the lab, the students were divided into small teams and were assigned a specific task: team A to fill SUs in the database, team B to take inventory of the artifacts and team C to map SUs on georeferenced orthophotos. The result of the first year was that six students were involved in this field training. They were all MA candidates and they already had some excavation experience. As a result of the 2021 campaign, we compiled 75 SUs, 50 artifacts in the inventory and drew over 1000 vector shapes, taking 4 weeks of work, of which 2 on field and 2 in lab, dedicated especially to the yearly report due to the Ministry of Culture.

The transition to the second year 2022 was instead focused on shifting on a multiuser, remote approach. Before the excavation, a server was assembled re-using an old desktop PC (i7, 12Gb Ram, 1 Tb SSD) running Ubuntu Server and hosting a PostgreSQL Server with PostGIS extension. A collateral goal was to judge, even in a subjective way, how difficult it was to set up such a machine and also to reuse an old PC to save money. Data from 2021 was then uploaded to the new server. Students were still asked to compile both digital and physical SUs and artifact inventories, but this time every student accessed the data directly on the server and everything was digitized into the remote database. Also, instead of teams dedicated to specific tasks, everyone worked on different parts of documentation. By the end of 2022, the PostgreSQL database hosted 100 SUs, more than 70 artifact items and over 1900 vector shapes. It must be noted that currently only vector data are uploaded to the server, while raster data, such as orthophotos are still on local machines.

The third year 2023 foresees the stabilization of the remote server protocols and workflow, addressing all the issues encountered previously (see below the SWOT analysis), as well as experimenting with digital recording in the fieldwork, possibly through mobile applications (i.e Qfield). Also the focus will be more on data elaboration and specifically on the implementation of structures and phases to build period plans.

4. Discussion-SWOT analysis

After two years of implementation, it was decided to run a SWOT analysis: while the primary goal of SWOT analysis is to increase awareness of the factors that go into making a business decision or establishing a business strategy, here is intended to evaluate the combination between the implementation strategy and the software more than the software itself. In terms of strong points, the team's feedback on the software was generally positive. It was found that, due to the detail in the data entry masks, single persons or teams dedicated to specific tasks (SUs, artifacts, drawing) were more effective than everyone working on every part. Moreover, if different users did not overlap, the same table wasn't accessed in the same moment by two users, making it easier to control the read/write data activity and avoiding locks and data being unintentionally deleted.

The accessibility of the documentation without paper and the possibility to work almost on the field was another positive side of the implementation of pyArchInit. As for what concerns workload and learning curve, the progressive integration between physical/digital and local/remote was acceptable: despite the time dedicated to training being short, the students grasped the basic skills of data entry and how specific sheets needed to be filled. In addition, the cost sustained to build and start the server was almost none, since it was an old machine running FLOSS software. At the moment, in fact, the computing power required to run pyArchInit on remote is not high, but it must be taken into consideration that only vector data (generally lighter than rasters) are uploaded. Finally, pyArchInit is already set for the output of the documentation along the guidelines required by the Ministry of Culture, speeding up the process of the composition of the final reports.

From the point of the user experience, one of the elements that emerged as problematic is the way some of the forms are designed. SUs and artifact sheets are very detailed and visually different from the physical ones, which usually the students are more familiar with. The sheet structure is a bit labyrinthic; many fields are stacked together and it makes data entry harder on small screen laptops. Another issue regarding data entry: in uploading tables from the local Spatialite database to the PostgreSQL server, often the process was stuck in an error due to the different length of data formats between the two databases.

Considering the different opportunities offered by the software, it must be noted that while at the moment pyArchInit works well in a desktop environment, the possibility to manage data directly from smartphones and tablets can really increase the software usability. Mobile batteries in general tend to last longer than laptops, they are usually handheld and incorporate a (generally good) camera and an Internet connection, making them perfect for fieldwork documentation such as compiling SUs. In the last months several regular updates enhanced the user experience and added useful tools such as a way to directly upload total station points. The crucial opportunity in pyArchInit is, as in every open software, the possibility to actively contribute to the software development. This contribution can be in the form of identifying and reporting bug and issues to the GitHub, suggesting new features to be implemented or contribute with new code, UI design, writing documentation and so on. As a result, it is also possible to develop pieces of software specific to one's needs that will also be available for other people to use, debug, enhance and so on. In this framework, the issues noted in this SWOT analysis are also a contribution of sort.

The first threat concerns specifically the excavation in Castelseprio but it is relatable to different contexts as well. In the framework of a fully digital multi-user workflow centered on pyArchInit, Internet connection becomes crucial. Around Casa Piccoli, mobile signal is weak and generally Castelseprio is not very well served by the Internet connection, which slows down work and asks for hybrid temporary solutions (such as coming back to 2021 workflow).

5. Conclusion

GIS applications have become the norm in archeological documentation; open source solutions from the mid '90 rose in number, opening new possibilities both for recording and elaborating archaeological data (Ullah, Clow, Meling 2023). PyArchInit finds its place in this framework, offering the only (to our knowledge) complete solution to handle stratigraphic data within a GIS open source environment. Overall, the implementation resulted in the development of a new workflow for our excavation, which produced a good outcome both in terms of data recording and students training.

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ABSTRACT

In the framework of the project 'Castelseprio, centre of power', the authors began excavating the structure known as Casa Piccoli in 2021. The area, already investigated by Piccoli in the 1970s, presents itself as an interesting case study for the application of an open and integrated solution for the management of stratigraphic data, specifically pyArchInit. Being an academic excavation project and, therefore, characterized by both research and training issues, it was decided to progressively and incrementally include the use of pyArchInit within the documentation protocols on site and post-excavation, over the three years of the permit granted by the Ministry of Culture for the excavations. Master's degree students who participated in the excavation, at the end of the planned period, will

have the basic skills to use the plugin also in a professional environment. At the end of the first two years of implementation, a SWOT analysis will show the results obtained within the site for both training and research purposes.