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Franciscan Landscapes

Conservation, Protection and Use of Religious Cultural Heritage in the Digital Era

vol. 2

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This volume collects the papers presented at the concluding conference of the European project 'F-ATLAS: Franciscan Landscapes: The Observance between Italy, Portugal and Spain' that took place in Assisi, May 11-13, 2023.
The publication underwent a peer-review-based acceptance and qualitative evaluation procedure entrusted to the conference's Scientific Committee using the double peer-blind review system.

F-ATLAS CONFERENCE – Franciscan Observance Landscapes, Assisi, May 11-13, 2023.

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'F-ATLAS – Franciscan Landscapes: the Observance between Italy, Portugal and Spain' project was funded in 2020 by the JPICH 2019 Conservation, Protection and Use Call.

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Principal Investigators: ISCTE Instituto Universitário de Lisboa, Universitat de Barcelona, Universidade Católica Portuguesa.
Associate Partners: ICOMOS Portugal, Sisma srl, Regione Umbria, Direção Regional de Cultura do Centro, Provincia Serafica di San Francesco d'Assisi dei Frati Minori.

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Façade of the Basilica di Santa Maria degli Angeli, Assisi (Italy). Drawing by Stefano Bertocci.

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via della Mattonaia, 8 Firenze 50121

ISBN 978-88-3338-222-7

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Bonaventura da Bagnoregio, *Legenda maior Sancti Francisci IX, 1*

PART III

Landscape and Territories: New Tools and Strategies

PROMOTING FRANCISCAN OBSERVANCE. REFORMIST MODELS IN THE CROWN OF ARAGON BETWEEN THE MIDDLE AGES AND THE MODERN TIMES (14TH-16TH CENTURIES)

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Abstract

In recent years, many aspects related to the Franciscan Observance have received the careful attention of historiography, as a result of a renewed interest in understanding the elements that accompanied the implementation, impact and final consequences of the reform. Our contribution aims to explore the possibilities offered by databases, georeferencing techniques and diachronic maps in the study of Franciscan observance in the territories of the Crown of Aragon. The work is developed within F-ATLAS, an international and interdisciplinary Digital Humanities project that aims to study, preserve and disseminate the Heritage of the European Franciscan Observance. We want to know the interests shared by the promoters of the Observant Reform in order to extract some 'territorial models' to guide us in understanding this complex phenomenon in the territories of the Crown of Aragon.

Keywords: Franciscan Observance, reformist models, spiritual landscapes.

opposite page
Fig. 1
Database sheets and F-ATLAS WebMap.

1. Introduction

Between the 14th and 16th centuries, numerous spiritual movements linked to the Franciscan observant reform flourished in the territories of the Crown of Aragon.

Depending on the time and place, these reformist movements took on a very different political meaning and followed diverse objectives and strategies for the management of religious spaces. From the first reformist movement, which we can call 'proto-observant' and which materialised in the foundations promoted by Queen María de Luna and by some pioneering friars in the north of the kingdom of Valencia, to the decisions taken in relation to the so-called '*cura monialium*', passing through the changes of the rule of conventual communities that took place from the 16th century onwards, the interplay of interests shared by the different political and ecclesiastical agents will not cease to change and recompose itself.

In recent years, many aspects related to these processes in specific spaces and moments have received the careful attention of historiography, as a result of a renewed interest in understanding the elements that accompanied the implementation, impact and final consequences of the reform (Bolgliani, Merlo, 2005; García Oro, 2006; Martín Prieto 2007; Miura Andrades, 2014).

These works have made us to understand the meaning of specific moments of this spiritual transformation. For the proto-observant period, the works of Nuria Silleras Fernández on María de Luna as a promoter of the reform (Silleras, 2012), or the studies of Chiara Mancinelli on the dialogue between the queen and Eiximenis first, and in the 15th century, between María de Castilla and Mateo de Agrigento, are clearly pointing in this direction (Mancinelli, 2014; 2017).

Our paper owes much to these studies, but it aims to take a further step forward in relation to the possibilities offered by databases, georeferencing techniques and diachronic maps in the study of Franciscan observance in the territories of the Crown of Aragon (Garí et al., 2014; Garí et al., 2018). Our work is developed within F-ATLAS[1], an interdisciplinary Digital Humanities project that aims to study, preserve and disseminate the Heritage of the European Franciscan Observance. We want to know the interests shared by the promoters of the Observant Reform in order to extract some 'models' to guide us in understanding this phenomenon in the Crown of Aragon.

[1] The European project 'F-ATLAS. Franciscan Landscapes: Observance between Italy, Portugal and Spain' (JPI Cultural Heritage – Horizon 2020 programme, grant agreement 6995237, PCI2020-112005) is led by the Universitá degli Studi di Firenze, in partnership with the University of Barcelona, ISCTE-Instituto Universitário de Lisboa and Universidade Católica Portuguesa (https://www.f-atlas.eu/).

2. Methodology

In order to reach this objective, two basic tools are needed. First of all, a georeferenced database. Secondly, a Geographic Information System (or GIS) platform, that we called F-ATLAS WebMap (https://www.f-atlas.eu/case-studies-map). The project database, designed in collaboration with the Italian and Portuguese teams of the project, has been created using MySQL, an open source software. The information of each observant convent has been saved in a database record, in which we filled the name, chronology, successive changes of order, and topographical location in geographical coordinates (Fig. 1).

The geolocation of the monasteries is esential for the work with GIS (Soler, 2022), the software of representation and cartographic analysis that will allow us to visualize each convent in its specific location, through multiple territorial approximations. The work with GIS is developed on the basis of different layers. Above the general cartographic bases (Urban plots, Hydrographic and Topographic bases), a layer of georeferenced points is created from the information stored in the database project.

The GIS platform of the project (F-ATLAS Webmap) have three main objectives. Firstly, to visualize the general census of Italian, Portuguese and Spanish monasteries, using region clusters and geo-referenced points. Secondly, to access the information saved in the database records linked with the geo-referenced points. Thirdly, to approach to the monasteries that we decided study in depth (the so-called 'case studies' in our project). Finally, the tool has filters that allow users to access information according to their own interests.

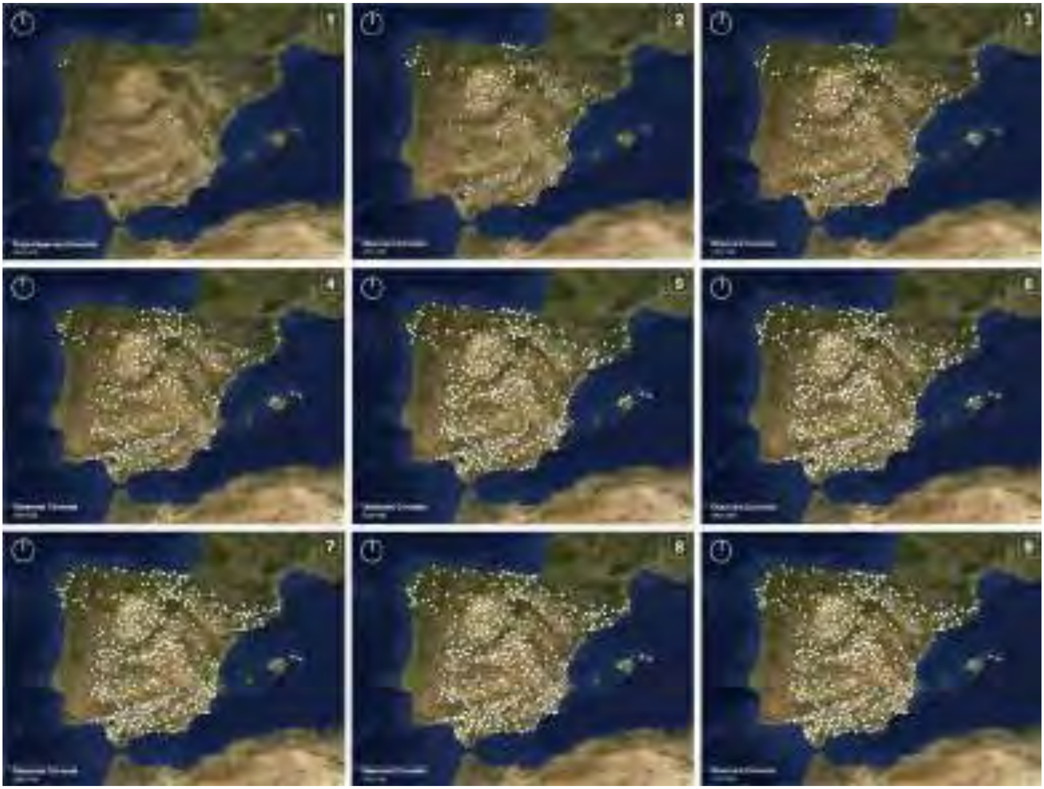

Fig. 2
Topography of the implementation of the Franciscan Observance in Spain.

3. The Franciscan Observance in Spain

By using this methodology, we have mapped the implantation process of the Observance in Spain. We have documented a total of 640 observant convents, between the end of the fourteenth century and the middle of the nineteenth century.

Our work has been carried out by the study of: 1) The fourteen volumes of the Observant Franciscan Chronicles of Spain; 2) An extensive bibliography: monographs, book chapters and scientific papers; 3) The edited and unpublished archaeological reports; 4) The fieldwork in some of the monasteries studied, which has allowed to document their buildings and to contact with local institutions (stakeholders) responsible of the conservation of the observant heritage (city councils, museums, archives).

On the basis of this research, the GIS have allowed us to elaborate nine thematic and chronological maps of the observant implantation in Spain (see Fig. 2):

- Map 1 (1350-1400): This map shows the first observant convents documented in

Spain at the end of the 14^{th} century. There are only seven monasteries, the oldest of which located in Valencia and Galicia.

- Map 2 (1400-1450) and Map 3 (1450-1500): The 15^{th} century was very important for the Observance in Spain, with the reform of pre-existing monasteries and the appearance of new ones made up of friars who rigorously followed the spirit of Saint Francis.
- Map 4 (1500-1550) and Map 5 (1550-1600): In Spain, the Council of Trent marked the disappearance of Conventualism and the rise of Observance through the Tridentine Reform of the 16^{th} century.
- Map 6 (1600-1650) and Map 7 (1650-1700): However, the 17^{th} century brought contrasting trends, seeing a certain decay in the reformist spirit, with the relaxation of some ascetic rules. Despite this, a new religious fervour also emerged, that promotioned the foundation of new convents.
- Map 8 (1700-1750) and Map 9 (1750-1800): The Observant convents continued their development until the 19^{th} century, a complex period during which Spanish monasteries were exclaustrated on several times, and their assets confiscated in the famous *desamortización de Mendizábal*, in which the ecclesiastical goods were acquired and sold by the state.

Undoubtedly, these chronological maps constitute a suggestive platform for the study and promotion of the Observance in Spain.

4. The Franciscan Observance in the Crown of Aragon

Beyond that, GIS also offers the opportunity to approach the study of smaller regions and chronologies, such as the Crown of Aragon between the Late Middle Ages and the Early Modern Period. In this objective, we can identify three implantation models of the Franciscan Observant reform:

- Model 1: Foundation of new Observant Convents, such as the four proto-observant convents of the custody of Aragon: 1) San Francisco de Chelva / 2) Nuestra Señora de los Ángeles de Manzanera / 3) Santo Espíritu del Monte de Gilet / y 4) Santa María de los Ángeles de Segorbe (see Fig. 3).
- Model 2: '*Cura monialium*': Conventets and Observance. The so called '*conventets*' were male observant convents dedicated to the '*cura monialium*' of the female communities. In the territory of the Crown of Aragon, we are very interested in the study of the conventet of Pedralbes, linked to the royal monastery of Poor Clares of Barcelona (see Fig. 3).

Fig. 3
Identification of three study models.

- Model 3: Changing the rule. Observant Franciscans from outside the order. In this model we have included the study of Sant Miquel de Escornalbou, an ancient Augustinian canonical that became observant convent in the mid-16th century (1580) (see Fig. 3).

Each of these three models constitutes a form of implementation of the observant reform in the Crown of Aragon and has its own materialisation on the territory. We will explore each case in greater depth below.

4.1. Foundation of new Observant Convents

As we said before, the convents of Chelva and Santo Espíritu constitute the origin of the Custody of Aragon, the first in the Spanish territories. Chelva stands out among them, for the value of the architectural remains that have survived until today. Also important is the Santo Espíritu monastery, located in the municipality of Gilet, which preserves an interesting architecture in the middle of a dense wooded area.
This small group of convents (to which must be added those of Manzanera and Segorbe, today disappeared) is linked to the will of the queens María de Luna and María de Castilla, and the Franciscan leaders Francesc Eiximenis and Matteo de Agrigento

to expand the Observance on the medieval spanish kingdoms. The politics of reginal patronage, the involvement of the friars as advisors to the royal family, and also the interest of these singular communities, make them particularly interesting from a historical point of view, but also in terms of landscape and heritage.

4.2. 'Cura monialium': Conventets and Observance

On the other hand, We are also studying the Conventet of Pedralbes. This case-estudy corresponds to the community of Conventual Franciscans first, transformed into Observants later, whose main function was the spiritual care of the great royal monastery of the Poor Clares of Pedralbes. It was a small convent built within the enclosure of the Poor Clares' monastery, built at the thirties of the 14th century.

Thanks to the King Fernando el Católico, the monastery was finally assigned to the Observants. However, the care of the female community was revoked in the 16th century, when it survived as a simply Observant convent.

In this third case study, the historical and architectural relationship of the Observant convent with the female community seems interesting for different reasons. On the one hand, it's a prototype case of *conventet* dedicated to the '*cura monialium*' of a female communitie. On the other hand, the monastery preserves an important archive that can provide a lot of information. Finally, the Royal Monastery of Pedralbes is today a museum under the patronage of the City Council and the Diocese of Barcelona, which is extremely dynamic in terms of dissemination and citizen participation.

4.3. Changing the rule. Franciscan Observants form outside the order

Finally, the third model corresponds to the observant convents whose origin is outside the Franciscan order. Such is the case of Sant Miquel de Escornalbou, which was originally an Augustinian canonical, founded in 1170 in the top of the Escornalbou mountain. After three centuries of decadence, in 1580, the bishop of Tarragona conceded the place to the observant Franciscans, who installed a community that survived until the exclaustration of 1835 (Soler et al., 2023).

Later, in the early twentieth century, after being abandoned for some time, the diplomat Eduard Toda invested part of his fortune in buying the place, which he restored and conditioned as a residence. Today's splendid building preserves the traces of this long historical journey, with the medieval and modern stages clearly visible, but also the transformations of the last centuries.

Fig. 4
Sant Miquel d'Escornalbou (Tarragona).

The territorial study of the convent of Escornalbou allows us to understand the impact that these implantations had on the territory and the landscape. The building is located in an exceptional site, in direct dialogue with Nature and the forest, essential elements in the Observant's desire of spiritual isolation (Soler et al., 2022).

5. Conclusions

We would like to end this paper with three main conclusions. Firstly, the territorial perspective constitutes an outstanding resource to better understand the spiritual landscape memory. Secondly, the presentation of data using GIS facilitates historical analysis with all kinds of sources: textual, archaeological and territorial. Finally, the landscape analysis allow us to understand the relationship between monasteries and their surroundings. In short, each of these approaches and their relationships constitute the basis of what we understand as Observant Franciscan landscapes.

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TECHNOLOGICAL INNOVATION TO SUPPORT PROTECTION, CONSERVATION AND PROMOTION OF FRANCISCAN OBSERVANCE LANDSCAPES BETWEEN ITALY, PORTUGAL AND SPAIN. SURVEYING USING U.A.V. INSTRUMENTATION

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Abstract

Although Franciscan convent buildings characterize the landscape of many Italian and European cities, it is difficult to delve into what is defined as the Franciscan universe. From these assumptions comes the project 'F-ATLAS – Franciscan Landscapes: the Observance between Italy, Portugal and Spain', which aims to study and survey the network of architectural complexes of the Franciscan Observance between Italy, Portugal and Spain, in order to outline a 'map' for the documentation and knowledge of these places, aimed at the preservation and promotion of this cultural heritage spread on a territorial scale. Complementary to the survey by TLS technology carried out within this acquisition process, aerial photogrammetry is to be included. As a result of recent developments in digital photogrammetry (Structure from Motion; SfM) and Uncrewed Aerial Vehicles (UAV) systems, it has been possible to carry out low-cost, multi-temporal topographic surveys. The processing of the obtained high-resolution digital elevation models (DEMs), which are essential for analyzing the geomorphological, structural, and architectural characteristics of the surveyed elements, has made it possible to produce 2D drawings, complementary to the nadiral data. Therefore, this process has provided a way to study, document what has been acquired in the various survey campaigns carried out from 2020 to the present. In this chapter, specifically, we have considered some case studies, emblematic for the types of UAV interventions. The results confirmed the usefulness of high-resolution SfM surveys, going on to form a useful starting point for similar processes of land study and interrogation.

Keywords: F-ATLAS Franciscan Landscapes, U.A.V. instrumentation, conservation and promotion

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Fig. 1
Some of the investigated sites during the 3 years of the project. Above, the Basilica of Santa Maria Maggiore near Assisi, then the Fortezza and Convento da Ínsua in Portugal and finally the Castle Monastery of Escornalbou in Spain.

1. Introduction

Throughout history, several Franciscan architectural complexes have been abandoned, losing their original functions. However, their strong architecture values and the ties with the surrounding area make them strategic points for the development of tourist itineraries to rediscover places rich in history and culture. The spread of the Franciscan mendicant orders, characterised by a poor lifestyle, was extensive and left deep traces in several European landscapes..

The project 'F-ATLAS – Franciscan Landscapes: the Observance between Italy, Portugal and Spain', aimed at studying and surveying the network of Franciscan Observance architectural complexes in Italy, Portugal and Spain, in order to define a 'atlas' of documentation and knowledge, useful for the conservation, protection and promotion of this heritage (Fig. 1). The cataloguing project makes use of traditional and innovative techniques with the aim of developing sustainable evaluation and conservation methodologies and involved four academic partners, including the Department of Architecture of the University of Florence, and various associated partners, including the General Curia of the Friars Minor, and followed a course of study to understand how the Order related to the surrounding space, analysing both the material and immaterial aspects of this heritage. The aim of this article is to present the results of the research, focusing on the study of the Franciscan Observance network and considering one aspect of the aerial data acquisition phase by means of U.A.V. (Unmanned Aerial Vehicle) instrumentation and its development, analysing the pros and cons.

2. Data Collection

Digital surveying is an evolving field of architecture that has developed over the last decades thanks to technological advances in the acquisition of 3D data, such as laser scanning, terrestrial and aerial photogrammetry, which make the process more efficient and precise and allow for the creation of a three-dimensional database, which is necessary as our heritages are victims of human negligence, wars, and natural disasters. The creation of 3D models of these sites represents a valuable resource for the protection, enhancement and enjoyment of architectural heritage and requires a methodology capable of capturing and digitally modelling its geometric details. Data acquisition and processing is achieved with simplified software-hardware solutions capable of providing a large amount of accurate and georeferenced 3D data that can be passed on to future generations and used for design, simulation and evaluation of energy performance, for restoration planning and for the creation of virtual and augmented reality experiences, but also

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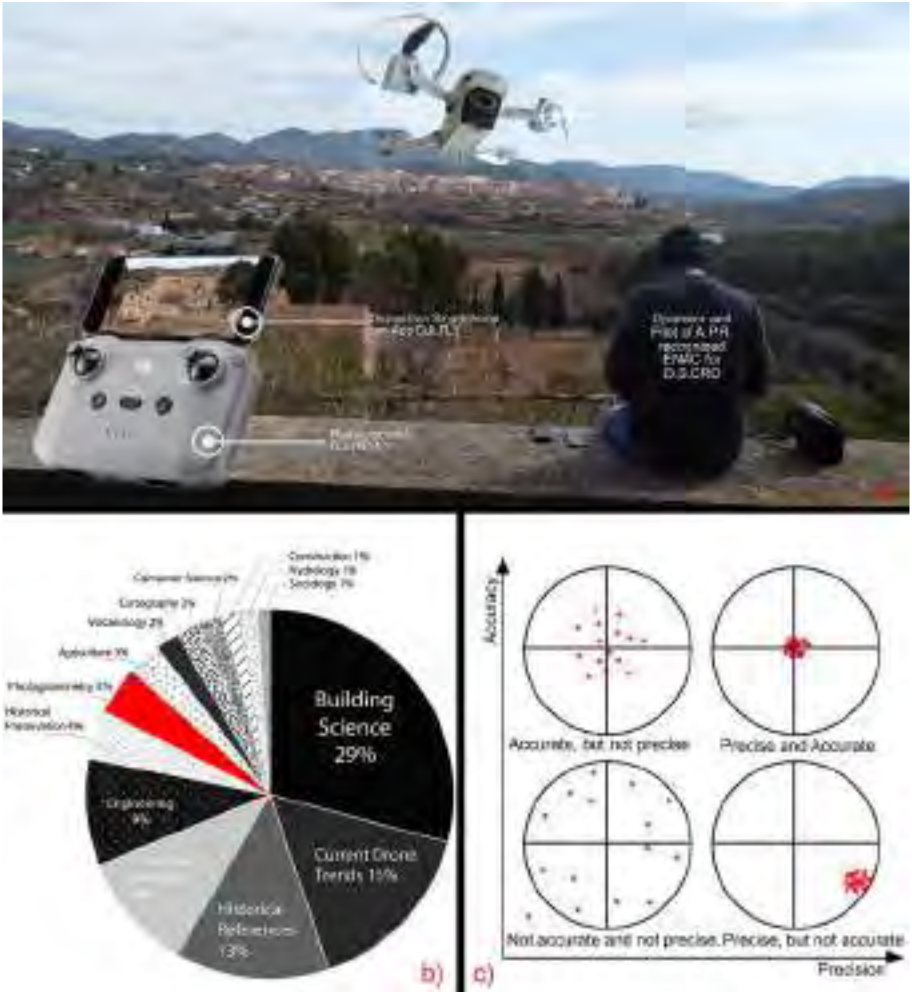
Fig. 2
Subjects to make an aerial photogrammetric survey using U.A.V. instrumentation. b) The field of aerial photogrammetry is 4% compared to the totality of the functions performed with drones. c) Accuracy and Precision.

for the creation of maps and geographical information systems for heritage management and enhancement.

2.1. State of the art of U.A.V. instrumentation

The ability to acquire images has always been an important necessity, as in archaeology and cartography. Since its first uses in the late 19th and early 20th century, aerial photographs have proved to be a key tool for understanding and analysing the territory (Alvisi, 1989). Over the years, various solutions have been tried out, such as the use of aerostats, kites and other means, but they were expensive, dangerous for pilots and with very long preparation and operation times. To overcome these problems and to bridge the gap between aerial documentation and common land surveying methods, the use of A.P.R. (Remotely Piloted Aircraft), commonly known as 'drones'[1] , called by the acronym U.A.V., was introduced when used for civil purposes. Characteristics such as ease of transport to areas of interest, relatively low cost, the ability to take off in a short time and in a small space with any sensor, easy manoeuvrability (ideal for low-altitude flights), and speed of high-resolution data acquisition, have extended the use of APRs from military to civil purposes, in the field of archaeological diagnostics and also in modern architectural research, offering the possibility of exploring hard-to-reach areas, of non-invasively identifying underground structures, of rapidly collecting data for predictive analyses or for the creation of 3D models and digital maps, and of installing different types of sensors on board the aircraft, for colorimetry or thermography. While informations gathered by aerial remote sensing or satellite acquisitions represent powerful means to measure the state and evolution of environmental changes caused by natural or anthropogenic processes (Whitehead, Hugenholtz, 2014), surveys, carried out at an altitude between 20 m and 200 m, allow the acquisition of both quantitative and qualitative detailed information (Eisenbeiss, Saurbier 2011). The drones used for architectural research are subdivided according to the type of wing: fixed-wing aircraft have strong wind resistance, reach high altitudes (70-150 m) and allow nadiral shots, according to the classic aerial photogrammetry scheme; with a flight of just a few minutes, medium to large scale surveys of extensive areas (many square kilometres) can be obtained (approx. 5cm/pixel.) ; drones with mobile or rotating propellers (multicopters), as in our case, have greater flexibility

[1] According to the definition of the ENAC (Ente Nazionale per l'Aviazione Civile – National Civil Aviation Authority) regulations in force since 21 May 2018, an APR is a "remotely piloted airborne means of transport without a person on board, not used for recreational or sporting purposes"; the system consisting of an airborne means of transport (APR) and the related components necessary for control and command by a remote pilot is called SAPR. The entire ENAC regulation 'Remotely Piloted Aircraft' is available at: www.enac.gov.it.



in the acquisition phase, allowing both nadiral and inclined captures thanks to the possibility of rotating the camera. Wind resistance is lower and, flying at even very low altitudes (not above 30m), they can provide surveys of limited areas but at a very large scale (approx. 1cm/pixel)[2].

[2] In digital photogrammetry, we must consider the famous GSD – Ground Sampling Distance. The GSD corresponds to the resolution of a ground image.

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Fig. 3
The size of a payload's sensor impacts the quality of images, especially those taken from a lower altitude and at high speeds. Measuring the real resolution of images with the same GSD gives an idea of the difference a high-quality payload makes.

3. Methodology used

Parallel to the acquisition phase using TLS, the survey was carried out using a drone, which is divided into three phases: flight planning, filming with image acquisition and calculation of the orientations and final results. In the surveyed sites, the first phase involved a study of the flight paths to optimise time and manage the filming according to the objective, carrying out photogrammetric acquisitions from above, trying to cover every area of the analysed object in order to obtain an intact 3D element, free of shadow zones. Video footage was also taken in order to document the site for a further output, no less important than the previous ones, with the creation of teasers to geo-locally frame the object and contextualise it in a few seconds. While there is no 'image overlap' with regard to the video shooting part, the overlap was taken into account with regard to the shooting for 3D photogrammetry.

3.1. A range imaging technique of computer vision and visual perception.

The technology to convert 2D digital images into 3D images is usually called image-based modelling, photogrammetry or Structure from Motion (SfM). The SfM algorithm, developed at Cornell University in 2006 by Professor Snavely, uses superimposed photos to automatically generate 3D scenes and camera position relationships and easily implements image registration despite camera position or scale changes by recognising characteristic points in the SIFT (Scale-invariant feature transform; D. G. Lowe, 1998) algorithm. For the purposes of correct processing (SfM), for the software used, Metashape from Agisoft, ideal for the analysis of buildings, sculptures and topography, it is in fact essential that a longitudinal image overlap of approximately 70/80% (overlap) and a lateral image overlap of 60/70% (sidelap, overlap of the swipes) is set, which is much higher than in traditional aerial photogrammetry where the overlap is usually 60% and the sidelap 30% (Fig.2). It was thus possible to obtain first a sparse cloud of points, then a dense one, to arrive at the mesh model that was the basis for the textured one, useful for the creation of the photoplans required for the elaborations. Another output that was realised, thanks to the new digital printers, is a perfectly scaled 3D model, including every detail. Using the point cloud obtained from the laser-scanner as a reference, the operational methodologies already consolidated within the research team were followed (Cioli, Lumini, 2021). Finally, starting from the digital model, virtual and augmented, immersive reality experiences of the studied object were obtained, both for tourism purposes and for the enhancement of cultural heritage (Argyriou et al., 2020; Häkkilä et al., 2019).

4. Result obtained

Once a point cloud (made up of unstructured data) was generated, a polygonal model (structured data) was created in order to produce the best digital representation of the surveyed object for applications such as 'digital twin', for conservation, virtual restoration, rendering, Virtual Reality VR, etc. Important results have therefore been achieved regarding the case studies analysed over the last three years (2020-2022)[3]. The three-dimensional elaborations characterised by a high metric-morphological reliability allowed further analysis of the architectures, with the support of the study of historical and archival sources, realising low-cost and multi-time topographic surveys. The processing of digital elevation models (DEM) made possible to create 2D drawings, complementary to the nadiral data. From the three-dimensional models, technical drawings such as plans, elevations and sections, perspective views, and axonometric cutaways were obtained, which made possible to study the represented architecture and provided metric and morphological information, including the materiality and chromatic appearance of the surfaces. This constituted a valid support, for example, for the analysis of the distribution aspects of the architectural complexes, those relating to the decorative apparatus, the state of conservation of the wall surfaces and the evolutionary phases of the buildings (Fig. 3).

4.1. Discussion of results

- The results obtained by means of U.A.V. instrumentation made it possible to better manage the 3D data, implementing ground acquisitions by means of a TLS station; regardless of the position of the study object, the drone made it possible to plan, analyse and acquire images and videos from a unique point of view. Within the various research

[3] Only some of the papers produced are listed below, for obvious reasons of space. For more information on this, please refer to the book in publication *F-Atlas: Franciscan Landscapes: the Osservance between Italy, Portugal and Spain* edited by Anastasia Cottini or go to https://www.f-atlas.eu/.

opposite page
Fig. 4
Development of post-production processes from point cloud acquired by aerial photogrammetry according to the SfM method. The site is the Romita di Cesi, in the Umbria region.

projects, the combination and integration of different sensors and techniques is the ideal solution, particularly for surveying large and complex areas. The generation of digital 3D models of large sites for documentation and conservation therefore requires the following properties:

- Accuracy: accuracy and reliability are important factors;
- Portability: due to accessibility issues for many heritage sites, lack of electricity, location constraints, etc;
- Quick acquisition so as not to disturb work or visitors;
- Flexibility: Given the great variety and size of sites, the survey technique should allow for different scales and be applicable in every possible condition.

As these properties are not found in a single technique, most projects involving complex sites combine several sensors and techniques to achieve more accurate and comprehensive 3D surveying and modelling results (Fig. 4). This specific instrumentation requires special attention to certain rules: while no authorisations from specific bodies are required for TLS instrumentation, the use of drones for cultural and conservation purposes is intended for qualified personnel and requires the acquisition of authorisations and compliance with specific regulations[4]. In order to collect and systematise the large amount of data of a very heterogeneous nature, an information system was finally structured, based on a shared drive on which to store the information, on which each individual survey with processed data was catalogued with an alphanumeric code through which it was possible to search at any time quickly and from any source.

5. Conclusions

3D virtual heritage offers great advantages in the field of remote sensing and third dimension technologies, and drones are an ideal tool for documenting and mapping archaeological sites. Although there are still communication difficulties between geomaticians and the cultural heritage community itself, new technologies are increasing the quality of 3D models with the aim of attracting new people into this world, and many companies have entered this market by developing software and surveying systems with good potential and impressive results. The number of 3D products is therefore enormous and, while the cost of these technologies is slowly coming down, it is difficult, especially for the uninitiated, to choose the right product due to the lack of standard terminology, specifications and performance benchmarks.

[4] The National Civil Aviation Authority (ENAC) is the Italian authority for technical regulation, certification and supervision in the civil aviation sector under the control of the Ministry of Infrastructure and Transport.

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NOTES ON REST STOPS ALONG THE VIA FRANCIGENA

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Abstract

The project for the fitments along the via Francigena conceived for the section of the path between Fidenza and Piacenza aims to provide a contemporary response to the spaces of the road and of the square, symbols of both walking and resting, by inserting architectural fragments into the landscape of the via Francigena in continuity with the historical stratification of the places and of their spiritual tradition. The architectural signs, expressed through the small built interventions, find a symbolic precedent in some existing and typical elements of the landscape while responding, at the same time, to the need to enhance the equipped itinerary and to provide the landscape with measure. With the interventions planned along the via Francigena an attempt is made, in dialogue with the context, to put back together some lost pieces of landscape history and to recompose the traces, both historical and human, left behind by the inhabitants, as well as by those who have passed along this route throughout the centuries.

Keywords: Franciscan fitments, walking and resting, street, square, light water.

opposite page
Fig. 1
The bench of light, plan, elevation and vertical section (Lavninia Antichi, Martina Calcinai, Giuseppe Cosentino).

1. The Franciscan fitments

> "The most persistent and singular element of Franciscan places is a dual movement: the Franciscan place is a place of an extreme, tactile proximity to the elements (the rock, the veins of water, the flora), which magnify as if under a lens and grow so close as to offer shelter, and it is at the same time a place open to the vastness of outer space, to the remoteness (in modern and entirely anachronistic terms we would call it a 'panoramic' place). It is a place that is at once cosmic and elemental, that enters into the earth as if into its bowels, projecting itself vertiginously outward as it does so. This double movement confers on Franciscan places a peculiar rhythmic nature which, still briefly outlining, we could refer back to the simultaneous gesture of closing and opening, or in even more 'cosmic' terms [...] to the elemental rhythm of Earth (the closing) and Heaven (the opening)" (Cuniberto, 2017).

The dual nature of the Franciscan places and their inherent double movement, both of proximity and distance, as described in Cuniberto's text, inspired and guided the design of the Franciscan fitments for the section of the ancient road that leads from Fidenza to Piacenza. This is a crossroads of ancient routes that branch off, forming an intricate network of roads, where the Via Emilia, a transversal axis for the whole of northern Italy, traverses the paths of the via Francigena, as well as those headed to San Colombano or to destinations beyond the Alps.

The fitments designed for the route, exemplifying the cultural values of the via Francigena and of the path of San Colombano, seek to translate into architecture the two main aspects of the journey: walking and resting. The project of the fitments for the via Francigena thus aims to offer a contemporary response to the spaces of the street and of the square, symbols of both walking and resting, by inserting architectural fragments into the landscape of the via Francigena in continuity with the historical stratification of the places and of their spiritual tradition. The architectural signs, expressed through the small built interventions, find a symbolic precedent in some existing and typical elements of the landscape – a cypress tree, a hedge, a historical fragment – while responding, at the same time, to the need to enhance the equipped itinerary and to provide the landscape with measure.

With the interventions planned along the via Francigena an attempt is made, in dialogue with the context, to put back together some lost pieces of landscape history and to recompose the traces, both historical and human, left behind by the inhabitants, as well as by those who have passed along this route throughout the centuries.

An action, both architectural and archaeological, which seeks to locate and give light once more to the traces that memory has left behind in the territory. After all, as Cuniberto again points out, "there is no 'landscape' if this experience does not activate a memory, which is the memory of a non-lived" (Cuniberto, 2017).

The idea is to give back to these territories and to an entire section of the via Francigena, the hospitality and interaction role that it played for so many centuries; in such a way that every place, loaded once again with signs and meanings, each a palimpsest of old and new historical elements, can contribute to enhance the experience of the modern pilgrim.
The fitments designed for the via Francigena can be described in two images: 'the bench of light', which indicates the direction, the path to follow, and 'the bench of water', a resting and meeting-place. A linear and a circular element, two gestures which follow one another and repeat themselves along the path and through multiple harmonic combinations, are able to represent the different features of places. The two ancestral elements that make up the binomial earth-water and sky-light, constitute the viaticum for the pilgrim while providing rhythm to the path as a whole.
The 'bench of light' Figg.1-2 consists of a horizontal monolithic concrete element that rests on another vertical element that supports it, almost permeating it, and which in turn houses inside it a circular cavity, an illuminated body. Light, like bell towers in ancient times, is a fundamental element to indicate the pilgrim's way, especially in territories where the layout of the path is intricate and complex and natural conditions are harsh. Thanks to its elongated shape, the bench indicates direction and represents the dynamic movement of going; the light provides guidance along the path and marks the space for reflection and contemplation.

Fig. 2
The bench of light (Lavinia Antichi, Martina Calcinai, Giuseppe Cosentino).

Equipped with an oak wood seat, embedded in concrete, the bench consists of two large boards connected by metal hinges which enables it to open. This new configuration offers the occasion for an intimate and meditative rest. The 'water bench' Figg.3-4 is eminently the place of being, of meditation, of understanding.

> "it is difficult to explain. I used water because it is a living substance, constantly changing shape, moving. It is a very cinematographic element, and through it I tried to express the idea of the passage of time. Of the movement of time. I like very much water, streams and brooks, it is a water that tells me many things" (Tarkovskij, 2012).

opposite page
Fig. 3
The water bench, plan, elevation and vertical section (Lavinia Antichi, Martina Calcinai Giuseppe Cosentino).

Also in the case of this fitment, a monolithic horizontal concrete bench rests on a vertical element from which water flows. Here the bench instead of being linear becomes circular, and with a gentle embrace resembles a niche. From the spring located on the turret, the water passes through a cylinder which, carved into the seat, serves as the interlocking point between the two elements, vertical and horizontal, and then exits into a basin forming a small stream at the base of the bench that can offer comfort to the tired feet of the

pilgrim, or else serve as refreshment for animal travel companions. Water, valued as "*utile et hùmele et pretiosa et casta*" (Francis of Assisi), is an element of individual contemplation and an opportunity for interaction that encourages dialogue.

In order to root the project more firmly into the context, or rather the contexts in which it is being implemented, special attention was paid to the materials used. The two fitments are made mainly of concrete, a poor material that well represents the values of sobriety and essentiality that inspire the experience of the via Francigena and confer to this unique path a different interpretation from that of any other hiking route.

Concrete is here ennobled and enhanced thanks to a distinctive touch provided by the different aggregates used in its realisation. In fact, the benches take on different colors thanks to the use of aggregates obtained from the waste derived from the processing of fine stones from the area in which the fitment is placed. The same bench can thus change color according to the area in which it is located, from Rosso Veronese to Siena yellow, thus allowing for a unified reading of the 'via Francigena system'.

Fig. 4
The water bench (Lavinia Antichi, Martina Calcinai, Giuseppe Cosentino).

In addition to the material aspect, it is above all the modular nature and the versatility of the elements which allow the furniture to be adapted to different contexts.
In fact, the fitments are each composed of two elements, one horizontal, the bench, and one vertical that, like a memorial stone or a milestone, indicate the path. These elements can be arranged within the intervention areas according to different configurations. Benches and memorial stones can interact with the contexts either individually or in rhythmic configurations of lines and curves. By re-proposing the same elements in a modular manner, the intervention enables a full understanding of the via Francigena system, fostering the discovery of toponymy, as well as the forms of landscape and architecture, with an experiential approach that is capable of elucidating the stratifications of places, their evolution and their present day shape. The territory of the Po Valley was shaped first by the Roman via Emilia and later marked by the mediaeval via Francigena and the path of San Colombano. Roads that not only ensured communication and transportation but also constituted, over time, a true and proper

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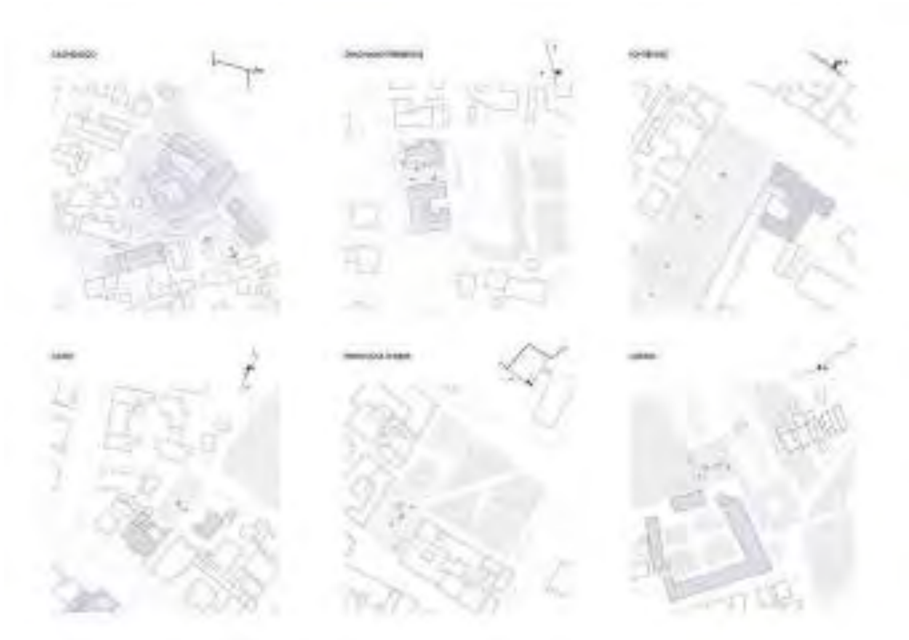
Fig. 5
Areas for intervention (Lavinia Antichi, Martina Calcinai, Giuseppe Cosentino).



cultural matrix for the regional and urban structure of the places they pass through, providing them with an identity. In Calendasco (Fig.5), the linear bench invites the wayfarer on the via Francigena to cross the road and enter the square where the circular benches engage in a dialogue with the castle tower and a memorial stone is placed at its entrance, highlighting it. Almost like a stage backdrop, at Gragnano Trebbiense the benches create a visual perspective connecting the road and the square, highlighting the entrances to the former cinema. In Pontenure, the intervention is structured on the strong axial nature of the square, where linear benches point the way to the circular bench that establishes a close, and also formal, relationship with the monument which stands in the center of the square. In Cadeo, a memorial stone marks the entrance to the via Emilia across from the shrine of the Blessed Virgin of Mount Carmel. The path, marked by the benches, leads into the rehabilitated urban space where the circular bench of the rest area is located.
Placed in the center of the square in Fiorenzuola d'Arda, almost like sculptural objects, the fitments follow the central compositional axis and create a relationship between the park behind and the main road. Finally, in Alseno, the elements lead from the via Francigena into the green square, creating a system in which the circular bench establishes a visual dialogue with the courtyard of the palace of the Commenda.

Credits

The franciscan fitments
2019-2020
Authors: arch. Lavinia Antichi, arch. Martina Calcinai, arch. Giuseppe Cosentino.

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NEW CONTENTS ON THE CONVENTS OF THE FRANCISCAN OBSERVANCE IN UMBRIA (ITALY): EXAMPLES FROM AN ONGOING RESEARCH ON THE HISTORICAL ARCHIVAL DOCUMENTATION

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Abstract

This essay sets out the results of research conducted in the main historical archives of Umbria, starting with that of San Francesco del Monte in Perugia (Monteripido) and especially the Historical Archive of the Patriarchal Basilica of Santa Maria degli Angeli in Assisi. The latter preserves, in addition to the papers of the Basilica and the Portiuncula, extensive documentation relating to a number of Franciscan Observance monasteries, including the Hermitage of Santa Maria delle Carceri in Assisi, the monasteries of Santissima Annunziata in Gualdo Tadino, Santissima Annunziata in Amelia, San Bartolomeo in Foligno, Monteluco, Sacro Speco in Narni and San Francesco in Stroncone. These documentary bodies – very fragmentary and incomplete, not always ordered and catalogued and therefore, often difficult to consult – consists of correspondence, minutes of sacred canonical visits, patrimonial and accounting notes, entries and exits, convent chronicles and memoirs, and concern various aspects of the history and life of the Osservanza convents. Among them, those considered most significant have been selected in order to document some fundamental episodes of the architectural complexes chosen as case studies (such as the construction, renovation and expansion works of the buildings), with the relations established, since their foundation, with the territory and the landscape in which they are set, regarding in particular the use of resources (mainly water and springs, woods and pastures, agrarian spaces), communication routes and urban settlements, in a period between the 17th and 20th centuries.

Keywords: Convents, Umbria, Historical Archives Documentation.

1. The historical archival documentation

The research, whose initial results are presented in this writing, was conducted in the main historical archives of Umbria, particularly in the Historical Archive of the Seraphic Province of the Franciscan Friars Minor of Umbria (located in Assisi at the provincial Curia attached to the Basilica of Santa Maria degli Angeli), where documentation from numerous convents has been gradually gathered over time.

An initial investigation also involved exploring the inventories of National historical archives and some local archives in Umbria, which house documentary collections related to convents that came into their possession following the suppression of religious institutions during the Napoleonic and Unification eras. These include the diocesan archives of Assisi, Spoleto, and Nocera Umbra with Gualdo Tadino, the Municipal Historical Archive and the Augusta Municipal Library of Perugia. For example, the latter holds documentation related to suppressed convents in its Manuscripts section; the Diocesan Historical Archive of Assisi, in the Bishops' Curia section, contains documents about female (16^{th}-20^{th} centuries) and male (16^{th}-20^{th} centuries) monasteries and convents; in the *Archivio di Stato* di Perugia, Spoleto Section, in the Religious Corporations section, there are five registers related not to a convent but to the hermits of Monteluco, with documentation from 1631-1780. However, this research path yielded few positive results for the selected case studies, as the documentation remained at their respective locations and then gradually converged (at different times and in different ways) to Assisi in the Provincial Historical Archive.

As stated on the website of the Seraphic Province, already "in 1614, a section of the Santa Maria degli Angeli provincial archive was set up, consisting of documentation taken from the archives of the province's convents. Since then, and especially since the post-World War II period, this practice has been consolidated and strengthened, and currently, the historical archive of the Seraphic Province of Saint. Francis of Assisi is increasing its function as a centralised repository, also for the better safeguarding of the documentary heritage. In 2003, the Provincial Minister, with a letter sent to all guardians and heads of communities of the Province, requested the transfer to the provincial historical archive of all the documentation still scattered in religious houses and coming from closed convents" (https://www.assisiofm.it/).

The concentration of historical documents in a single central location has been a fundamentally important operation, allowing for preserving and enhancing the documentary heritage. It has facilitated its use by scholars and those interested in the history of convents, thus encouraging research paths and projects.

In recent times, users have been able to avail themselves of documentary research tools, thanks to the reorganisation and inventory project of all documentary collections that have flowed into the provincial archive, promoted since 2004 by the Provincial Minister and entrusted to the care of Andrea Maiarelli, with the collaboration of lay archivist personnel and religious experts — a project that is still to be completed.

The provincial archive houses extensive documentation related to some convents of the Franciscan Observance, including the Hermitage of Santa Maria delle Carceri and the Convent of San Damiano in Assisi, the convents of the SS. Annunziata of Gualdo Tadino, the SS. Annunziata of Amelia, San Bartolomeo of Foligno, Monteluco, the Sacro Speco of Narni, and San Francesco of Stroncone.

In the same location, there is also the Historical Archive of the Seraphic Province of Saint Francis of Assisi of the Friars Minor in Umbria, established in 1946 through the merger of the two previous Observance provinces of Umbria: that of Saint Francis and that of Saint Clare. The reorganisation work, also initiated in 2004, led to a printed inventory (Maiarelli, 2005). This archive includes the Closed Convents Section, "consisting of 49 archives, originating from just as many convents belonging to the observing provinces of Umbria, also located outside the current administrative boundaries of the region" (Maiarelli, 2005, p. XIV), which were concentrated in the provincial headquarters following the suppressions of religious orders and closures that took place during the 19th century. The documentation is extensive, covering a chronological span from 1230 to 2004, and within this section are the few documents related to the Hermitage of the Santissima Annunziata in Cesi.

Apart from the archives of the closed convents, only for the Basilica Patriarcale the detailed inventories with printed catalogues exist (Maiarelli, 2004; 2007); for all the others, at the moment, there are rather summarised and incomplete lists of contents, and it is only thanks to the availability of the friars that we have been able to consult the papers of our interest. Only the documentation of San Francesco del Monte of Perugia (Monteripido) has remained on-site and is preserved in the internal archive, reorganised, inventoried, and accessible through a printed catalogue from 2004, edited by Andrea Maiarelli himself. These documentary collections are, with few exceptions, quite fragmented and incomplete; some still need to be ordered and catalogued (such as those related to Monteluco and the Sacro Speco of Narni) and thus difficult to access. As Andrea Maiarelli writes (2005, p. XIV), "in most cases, we are indeed faced with modest documentary remnants of archives that were much more substantial, as clearly evidenced by the numerous ancient inventories found during the cataloguing process".

The documentation that has primarily attracted our attention consists of correspondences, minutes of sacred canonical visits (required by the general norms of the Order and conducted periodically by both a General Visitor and a Provincial Minister), asset records, administrative and financial documents, income and expenditures, chronicles, and conventual memories (notations about the most important events that occurred in a year, usually presented chronologically), and construction works. Consequently, the most significant papers were selected to document some events related to the architectural complexes, such as construction, renovation, and expansion works of the buildings, property states, relationships established by the convents with the environment and territory in which they are situated, particularly regarding the use of modest property resources (mainly water sources, forests and pastures, agricultural spaces), communication routes, and urban settlements. The aim is to bring new insights into the history and life of the Observance convents chosen as case studies[1], spanning from the 17th to the 20th century.

This contribution will present only a few examples that will be the subject of more extensive discourse in subsequent work by the research group.

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[1] This research has taken into consideration: the Hermitage of Santa Maria delle Carceri in Assisi, the convents of San Francesco del Monte of Perugia (Monteripido), of the SS. Annunziata in Gualdo Tadino, of the SS. Annunziata of Amelia, San Bartolomeo in Foligno, S. Francesco di Monteluco in Spoleto, Sacro Speco of Narni, San Francesco of Stroncone and the Hermitage of the SS. Annunziata in Cesi.

cles, and conventual memories (notations about the most important events that occurred in a year, usually presented chronologically), and construction works. Consequently, the most significant papers were selected to document some events related to the architectural complexes, such as construction, renovation, and expansion works of the buildings, property states, relationships established by the convents with the environment and territory in which they are situated, particularly regarding the use of modest property resources (mainly water sources, forests and pastures, agricultural spaces), communication routes, and urban settlements. The aim is to bring new insights into the history and life of the Observance convents chosen as case studies , spanning from the 17th to the 20th century.
This writing will present only a few examples that will be the subject of more extensive discourse in subsequent work by the research group.

2. The convents and their landscapes in the archival documentation: some examples

Since their foundation, the convents have contributed to the management and evolution of the landscape with their assets — albeit modest, considering the rules of the Order — consisting of forests, small plots of land, vegetable gardens, and sometimes farms: for example, with reforestation efforts or more frequently with the planting of fruit trees, especially vines and olive trees.
In the meagre real estate assets of the religious structures under consideration, there are also some peasant houses and hospices, as we will see with some examples later.
It is known that the convents establish privileged relationships with the physical characteristics of the spaces in which they are founded, giving rise to that particular process that semioticians call 'signification', that is, the attribution of specific meanings to the physical environment, hydrography, geological features, and aspects of vegetation. Historiography (and the archival documents consulted confirm this) has highlighted in numerous studies the close connection between convents and environments and landscapes, particularly with water sources and watercourses and forests. This connection is established from the very beginning when the first hermits choose places for their retreats. For example, in 1977, Luigi Pellegrini reflected on the location of the first Umbrian settlements in the hermitic experience of Francis and his followers: precisely concerning the forest and the centuries-old presence of oak and coppice forest for wood and animal grazing; or about high pastures (once much more extensive than today), which sometimes extended to the hermitages; or in relation to springs and natural shelters for humans and animals. The location of hermit and convent sites is also important, including both primary and secondary roads, such as the roads and paths that connected forests and pastures to inhabited centres, especially in pastoral hill areas towards neighbouring regions.

Examples include the Sacro Speco of Narni, located on a path that connects Poggio Bustone to high pastures and descends towards La Leonessa; Greccio, which gravitates towards Stroncone and Terni; Monteluco on the way to Valnerina; the Fonte Colombo area connecting Rieti with the farms and villages of the higher agricultural and pastoral zone (Pellegrini, 1977, pp. 307-309).

From the consulted documentation (though extremely fragmentary and discontinuous), it emerges that many convents owned or could use forested areas during the period under consideration. All had one or more vegetable gardens, almost always enclosed spaces, equipped with wells or cisterns for water, which provided a significant portion of the friars' sustenance throughout the year, thanks to the seasonal cultivation of vegetables and the presence of fruit trees.

Let's now delve into some significant examples.

From a report by Friar Bonaventura from Perugia in 1650 (preserved in the convent's archives), it is learned that around the convent of San Francesco del Monte in Perugia, there was the enclosure wall which included a very large space, including, in addition to the church, a forest of oaks and cypresses, and terraced vegetable gardens; a third cloister (now known as San Giacomo della Marca's) enclosed another area used as a vegetable garden at the time (Giacometti, 2014, pp. 89-90).

A document from the same year about the state of the Convent of San Francesco di Stroncone stated that the religious had no property, "except for the church, a cloister, vegetable gardens, and the woods" (San Francesco di Stroncone, Carteggio, 5, c.n.n.). In some documents from 1620, it is learned that the water supply for the vegetable garden was provided by a concession from the Municipality "of ancient use and possession of water" from two springs. One — it is written — flows from a spring "and flows through a hole in the ground and falls into a certain pool to go to San Francesco through the conduits that can be seen and appear up to the convent and vegetable gardens of the same Fathers, where the preserve and fishpond are for watering salads and herbs in the summer"; the second "is the one that flows through the earth in the rains, passes through the Square of Stroncone towards the Archive under which there is the house of Antonio di Placido, where at the bottom there is a sewer, or washroom", further on, it passed by other houses and other "washrooms". Given the Community's intention to sell the spring, the friars requested and obtained permission to maintain ownership (Convento di San Francesco di Stroncone, Carteggio, 11, c.n.n.).

The large vegetable garden of Santa Maria delle Carceri also provides information, at least in the nineteenth and twentieth centuries, on the numerous and substantial work for the construction and maintenance of the enclosing wall, which also served, in one section, as support for the road that still connects the city to the sanctuary. For example, on May 8, 1822, the master mason Bernardino Barili from Assisi, appointed by the guardian Friar Andrea from Spello, carried out an appraisal of the work done on the vegetable garden walls, with surveying, measurement, and detailed expense calculations, also planning the enlargement and some restorations to the cistern (bottom and side walls, walls with vault and roof) (Archivio dell'Eremo di Santa Maria delle Carceri in Assisi, Carteggio, 7, c. 8).

During the twentieth century, efforts were made several times to repair or rebuild the enclosing wall of the convent vegetable garden: for example, in 1927, at the expense of the Directorate of Monuments of Umbria; in 1931 and 1948, when a section of the enclosing wall was demolished, and an internal road was built that crossed it all to reach the heart of the convent; in 1949, a door was opened from the vegetable garden to the lower part of the convent, and a 'cistern' (a water reservoir) was built next to the new road, where 'vines and fruit trees' had been planted; in 1953-1954, to increase the cultivable area, stones were removed from part of the pavement and replaced – it reads – "with earth from the Mountain that will allow planting"; in 1956-1957, the chronicler wrote: "With much regret, the 70 vines of the vegetable garden were removed. Their yield was zero, and the very few clusters did not ripen"; finally, in 1971 (the year in which the convent served as a set for Franco Zeffirelli's documentary *Fratello Sole Sorella Luna*), repairs were made to the vegetable garden road (Archivio dell'Eremo di Santa Maria delle Carceri in Assisi, Cronache, 1).

In a Memoir from the Convent of the SS. Annunziata of Amelia, undated but dating back to the first half of the twentieth century, the typical landscape context of sharecropping is well described, in which the structure is located, consisting of hills covered with crops, with the distinctive mixture of fields of cereals, olives, fruit trees, and married vines; a landscape that stands out from the Apennines, visible to the north and northwest, and from the flat Roman countryside, open to the south. Outside the enclosure extends a dense thicket belonging to the Convent, donated in previous centuries by various individuals and the Municipality of Amelia.

The anonymous document reads: "The convent is surrounded by fertile hills cultivated in a special way, as fruit cultivation is unique [...]; rows of vines and trees with vines wrapped around them, and this is common, but what is unique here is seeing olives and all sorts of fruit, especially figs, growing in great abundance without order, so closely spaced that one almost touches the other. Nevertheless, the land yields and the tenants are much

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Fig. 1
Project of the walls to establish the exact ownership of Santa Maria delle Carceri convent, with a request for a portion of land adjacent to the neighbouring owner, by Lorenzo Carpinelli, 1841 (Archivio dell'Eremo di Santa Maria delle Carceri in Assisi, Carteggio, 11, c. 14).

better off here than in other parts of Italy". The description then states that "from the convent, at an altitude of 500 meters, there is a view over the vast plain of the Roman countryside, while to the east and north the landscape is made up of hills and ridges of the Apennines, which continue towards Lazio; to the west, there is Mount Cimino, at the foot of which is the village of Surigno and Viterbo can be seen; beyond, there is a vast plain that extends to the sea" (Archivio SS. Annunziata di Amelia, Memorie diverse, 4).

Numerous documents from the convents reveal the problematic relationship with the shepherds who passed through (for autumn and spring transhumance or summer mountain grazing) on the roads, fields, and woods belonging to the religious, causing damage to the structures and vegetable gardens, cutting vegetation, etc.

For example, at the Sacro Speco of Narni, in a note from 1746, it is learned that the convent had a large wooded area granted by the Popolo of San Volano: "all the thicket or large forest" located near the road leading to Narni, including "that little corner or patch of thicket that remains below the road that leads to San Volano", of which the exact boundaries needed to be recognised. In the document, the friars appeal to the Community to grant them the maintenance of this possession, especially "to escape the troubles with the shepherds of Vasciano who continually damage the forest with their herds, reducing it to a thornbush, not content with grazing, but if there is any tree, they have no scruples about cutting it down", to the point that the forest around the convent was practically bare and the friars without firewood (Sacro Speco di Narni, Archivio non inventariato, Inserto 1700, c.n.n.).

In 1755, in a letter sent to the superiors, the guardian and the friars once again complained of frequent damage to their vegetable gardens by shepherds and livestock from nearby areas passing through and grazing, as there was no wall protecting the convent's properties (Sacro Speco di Narni, Archivio non inventariato, Inserto 1700, c.n.n.).

The forest of the Sacro Speco of Narni also became the subject of disputes in the next century, as revealed in a series of documents produced in the mid-nineteenth century: the first is an appraisal signed by Dioniso Ridolfi in 1835, which talks about the need to mark the boundaries of the wooded area due to a dispute over a piece of land below the minor road, or 'Morrone', contested between the friars and Messrs. Battistelli; the expert advised the friars not to engage in a lengthy and risky lawsuit and not to insist on the ownership of this disputed area, but to be satisfied with certain and provable possession.

Apparently, the religious did not follow the expert's advice but continued the lawsuit,

Fig. 2
The convent of Santa Maria delle Carceri with the wood around it, in 1704, with clear signs of human pressure and deforestation (Francesco Maria Angeli, Collis Paradisi amoenitas, seu, Sacri conventus Assisiensis historiae libri II, Montefalisco, ex Typographia Seminaris, 1704).

eventually leading to a trial in 1855, so that by 1859 the issue still needed to be solved[2].
The difficult relationship with the shepherds also emerges at Santa Maria delle Carceri in Assisi. In an appraisal of September 15, 1824, preserved in the convent's correspondence, the damages caused by shepherds who passed with oxen, sheep, and pigs near the sanctuary were noted; to remedy these inconveniences, it was established that shepherds should pass along the upper road leading to Mount Subasio, thus prohibiting access to livestock near the convent and prohibiting the cutting of the sanctuary's forest by shepherds and the rest of the population (Archivio dell'Eremo di Santa Maria delle Carceri in Assisi, Carteggio, 7, c. 7).
In 1841, as the problems persisted, a project was drawn up by surveyor Lorenzo Carpinelli to surround the convent's thicket with walls to establish its exact ownership, with a request for a portion of land adjacent to the neighbouring owner, Mr. Francesco Antonio Bensi, to make the boundary line regular (as indicated on an attached map) (Archivio dell'Eremo di Santa Maria delle Carceri in Assisi, Carteggio, 11, c. 14) (Fig. 1).
The thicket of the Carceri was apparently frequently visited by the locals, even for festivals and entertainment, as a century later, in 1924, the mayor of Assisi was forced to issue

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Fig. 3
The convent of Santa Maria delle Carceri with the thick wood around it, today.

[2] The insert contains other documents on the disputed spot, including a report with a plan from 1836 (Sacro Speco di Narni, archivio non inventariato, Inserto 1800, c.n.n.).

a '*manifesto*' against obscene language and revelry in the Carceri thicket threatening to close the enclosure and prevent public access (Archivio dell'Eremo di Santa Maria delle Carceri in Assisi, Cronache, 1, "Cronaca di S. Maria delle Carceri dal 1909 al 1971").

Among the papers of the Carceri convent, interesting notes are also found about the reforestation of Mount Subasio, carried out during the years of the First World War by Austro-Hungarian prisoners of Czechoslovak and Hungarian nationality. These were the first reforestation efforts using black pine alternated with broad-leaved trees (Regione Umbria, 2015). The chronicler reports that from May 9, 1916, until 1919, the prisoners stayed in the sanctuary itself, initially "in the thicket below the Carpenter's Chapel" and then directly in the convent, completely invading it, much to the annoyance of the friars, who were forced to retreat to four rooms that had to be separated from the rest of the building by a wooden gate. During this period, the prisoners also performed other work for the convent, such as the road from the city to the Sanctuary, a new roof, and a wooden floor in the shed under the guesthouse. In 1919, the reforestation continued by workers who also stayed in the convent (Archivio dell'Eremo di Santa Maria delle Carceri in Assisi, Cronache, 1) (Figg. 2- 3).

As previously mentioned, the hospices are among the few real estate assets owned by the Observant Franciscan friars. These modest buildings constituted "the centre of a Search, a well-defined territory in which the searching friar, the holder of the hospice", would go during specific periods of the year, exercising the right of begging (the goods begged by the friars generally consisted of cereals, cheese, wool, hemp, legumes, oil, must, and eggs). Most of these buildings were, for the most part, if not entirely, abandoned after the suppressions of the 1860s and, unlike the convents, were not "repurchased or restored" (Maiarelli, 2004, pp. 57-58).

For example, the religious of the SS. Annunziata of Amelia owned four hospices: one in Porchiano, received as a gift in 1559; one in Penna; one in Melezzole, obtained in 1807; and one in the city of Amelia, obtained in 1613, which was later sold to purchase another one near the hospital, so that it could serve as an infirmary (Archivio SS. Annunziata di Amelia, Memorie diverse, 4, '*Storia del Santo Ritiro della Santissima Annunziata di Amelia*', authorless – but attributed to Padre Bernardino Pacifici – and dateless).

In the documentation of the San Francesco del Monte Convent in Perugia, eleven hospices are listed in 1723[3], all dependent on the structure and located in the diocese of Perugia (Archivio Storico di S. Francesco del Monte in Perugia, Processi verbali delle Sacre Visite Canoniche, n. 1).

The friars of the Sacro Speco of Narni also used a house as a hospice in the city of Narni, which was also intended as a shelter for sick and convalescing religious and laypeople. In a letter from 1755, they asked their superiors for permission to sell the building to find a better situation, lamenting the position and the unhealthy and damp air due to the proximity of the tanneries and the public washhouse. It seems they were soon granted their request, as another document from 1784 speaks of a new hospice, apparently located "in the area of Monte or Piazza delle Grazie" (Sacro Speco di Narni, archivio non inventariato, Inserto 1700, c.n.n.).

The fathers of the Hermitage of the SS. Annunziata in Cesi in 1731-32 received as a gift from the Community of Terni (with certain unspecified conditions of use) the Hermitage of San Onofrio[4], a hospice with some 'adjacencies' consisting of a piece of olive land with a small house in a place called *Le Ficare* or *Canapine*, near the public road; five other working and olive-growing plots in places like Campomaggiore, San

[3] Canneto, Castel del Piano, Castel Rigone, Magione, Mantignana, Mugnano, Papiano, Pian di Renzano, Pieve di Campo, Ponte Valleceppi e San Martino in Campo; a quali si aggiungono, citati in altri documenti, Campiglione, Monte Melino, Ponte Pattoli, Ponte San Giovanni, Prepo e Rancolfo o San Sugaro (Maiarelli, a cura di, 2004, pp. 57-59).

[4] It could be the complex located above the town of Cesi, surrounded by woods that dominate from above the entire historic centre of Cesi and the whole Terni valley: it is located on an ancient hermit site of the fourteenth century and consists of a seventeenth-century church and an annexe building with the function of a hermitage, currently in a state of neglect (https://www.iluoghidelsilenzio.it/).

Martino, Le Canapine, and Le Valli, and other fields whose use is not specified (Archivio Storico della Provincia Serafica di San Francesco d'Assisi dei Frati Minori in Umbria, Sezione Conventi Chiusi, Eremita della SS. Annunziata in Cesi, Carteggio, 2 e 4).

3. Conclusions

After various events connected to the pontificate of Martin V, who approved the new 'Martinian' constitutions drafted and proclaimed by John of Capestrano, which prohibited the use of money and established renunciation of property, it was mostly his successor, Eugene IV, an admirer of the Observance movements, who confirmed the concessions granted thus far, albeit not without a certain degree of uncertainty and wavering. He appointed Bernardino of Siena as Vicar General and Commissioner to the Minister General for the Italian Observants. In 1446, he issued the bull *Ut sacra Ordinis Minorum religio* which removed the reformed friars from the Provincials' jurisdiction and restricted the Minister General's authority over them to matters concerning their way of life and correction. He entrusted the governance of the new community to two Vicars, each overseeing the Cismontane family and the Ultramontane family of common obedience. The examination of, albeit fragmentary and incomplete, archival documentation – of which a few examples are provided and will be subject to a more extensive discussion – offers us further interesting details about the relationships between the convents and the environments in which they are situated, particularly, as we have seen, regarding the use of forests and land for agriculture.

The management of water resources is another focus on which our attention has been directed: watercourses, but above all springs and sources, important locators for human settlement and especially for sacred sites (dating back to pagan rites and cults) chosen by hermits for their retreats and later for monastic establishments. This water use sometimes generates conflicts between the convents and the local communities, as evident from certain documents in the archives of San Bartolomeo of Marano di Foligno or San Francesco of Stroncone.

Another theme that has been sought out in historical-archival documentation concerns architectural transformations, works, restorations, and enlargements of the conventual structures, interesting pieces of information that allow for an absolutely episodic reconstruction but at the same time functional when integrated with survey and on-site investigation data.

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ECOSYSTEM PROJECT FOR SILK PRODUCTION AND REGENERATION OF THE HERITAGE OF THE CONVENT OF SAN FRANCESCO D'ASSISI IN TURSI

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Abstract

The convent of San Francesco is located on the hill overlooking the ancient city of Tursi, and its position provides a lesson in harmony between the orography and the settlement structure. These places have been waiting for redemption for a long time since the 1980 earthquake. Forty years later, there are still no strategic lines that represent real solutions capable of overcoming this serious isolation. A series of safety measures, occasional consolidations, and restorations have been carried out in the absence of a unified project and coherent approaches to enhancement. The architectural project assumes protection and valorization as a form of advancing knowledge, imagines and composes new spaces, and takes 'care' of historical, technical and social, material, and immaterial values, restoring identity to this heritage. The spaces built by the Franciscan Order have been relocated within the theme of restoration and regeneration and contribute in terms of circular sustainability with productive future visions.

Keywords: Inner Areas, Basilicata, Silk Ecosystem.

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Fig. 1
Tursi, Giovan Battista Pacichelli, Il Regno di Napoli in prospettiva, Parrino e Muzio Ed., Napoli, 1702.

1. Historical and morphological context

> "La povertà francescana non può essere considerata una privazione, ma piuttosto un arricchimento, una fonte di gioia [...] Da questi principi basilari, Francesco tira le conseguenze per la pratica esistenziale dei suoi figli: non vuole costruzioni appariscenti né consistenti, ma solo capanne, tuguri, romitori. L'applicazione ha valore in tutti i tempi, tenuto conto della validità del principio; e dovrebbe far riflettere ogni architetto che si pone a servizio dei francescani"[1].

The territory of Tursi is in the southwestern area of Basilicata, Matera province, at the bottom of the sub-Apennine mountain. It lies along two main hydrographic basins, the Agri River to the north and the Sinni River to the south. The town of Tursi is crossed by the Pescogrosso stream. The landscape is characterized by the presence of clayey soils and areas composed of sandy-clayey soil, marked by the passage of rivers that have designed steep slopes. Climatic and lithological phenomena have given rise to a landscape full of '*calanchi*' that have defined the hydrographic structure of the area.

Tursi has always been an important cultural center, intertwining different communities that have left traces of architecture such as the Angevin Castle, the Church of Santa Maria degli Angeli, and Arab influences. The Convent of Saint Francis of Assisi stands on the hill in front of the old town and the Rabatana.

The Byzantine authorities in Acerenza, Matera, Tricarico, and Tolve led to the establishment of various monastic orders in Basilicata that favored its repopulation and economic development. The expansion of the Franciscan Order took place thanks to the connections with neighboring regions, succeeding in founding the Franciscan province in Basilicata in 1515. Heritage and history, landscape and tourism, valorization and reuse, resources and economic production, represent the operative relationships that through architectural design can develop sustainable strategies to relaunch the industriousness of those territories that fall under the definition of 'Inner Areas'[2]. The Convent of Saint Francis, founded by the Observant Friars in 1441, is located on the hill overlooking the ancient city of Tursi. Its position provides a lesson in the harmony between geography, orography, and settlement structure. The typology of the architectural complex is built around a double-order cloister[3].

These places have long been waiting for redemption since the 1980 earthquake.

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[1] "Quaderni di Spiritualità francescana" n° 19. La Povertà nella Spiritualità francescana, Typography Porziuncola, S. Maria degli Angeli, Assisi 1971. Pag. 88.

[2] SNAI Aggregation Municipalities of 'Montagna Materana' (Accettura, Aliano, Cirigliano, Craco, Gorgoglione, Oliveto Lucano, San Mauro Forte, Stigliano).

[3] Ministry of Cultural and Environmental Assets, Insediamenti francescani in Basilicata. Un repertorio per la conoscenza, tutela e conservazione, Basilicata publishing, Matera 1988, pagg. 260-262.

Forty years later, there are still no strategic lines that represent real solutions capable of overcoming this serious isolation. A series of safety measures, occasional consolidations, and restorations have been carried out in the absence of a unified project and coherent approaches to enhancement.

The knowledge and documentation work compiled for the book 'The Design of the Orders' (Conte, 1996, pp. 250-253) placed the value of sacred places as systems of relationships, places of culture and tradition, organized structures, and small businesses, capable of determining a project from the definition of a territorial network, back at the center of the cultural debate. The architectural project assumes protection and valorization as a form of advancing knowledge, imagines and composes new spaces, takes 'care' of historical, technical and social, material, and immaterial values, and restores identity to this heritage. It relocates the spaces built by the Franciscan Order within the theme of restoration and regeneration and contributes in terms of circular sustainability with productive future visions[4].

[4] The research is part of a thesis conducted within the Design Laboratory 5: 'Architecture and Heritage of the Built' entitled: 'N-EST: New Ecosystem for silk production in Tursi. Memory and conservation of the heritage of the convent of San Francesco D'Assisi'. Student: Vanessa Tancredi. Supervisors: Antonio Conte, Antonello Pagliuca. Consultant: Don Domenico Giacovelli.

Fig.2
Framing of the convent in the Tursi territory. Edited by Vanessa Tancredi.

2. The foundation of the convent, formal and constructional characters

The Mendicant Order gave birth to a new architectural figuration characterized by the poverty of structures and construction methods. The architecture is essential and the geometric volumes of the spaces are as elementary as the functional organization of living that is useful for preaching. The typological schemes on which the architecture of mendicant churches, especially Franciscan ones, is based are mainly three: the barn or hall church, the basilical, and the pseudo-basical layout. Mendicant architecture reached the peak of its expansion in the 14th century, contributing decisively to the evolution of architectural history by influencing the rest of ecclesiastical architecture. The Order with the greatest spread in Basilicata was that founded by saint Francis with its four families: Conventuals, Observants, Reformed, and Capuchins. The Franciscans were the only ones to establish legal organizations such as autonomous provinces in

Basilicata. In the 14th and 15th centuries, the Orders saw a great expansion with the spread of the Observance, which led to a notable increase in the number of foundations in the Lucanian area, increasingly rooting the message of Saint Francis. The growth and gradual settlement of the Franciscans occurred mainly during the period of the alliance between the Normans and the papacy. The realization of observant community convents took place with the foundation of those in Miglionico (1439), Pietrapertosa (1474), S. Arcangelo (1474), Stigliano (1475), Viggiano (1478), Tricarico (1479), Oppido (1482) (Monaco, 1988, p.21).
The convent in Tursi was erected with the bull of Eugene IV in 1442, the first stable Franciscan building in the Anglona diocese strongly characterized by Byzantine, Benedictine, Carthusian, and Cistercian spirituality. It was built on the hill to the east of the town, at an altitude of 300 m above sea level, and rose in isolation following the hermitic instances that defined the Observant movement. The convent has formal origins around the cloister, a space ordered by the geometry of the square, which reveals a reference to the issues of the 'Franciscan rule' and living, composed in a precise pattern of scores, porticoes, rhythms of openings according to principles of essentiality and simplicity. The dimensions of the church and cloister represent the idea of organizing around a free space the various parts for collective and individual life, work, and prayer, with elementary forms that can be understood as principles of order. These artifacts in their elementary forms are subject to the rule that determines the church and cloister, such as the order of the rooms. The unit of measurement is the geometry of the square that marks the shape of the cells. The original layout of the complex included the cloister and the church aligned on the façade; a small bell tower erected on the right side of the church in communication with the sacristy and the cloister; the convent rooms and cells facing the main façade on the ground and first floors; the refectory with direct access from the cloister; the basement room used as an animal shelter and the cellar; the stables open to the surrounding land. This period runs from 1441 to 1609 when the library was extended and built. Within this historical segment, we trace the construction of the bell tower on the façade; the covered oven with a pitched roof; the southeast rooms open to the garden on the outer wall of the refectory; the extension of the cellar with the staircase in the refectory. The second-long period was from 1609 to 1806 when the friars abandoned the convent due to the Napoleonic suppression. An earthquake in 1857 worsened the structural condition of the complex, with further damage to the vaults and wall males.
The convent was recognized as a 'Public Property' in 2000, subjected to a Ministerial Decree constraint under Law 1089/39, allowing for urgent work to stop structural

Fig.3
Plan volumetric and drone views of the convent. Edited by Vanessa Tancredi.

instabilities and secure the building, preventing access and preventing vandalism and public safety[5].

3. The foundation of the convent, formal and constructional characters

The building tradition of the Franciscans was fully respected in the construction of the convent, as was the use of means, construction techniques, and functional distribution layout. The external and internal vertical structures are all built using the technique of 'sack' masonry that allowed for the use of local materials, of fluvial origin, rough-hewn and arranged irregularly on two wall faces and filling material. The masonry shows limestones and sandstones of different qualities, such as the '*Gorgoglione*' sandstone, mixed with the brickwork of roofing tiles, wedges, and flakes. The angular and vaulted elements were made of solid brick. Much of the masonry was covered with multi-layered plaster, the last of which was painted and decorated with geometric and floral motifs. For

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Fig. 4
Ground floor Plan of the convent. Edited by Vanessa Tancredi.

[5] 70% of the entire complex of the convent building is owned by the Tursi municipality; 20%, the church, is owned by the Bishop's Curia of Tursi; the remaining 10% comprises three small rooms plus the narthex and the bell tower and belongs to a private individual.

the floor beams and scaffolding, chestnut wood was used.
The convent is today partially reduced to a state of ruins, preserving intact the typological layout and morphological scheme, it covers an area of approximately 2000 m^2 on two levels. The church is located on the north side according to the east-west axis. The cloister represents the focal point of the functional distribution; it allowed the connection to all the rooms and the entrance from the outside was located between the convent and the church. The room below the dormitory cells formerly housed the stables and communicated with the ground floor via a stone staircase. The church is characterized by a single room preceded by a cross-vaulted narthex.
The main façade of the church still retains its original plasterwork as do the sides of the bell

Fig. 5
Elevations, sections and details of the current state. Edited by Vanessa Tancredi.

tower. Under the bell tower is the main entrance to the convent. The cloister is the central nucleus and the courtyard leads to the garden with a central wall; it is characterized by two rows of rounded arches resting on quadrangular brick pillars that form an embouchure to the original slate pillar that was circular. Crowning the double series of arcades is a projecting brick cornice in the shape of a '*romanella*' under the pitched roof of the building. In the center of each façade, at the three corners, brick gargoyles protrude from which rainwater was drained. At the cloister, all the rooms are barrel-vaulted. The south wing of the convent is the one that has suffered the most degradation; here, around the dormitory cells, there is a long, pointed-arch vaulted corridor with direct access to the façade that connects the refectory with the upper floor. Part of the ceiling of the corridor has collapsed, exposing the load-bearing structure, consisting of wooden beams, overlaid with brick flooring.

Access to the refectory, a large barrel-vaulted space with brick elements, is provided by several sandstone staircases that have suffered the collapse of the vault and part of the external masonry. A narrow, recently consolidated staircase leads to the first floor, where the other cells open onto the cloister, all with barrel vaults. Apart from the perimeter walls, nothing else remains of the library. The bell tower has a first level with a quadrangular plan made of stone and brick and a second level consisting of an octagonal section. A single lancet window characterizes the openings on each side. The church has a simple façade in the architectural style of Franciscan architecture; a round-headed doorway leads to the narthex that anticipates the entrance, with a room covered by a cross vault. It consists of a large nave concluded by an open triumphal arch at the high altar, the choir, and the sacristy. The state of preservation is very bad. The floor is non-existent and characterized by cavities due to the looting of the 'bean' tombs. Almost all the decorated surfaces have gaps. Next to the nave, there is a narrow building consisting of five cross-vaulted bays built later and used as a burial place.

4. Ecosystem project for silk production and heritage regeneration

The convent is one of the municipalities classified by the PNRR as 'peripheral areas' and the resilience of these, identified in 'Mission 5: Inclusion and Cohesion', is the possible design key for this heritage. These guidelines are articulated in the reuse project, which acts as a flywheel for the recovery and resilience of the area, pursuing several objectives:

- initiate didactic-training-entrepreneurial activities in line with the industriousness that characterized the Franciscan friars;
- envisage the creation of operational spaces for the traditional phases of silk production, starting from cultivation, and silkworm breeding, up to the production of the textile fiber.

The regeneration project is part of a concrete reality, made up of conservation and valorization, transformation, and functional renewal, capable of interpreting the heritage and returning it to a community that can project these heritage resources towards a productive future. There are questions about the set of works present and evaluates their potential in compositional tools for construction and restoration by renewing ways of existence between nature and culture, space and place, memory and design, the function of cultural living, and productive living. The research aims to define a new relationship between living and places, the form of designed spaces that adapt to the morphology of the site, outlining cultural landscapes that redesign ways of being and producing, of relating to reality by taking care of it. Living in this approach can be interpreted as a different relationship between individuals and the settled communities who, by culturally appropriating the resources and using them as the friars did at the foundation, make it an inclusive place that has been integrated into the community for centuries. The convent represents the sacred space of union between the city and the community. The productive one is linked to the outdoor spaces with the construction of stone terracing, dry stone walls, and the cultivation of mulberry trees that

Fig. 6
Plan volumetric, plan of the semi-hypogeal houses for tourists and workers and elevation of the landscape project. Edited by Vanessa Tancredi.

will allow the breeding of larvae. In addition to silkworm production, centuries-old olive trees also characterize the convent's surroundings and are integrated into the project strategy. In addition to the convent's socio-economic incubator, the premises will house machines to produce oil, an economic and cultural asset of the area. Along the contours below the convent, residences have been planned for travelers, tourists, and pilgrims, as well as for workers engaged in silk processing. The interventions involve the use of materials, techniques, and construction elements with a 'reversibility of intervention' approach. The project aims to reuse the former convent as a new hub for the revival of textile manufacturing in Basilicata, particularly renowned in the town of Tursi and the Agri Valley, and envisages the recovery of this tradition from silkworm breeding to the processing and spinning of raw fiber, promoting cultural opportunities for sustainable development of the territory.

This project, between experimentation and research, presents itself with a clear character, with clarity and with a program capable of interpreting a tension of rootedness to the place, between scientific rigor and technical sustainability, capable of linking the difficult terms and issues of the cultural heritage to an understanding of historical reality through architecture and glimpsing an economically profitable future.

> "Nel comporre, ma anche nel decifrare le architetture che ci interessano e ci coinvolgono, occorre saper unificare i due ambiti antitetici, considerandoli come due momenti di una sola volontà: migliorare l'abitare con edifici in cui la dialettica tra la densità corporea degli elementi architettonici e la rarefazione che li precede e li segue sia uno dei principali caratteri della loro forma" (Purini, 2022).

For hundreds of years, thousands of men have frequented this sacred place to enjoy the pleasure of the sun and to honor the principles of the Franciscan order. The project attempts to interpret this history, this aura of human passions and senses of inhabiting the earth and taking part in domestic and working spaces, for outdoor activities and spiritual retreats at the same time. The restoration and regeneration project for the convent follows compositional procedures defined as a succession of simple architectural parts and elements, integrating new volumes and confirming certain absences. The convent complex is enriched with living spaces that geometrically adapt to the orientation and morphology of the site, along its terraces, and through the lines of the load-bearing walls the domestic spaces and paths, unique observation positions of the territory, producing renewed rites and cults that evoke sacred representations, places of prayer, faith and intimate atmospheres.

Credits

Paragraphs 1 was written by A. Conte, paragraph 2 was written by M. Calia and paragraph 3 was written by V. Tancredi.

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‘ACQUARIO DELLA FLORA E DELLA FAUNA DULCACQUICOLA ITALIANA’. PROJECT FOR A LIVING MONUMENT TO SAINT FRANCIS OF ASSISI

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Abstract

The paper presents the experience related to the project of the ‘*Acquario della flora e della fauna dulcacquicola italiana*’ in the city of Assisi, interpreted as a living monument to Saint Francis, considered the first true ecologist in history, and dedicated to the study, conservation and reproduction of native freshwater species. The project, drawn up in 1991 by the architects Franco Antonelli and Sergio Lenci, while intervening in the regeneration of a specific area identified in the Regina Margherita park, fell within a broader context of the promotion of Franciscan culture, called ‘*Sorella Natura*’ (Sister Nature), and was supported by a rich scientific committee involving important institutions active on the national scene.

Keywords: Architecture and regeneration, ecology, awareness.

1. Introduction

"Laudato si', mi' Signore, per sor'aqua,
la quale è multo utile et humile et pretiosa et casta"[1].

Thus recite the verses of the Canticle of the Creatures composed by St. Francis of Assisi intended as a hymn to Nature as the whole of sacred components linked by a brotherhood relationship that arranges them all on the same level, denying the presence of a hierarchical classification within Creation. On November 29, 1979, with the bull *Inter sanctos*, Pope John Paul II proclaimed St. Francis of Assisi as the patron saint of ecological devotees (Giovanni Paolo II, 1979). The lesson offered by St. Francis has long been studied by the Church's ministers and over time incorporated into the modern meaning of the term ecology[2], whereby the original meaning of discourse around the home and living places derived from the Greek word *oekologie* – union of the terms *οίκος* , 'home' and *lógo*ς, 'discourse' – borrows into a broader sense that embraces both the human and environmental spheres and emphasizes the need for a renewed "alliance between human beings and the environment" (Benedetto XVI, 2009). In this context, water represents the primary good for human survival on earth and pervades every aspect of Creation, significantly characterizing both the terrestrial globe and the human body – as known, it is quantified in both cases at around 70 percent. In the Franciscan vision, water is associated to five characterizing adjectives such as usefulness, humility, preciousness, and chastity (Francesco d'Assisi, 2017): they belong to a complex organism in which everything is connected and call for a careful use of the resource to ensure its balanced use globally. It will then come as no surprise that in the last decade of the 1990s, in the city of Assisi, the very place where the St. Francis' thought originated, it was imagined to dedicate a "living monument to the first genuine ecologist in history" (Leoni, 1991) through the realization – which has unfortunately remained unfinished – of an *Acquario della Flora e della Fauna Dulcacquicola Italiana* (Aquarium of the Italian Freshwater Flora and Fauna) dedicated to the study, conservation and reproduction of the species peculiar to native freshwaters. The architectural design of the aquarium, drawn up by architects Franco Antonelli and Sergio Lenci, is part of a broader context of Franciscan culture promotion called *Sorella Natura* (Sister Nature) and fostered by the *Associazione Commercianti* (Merchants' Association-ASCOM) of Assisi in the figure of President Roberto Leoni together with a rich scientific committee that involved the University of

[1] St. Francis of Assisi, Canticle of the Creatures (Laudes Creaturarum), c. 1224-1226, vv. 15-16.
[2] The term ecology was coined by Ernst Haeckel in 1866 to denote the "science of the totality of the relations of organisms with the surrounding world, broadly encompassing all conditions of existence".

Perugia, the Umbria delegation of WWF, the *Centro Ittiogenico del Trasimeno* (Trasimeno Ichthyogenic Center) and specialized magazines such as Aquarium and Airone[3]. The scientific motivation behind this project belongs to the fact that the freshwaters environment was, as first, subjected to the "repercussions of a predatory policy of the territory" (Lenci, n.d.) that had led to the deterioration of the faunal and floral heritage. In fact, as a result of pollution, deforestation, hydrological degradation and pseudo-land reclamation, botanical and animal species saw their natural habitats shrink to the point of risking extinction. Hence the importance of establishing a 'nature station' used for the conservation of endangered species, as well as the establishment in 1991 of *Sorella Natura* Association – still active and known by the name Sister Nature Foundation – whose activities, under the banner of protection of life and environmental education, were disseminated from the Umbrian cradle of Franciscan spirituality to the entire Italian territory. The foundation's pivotal thought still resides in the concept of 'Wise Ecology', a locution addressed to all activities that have the individual, ethically and socially responsible, as their focus and driving force. In particular, this principle is explicated in three documents edited by the *Sorella Natura* Association: the Foundation's Manifesto, the Decalogue of Wise Ecology (1993) and the Deontological Charta of Sustainable Development (1996). The project had such a resonance that it was accepted by the Chamber of Deputies since it was able to systematize a series of economic and social interventions with positive impacts not only at the local scale, but on a national scale (Camera dei Deputati, 1991). It was precisely in this sense that, according with the architectural project of the Assisi Aquarium, a campaign of dissemination and awareness towards the flora and fauna of Italian freshwaters was promoted through the creation of a Panini stickers album entitled precisely *Sorella Acqua* (Sister Water). In this context, a scientific team[4] was responsible for representing the complexity of the species involved in an unprecedented mapping and cataloguing operation programmatically aimed at sensitizing even the youngest public with respect to the scientific theme, thus transforming the stickers collection into an educational game with extraordinary didactive potential (Farné, 2019). According to a vision of democratization of knowledge, in which understanding hitherto considered the privilege of the few is elevated to common heritage, in other words "to introduce the aquatic environment in its physical, chemical and above all biological complex" (Confocommercio-Ascom

[3] On behalf of the University of Perugia, Giancarlo Dozza (Magnifico Rettore), Bruno Granetti (full professor of Botany), Mario Mearelli (professor of Applied Ecology) and Quirico Pirisinu (professor of Zoology) were involved; on behalf of the Umbria delegation of WWF, Giampiero Cannata was involved; finally, on behalf of Centro Ittiogenico del Trasimeno, the director Mauro Natali was involved.

[4] The work team, coordinated by Quirico Pirisinu, professor of zoology at the University of Perugia, involved ichthyologist Mauro Natali and naturalistic drawer Angelo Speziale and was advised by professor Bruno Granetti and doctor Francesco Velatta.

Fig. 1
Panini stickers album Sorella Acqua (illustrations by Angelo Speziale, Italy 1991).

Assisi, 1991, s.p.) stories, anecdotes, information, riddles, and curiosities animated the thirty pages of the album designed to showcase the naturalistic illustrations (Fig. 1). An approach that is also as contemporary as ever in light of the Encyclical *Laudato sii* pronounced by Pope Francis on May 24, 2015, where the inseparable pair consisting of 'human ecology' and 'nature ecology' is joined by a third component, that from the 'ecology of communication and media' proposing an 'integral' vision (Semeraro, Gilli, 2016) in which the balanced relationship with sources of information and knowledge is considered indispensable to foster the daily capacity "to live wisely" and "to think deeply" (Franciscus, 2015, no. 47).

2. The Aquarium project

In September 1991, on the occasion of the First National Conference *Sorella Acqua*, at the Convent of St. Francis of Assisi, the project for the Aquarium of Italian Freshwater Flora and Fauna conceived by architects Franco Antonelli and Sergio Lenci, who had already been involved in the drafting of the *Piani Particolareggiati Esecutivi* (Executive Detailed Plans) for the historic center of Assisi from 1976 to 1983 (Talia and Moretti, 2022), was publicly presented. Conceived for the 1976 *Piano Particolareggiato Esecutivo*,

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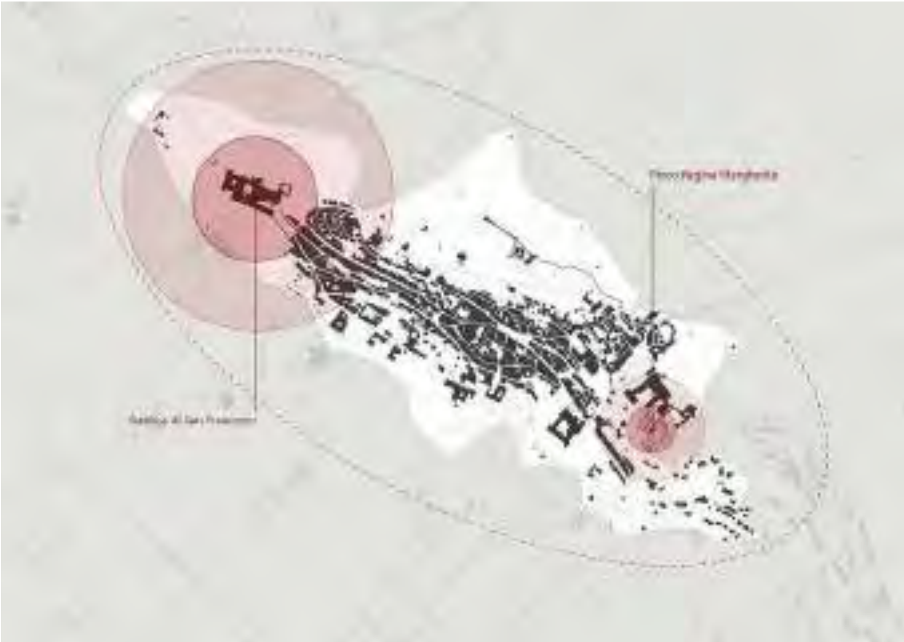
Fig. 2
Schematic diagram of Assisi perimeter as an ellipse (authors' elaboration, 2022).



the aquarium design was further developed in 1991, deepening its feasibility in relation to the site and conceptual intentions. The conception of the project within an overall vision at the urban scale is evident starting from the choice of its location, identified within the Regina Margherita park. According to the interpretation of the Assisi historic perimeter as an ellipse and the areas of the Basilica of St. Francis of Assisi and the park as two foci lying on the same axis, the realization of the aquarium project would have generated a renewed balance in the fruition of the city: on the one hand the basilica, a sacred monument to St. Francis as a spiritual reference model, and on the other the aquarium, a living monument to St. Francis as an ecological reference model (Fig. 2).

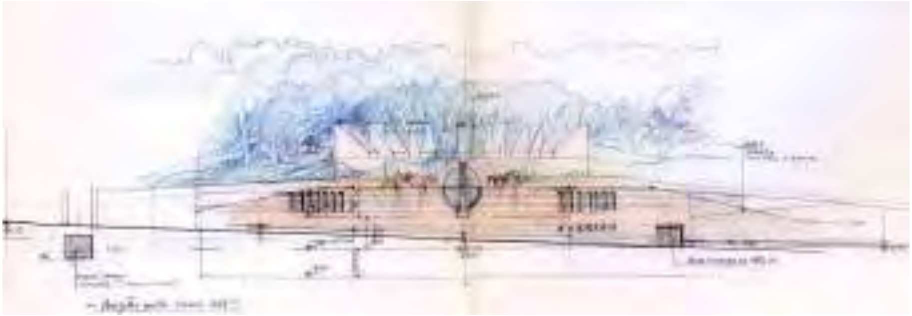
Going into the details of the project illustration, the aquarium is conceived as an extension of the Regina Margherita park, commonly known as Pincio. Designed by Alfonso Brizi in 1882 on a municipal commission, the area consists of a series of overlapping terraces connected by pathways (Bollettino della Deputazione di storia patria per l'Umbria, 2000, p. 115) that culminate in an open-air theatre whose aesthetic value was also emphasized by the German Karl Baedeleu in his 1894 Central Italy guidebook, highlighting the site as an architecture worthy of a visit to Umbria (Quinterio et al., 2010). Based on the reading of the pre-existences, the perimeter of the aquarium is defined by the shape of the theatre's hemicycle and

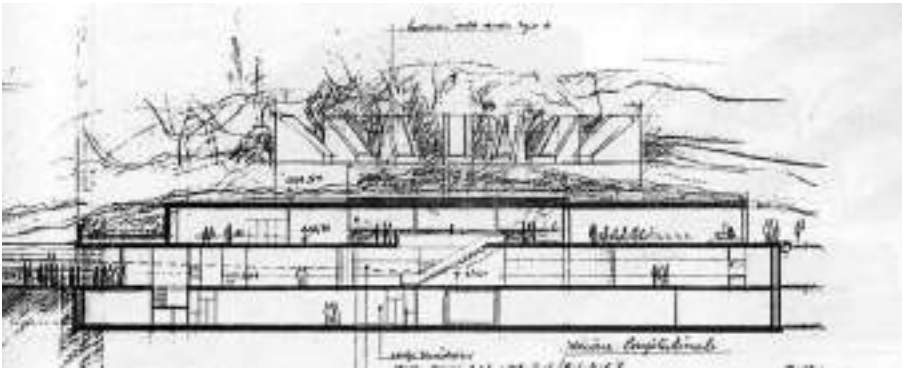
Fig. 3
Project of the Aquarium in Regina Margherita park (Antonelli & Lenci, site plan, 1991, AFA).

opposite page
Fig. 4
Project of the Aquarium in Regina Margherita park (Antonelli & Lenci, hand-drawing elevation along Viale Umberto I, 1991, AFA).

Fig. 5
Project of the Aquarium in Regina Margherita Park (Antonelli & Lenci, hand-drawing cross-section along Viale Umberto I, 1991, AFA).

the alignment of the high retaining wall facing the main road below the park – today is Viale Umberto I (Fig. 3). Marking the boundary between the architectural and urban scales of the intervention is the attention paid to the theme of the wall, designed in a position set back from the existing one in order to improve the road network and facilitate access to the aquarium, as described by Franco Antonelli in one of the many tables containing the study drawings. "The retaining wall must lose its prerogative of gravity in order to assume the role of an enclosure that hints at an animated void within it. The urbanistic role of the wall (direction, sign of the urban viability) remains, but the function of the retaining wall disappears, without assuming the role of the 'elevation' of a building" (Archivio Franco Antonelli-AFA, 91A 1/1, 1991) (Fig. 4). Entering through a pedestrian tunnel below street level and avoiding the highly trafficked driveway, the aquarium finds its space within the embankment. Consistent with the international provisions of the European Association of Zoos and Aquariums (EAZA), the association of zoos and aquariums was founded in 1988 among the countries of the European community with the aim of promoting cooperation between zoological institutions in order





to preserve animal species (eaza.net), the aquarium in Assisi aims to respond to three main functions identified in education, conservation and research (Gippoliti et al., 2021). However, the Assisian experience presents innovative features that distinguish it from previous ones, to the point of being considered a “scientific and didactic structure that is unique in Italy and Europe” (Genghini, 1991, s.p.). In fact, in addition to its didactic and informative objective aimed at a heterogeneous public – from schools to any interested figure – the aquarium is proposed as a medium capable of connecting scientists and operators of the sector. The multi-purpose character of the project is reflected in terms of the variety of functions welcomed and their distribution within the aquarium (Fig. 5). Proceeding from the bottom, the aquarium is divided into three levels connected by a vertical distribution block arranged in a barycentric position. The underground floor – about four meters below street level – mainly dedicated to housing the technological services; the ground floor, which houses the entrance to the building and the beginning of the path dedicated to the invertebrate and

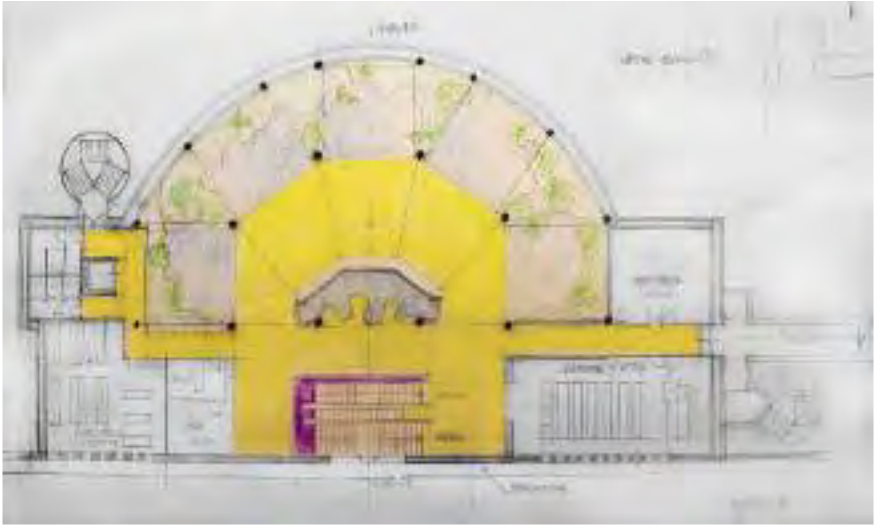


Fig. 6
Project of the Aquarium in Regina Margherita Park (Antonelli & Lenci, hand-drawing plan of the ground floor, 1991, AFA).

Fig. 7
Project of the Aquarium in Regina Margherita Park (Antonelli & Lenci, hand-drawing detail of the interior, 1991, AFA).

vertebrate aquariums; the first floor, which houses five aquariums in 'diorama form' – corresponding to as many thematic tanks divided into spring, stream, river, lake, brackish water – a children's educational tank, a video library and a library (Fig. 6). The designed tanks meet a twofold need. On the one hand, they are amply suited to the '*ex-situ*' conservation needs of the endangered species housed, as well as to the reproduction of the natural environments of watercourses – from brook to stream, from river to lake. On the other hand, they fulfil the educational intent by providing different types of tanks capable of attracting different categories of users . Thus in the views intended for the study of the interior of the first floor, the full-height aquariums marking the side perimeter are combined with a central irregularly shaped tank explicitly intended for children (Fig. 7).

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Fig. 8
Project of the Aquarium in Regina Margherita Park (Antonelli & Lenci, hand-drawing axonometry, 1991, AFA).

Finally, the design of the roof appears particularly significant in indicating the role assumed by the project, also in terms of social and collective value. Maintaining the memory and signs of the pre-existence, the architects plan a new configuration of the heavily degraded open-air theatre, updating its compositional design in relation to the new function and needs introduced.

The rhythmic succession of steps is interrupted to accommodate a series of skylight used to lighting the tanks below and is enhanced with tree species, whose arrangement is in continuity with the environmental restoration project of the entire park area. The new roof, which can be accessed both from upstream, following the original access, and from downstream, through a new ramped path around the aquarium, assumes the function of a public square accessible at any time not only by aquarium visitors, but also by the inhabitants and tourists of the city of Assisi (Fig. 8).

3. Conclusions

In contrast to a traditional approach that refers to the dissemination of the St. Francis' spiritual teaching and is embodied by the historical-architectural emergencies scattered throughout the local area, in a novel way, the aquarium project aims to enhance the memory of the Saint by spreading his teaching in terms of an ecological vision, re-educating mankind in the awareness of being an integral part of the balance of Creation. Interpreting the ecological lesson of St. Francis, in the aquarium project man is made a protagonist and an active part. It is a work of architecture in which the memory of the Saint lives on through the stimulation of knowledge and the performance of practical actions to which the entire community is called.

The originality and importance that characterize the Assisian project experience is demonstrated by the relevance that the project assumed nationally at the time of its conception, but even more so by the interest and extreme topicality that the project could continue to have in contemporary society.

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THE ‘BATTENDIERO’ CONVENT IN TARANTO.
A CHARACTERISTIC SITE OF THE CAPPUCCINI FRIARS

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Abstract

The Order of Cappuccini Friars was founded in 1525 by Friars from the Franciscan Osservanti and spread throughout Europe in about fifty years. The first Cappuccini site in Taranto dates to 1536, followed by the construction of the large convent in 1556. In addition to preaching, the Cappuccini Friars in the Ionian capital were dedicated to preparing wool and fabric to make their clothes. A ‘*gualchiera*’ was founded in 1597, not far from the central convent, on the Mar Piccolo at the source of the Cervaro River. The ‘*gualchiera*’ was a building where the cloth was washed, and wool was degreased, beaten, and firmed; it is precisely from the operations of winning wool and material that the italian name ‘*Battendiero*’ derives. The convent is on two levels: on the ground floor, there are rooms for communal activities (kitchen, refectory), storerooms and a small church, and, on the upper floor, there are 12 cells. This contribution aims to describe a singular Capuchin site (the fulling mills managed by the Order are very rare in fact) especially in the current state with the structure managed by private individuals and difficult for public use. This article, therefore, has only the claim to provide the scientific community with the knowledge of an O.F.M. Cap site. outside the more well-known Franciscan circuits.

Keywords: Cappuccini Order, Battendiero Convent, wool beating.

opposite page
Fig. 1
Detail of the map of G. Ottone di Berger, from: T.N. D'Aquino, Delle Delizie Tarentine, Naples 1771.

Fig. 2
Plan from: G.B. Gagliardo, Descrizione Topografica di Taranto, Napoli 1811. In below: detail of the area with the Convent of Battendiero.

1. The Franciscan First Order

The *Cappuccini* movement (Order of 'Frati Minori Cappuccini', in Latin *Ordo fratrum minorum capuccinorum*, O.F.M. Cap.), together with the Friars Minor *Conventuali* and the Friars Minor *Osservanti*, constitutes the so-called Franciscan or Minorite First Order. The Cappuccini were born at a time of incredible transformations of the monastic Orders that sprang from Franciscanism and – more generally – at a time of religious upheaval due to the appearance of the Lutheran Reformation.

The first contrasts between the two Franciscan souls of the *Conventuali* and the *Osservanti*, originating from the question of the poverty of Christ and the apostles, had already emerged by the end of the 13th century and continued into the following century. These disputes escalated in the first decades of the 15th century and were not healed despite repeated interventions by the popes. This led to the definitive separation of the Orders sanctioned by Pope Leone X on May 29, 1517, with the bolla *Ite vos*, perfected on June, 12 of the same year by a further bull called '*di concordia*' issued to prevent new disputes and claims. However, the period of relative calm resulting from the separation between Osservanti and Conventuali lasted very little: the more relaxed climate led to the abandonment of the original rigour. Thus, within the Observance, the ferment of renewal resumed, which soon led to the emergence of new demands and the birth of the Order of Friars Minor *Cappuccini* in 1525.

2. The birth of the Cappuccini Order

The *Cappuccini* movement was born in 1525, when Fra' Matteo da Bascio, of the Osservanti of the Marca di Ancona, began to call for a return to the Franciscanism of the origins, even after the breakaway of 1517.

By the Order historians, Matteo da Bascio is now regarded as an ardent ascetic, now an intolerant fanatic; he, wishing to return to the purest principles dictated by Francesco, took to wearing a crude habit and practising very strict poverty. This model made, with unusual rapidity, numerous proselytes eager to relive primitive spirituality, poverty, and asceticism. However, there was no lack of fierce opposition and persecution from the other two Franciscan families, concerned that many *Osservanti* and even *Conventuali* were leaving their communities to join the *Cappuccini* movement.

His superiors tried to suppress these innovations, so much so that Fra' Matteo and his first companions were forced into hiding by the Church authorities, who intended to arrest them for abandoning their religious obligations. These were, after all, the years following the Lutheran Reformation and any attempt at renewal was viewed by the church leadership with suspicion and distrust.

Fig. 3
Shows the convent from the southwest (Photo Laura Pentassuglia). In the foreground, on the left, the large tanks for washing clothes and wool.

opposite page
Fig. 4
View of the convent from the south (photo Laura Pentassuglia). The tubs are in the foreground.

Fra' Matteo and his confreres found refuge with the Camaldolese monks in Le Marche; later, as a sign of gratitude, they adopted the long hood worn by that Order and the custom of wearing beards. The popular name of their movement originates precisely from this characteristic element of their habit.

Within three years, numerous brethren gathered around Matteo da Bascio, so much so that Pope Clemente VII, with the Bolla *Religionis Zelus*, on July 3, 1528, deemed it appropriate to approve the foundation of the new Order.

The first Order was held on the first general chapter of the Order in 1529, when the *Constituzioni di Albacina* were drawn up, probably by Fra' Lodovico da Fossombrone, in which the hermitic roots of the movement, the connections with the older Franciscan tradition and the need for poverty are codified. These were then reaffirmed in 1535 by the new *Constituzioni*, drawn up by Bernardino d'Asti, also considering the significant growth of the Order. Faced with the growth of the Cappuccini family, the other Franciscan Orders succeeded, with continuous pressure, in obtaining that Clemente VII, with a *Breve* of 1534, forbade the Cappuccini to open new convents, a restriction reiterated shortly afterwards by Paolo III with the addition that they should no longer accept religious coming from other Orders.

Pope Gregorio XIII in 1574 allowed the Cappuccini to establish themselves in "*Francia e in tutte le altre parti del mondo e di erigervi case, luoghi, custodie e province*", effectively authorising their spread outside Italy. From the end of the 16th century, the Order expanded rapidly throughout the world, growing until the middle of the 18th century. To understand the importance of the Order's role in this century and a half, we need only think of Alessandro Manzoni, who chose one of the *Cappuccini*, Fra' Cristoforo, to oppose Don Rodrigo in his Promessi Sposi (The Betrothed).

3. The Cappuccini in Taranto

The first Cappuccini settlement in Apulia is documented in 1533, when the Bishop of Lecce, Alfonso Sangro, ceded to Fra' Tullio da Potenza a church dedicated to Nostra Signora in Rugge, about a mile and a half from the city. A small friary (Valenzano, 1926, p. 96) was later built there by the instructions in the '*Constituzioni of Albacina*'[1], where it was recommended

[2] *Le Constitutione*..., Napoli 1537, f. 21): "*Le celle in longhezza et larghezza non passino nove palmi, in altezza diece; le porte alte sette palmi, larghe duoi et mezzo; ma l'andito del dormitorio largo sei palmi. Et così le altre officine siano piccole, humili, povere abiette et basse, acciocché ogni cosa predichi humiltà, povertà et di sprezzo del mondo: le chiese nostre etiam siano piccole, povere et honeste [...]*".

opposite page
Fig. 5
Plan of the ground floor of the convent (Survey Carmela Crescenzi and Marcello Scalzo; Marcello Scalzo returns).

Fig. 6
Plan of the ground floor of the Convent (Survey Carmela Crescenzi and Marcello Scalzo; restitutions Marcello Scalzo).

that each friary should not exceed seven or eight friars, with the possibility of exceptions only for large cities. Soon after, Fra' Tullio moved to Taranto and then to Potenza[2], managing in 1534 to lay the foundations for constructing two convents, thanks to offerings and donations (Coco, 1940, p.397; Da Roccagloriosa, anno, p. 393).

The first Cappuccini site in the Ionian city dates to 1536 when historians and chronicles speak of the foundation of a convent near the Galeso river[3]. We are sure of this because the indication remains on the topographical map published in D'Aquino's '*Deliciae Tarentinae*'[4]. This Cappuccini complex likely developed around a pre-existing rural church, with the construction of a few cells needed to house the first friars; the first Provincial Chapter was held here in 1536. Unfortunately, due to the swamping of the Galeso river, the place became unhealthy, so much so that, barely twenty years after the friars had settled there, the small convent was abandoned (D'Aquino, 1771, p.393). As a result, nothing remains of the site, not even in ruins.

The site for building the new complex was identified in 1556, less than a mile west of Taranto[5], not far from the coast of the Mar Grande, near the port and on the road leading to the city gate. The convent and church were dedicated to Saint Mary of Consolation. The Cappuccini community in Taranto was conspicuous: there were thirty cells on the first floor and at least another four (for tertiaries) on the ground floor. Unfortunately, the architectural appearance and the current characteristics of the complex do not allow us to highlight the construction phases of the convent, which, from 1556 onwards, continued over the following centuries[6], especially after the two suppressions of the 19th century[7], when the friars abandoned the convent for good.

[3] From: Francavilla, ms. in Curia Prov. O.F.M. Cap. by Bari, c. 9. The ms. was edited under the title "*Istoria cronologica dell'Ordine dei Frati Minori Cappuccini di S. Francesco della Provincia d'Otranto, descritta e posta in ordine da P. F. Emanuele Martina da Francavilla, Predicatore e Precettore dell'istesso Ordine e della stessa Provincia*", edited by P. Antonio Da Stigliano, Bari 1941.

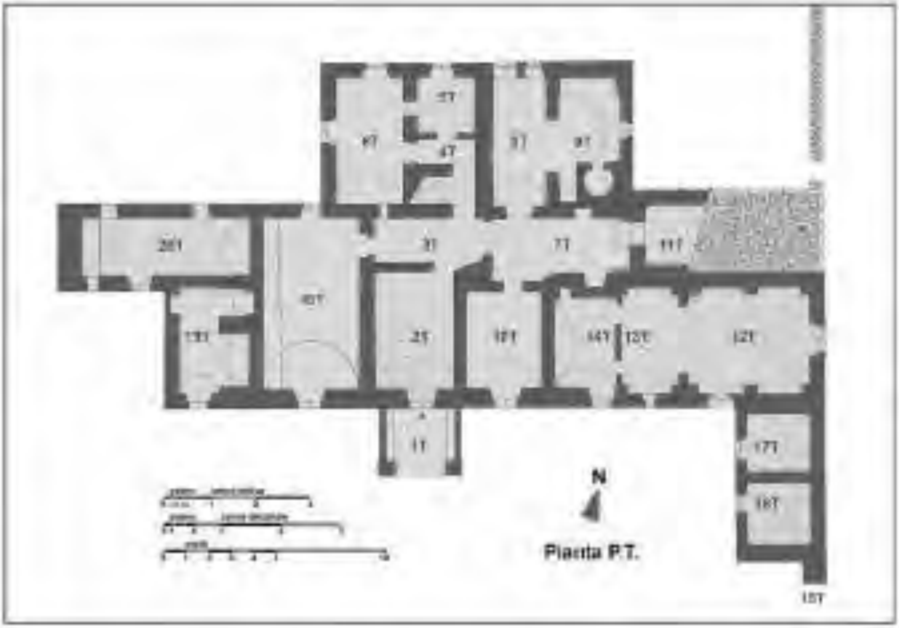
[3] Coco, p. 297 reports of a donation to the Capuchins by Francescantonio Troccoli that *«con licenza dell'Arcivescovo D. Antonio Sanseverino, cede la chiesetta della sua masseria, sita nelle vicinanze del Galeso»*.

[4] D'Aquino T.N., *Delle Delizie Tarentine*, Book IV, commented and republished by Carducci C.A., Naples 1771, p. 393.

[5] Let us remember that, in accordance with the Constituzioni, the Cappuccini convents, unlike the Franciscan sites, were built extra moenia, outside the city-walls.

[6] We refer not so much to the building interventions of the 16th, 17th and 18th centuries, as to the changes in function, when the convent was used as a lazaret, military hospital, nosocomial hospital, infirmary for the prophylaxis of contagious diseases, until the final abandonment of the site around 1960. The complex, owned by the municipality, was restored with Jubilee 2000 funds to a project by the writer.

[7] Murat's decree of 1809 suppressed the religious orders. The work of dismantling resumed with the unification of Italy: the decrees of 1866 and the following year established the drastic downsizing of the properties of all religious orders, abbeys and collegiate churches. The entire patrimony they had accumulated over the centuries was claimed by the State and passed into the public domain.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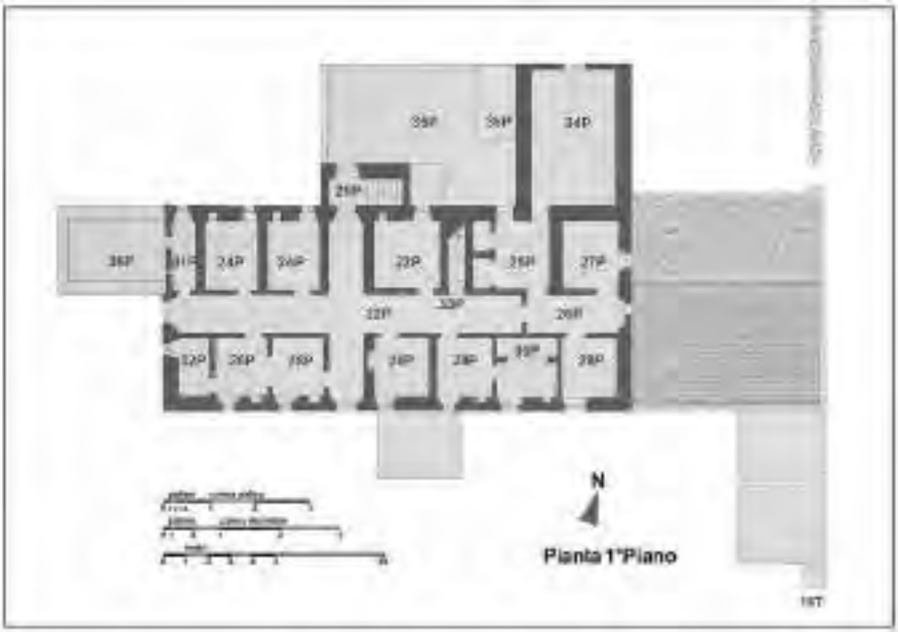
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Fig. 7
View of the convent from the southwest (Photo Laura Pentassuglia). At the top left the circular well.

4. The founding of the Battendiero Convent

One of the extra-spiritual occupations of the Cappuccini of Taranto was fulling cloth with wool woven from nearby monasteries. Soon the friars felt the need for a gualchiera, which they built, in 1597, not far from their first complex on the Mar Piccolo, but no longer on the mouth of the Galeso, but close to the Cervaro river[8]. Moreover, the convent's popular name of '*Battendiero*' or '*Battendieri*' derives from the fulling of wool and cloth. Due to its location next to the springs of the watercourse, the complex was well suited for fulling the wool and cloth that arrived here from the various convents in the province. After being degreased, beaten, and firmed, the fabrics were washed, and the thread was sent to the Provincial Minister, who redistributed it among the convents[9].

The building was conceived as a unitary structure, although over the centuries during which it housed the Cappuccini community, it underwent minor alterations and

opposite page
Fig. 8
Front of the convent from the south (Photo Laura Pentassuglia).

[8] Coco, p. 348: *"il suolo fu donato dal nobile signore Francesco Marrese, confermato dal figlio Scipione, con atto legale del 1597 e col diritto di retrocessione, in caso di abbandono dei detti padri. Questi vi fabbricarono una piccola chiesetta, tuttora visibile, con accanto le stanze per sacrestia, refettorio, cucina, e le officine per la pulizia e la lavorazione della lana necessaria per confezionare gli abiti dei religiosi della provincia, con nel piano superiore otto celle e altre piccole comodità per i religiosi"*.

[9] From Valenzano, p. 100: *"v'erano di residenza due sacerdoti, tre laici e due terziari, che ricevevano i panni da Conventi, destinati a tesserli, e, dopo averli fatti passare dalla gualchiera e asciugati, li rendevano al Provinciale che pensava a distribuirli ai frati"*.

additions; others in the periods following the Murat and post-unification suppressions up to the present day[10]. A dry-stone wall of considerable thickness initially enclosed the entire complex, about 80 cm, interrupted only on the east side by the very simple, gabled façade of the church and the low-arched (Figg. 5-6) gateway to the site. The enclosed area included, on the northwest corner, a circular construction built over a spring water[11] well where operations related to washing and fulling cloth and wool took place. To the south, along the course of the Cervaro river, the friars-built canals, sluices, and basins to regiment and channel the water. In surveying the structures, we found the use of three different measurement systems: for the earliest phase, the 8-palm barrel, corresponding to 2.12 metres; for the intermediate stage, the 10-palm barrel, reaching 2.65 metres; and for the post-unification step, the metric system. The central nucleus of the monastery is a quadrilateral block on two storeys, with a total height of 33 palms (8.73 metres); we believe that it was designed in close connection with the church, as can be seen from the overall dimensions: the length of the block, plus that of the church, is precisely ten canes, corresponding to 21.16 metres.

[10] At the time of our survey campaigns, 1979 and 1985, the complex was privately owned.
[11] Both the well and the small Cervaro river are fed by 'citri' these are sources of fresh water that flow from the underwater crust, typical of the Taranto area, found in the Golfo of Taranto, the Mar Grande and the two sinuses of the Mar Piccolo.

Fig. 9
View of the convent from the east (Photo Laura Pentassuglia). At the top right the circular well.

opposite page
Fig. 10
View of the convent from the north (Photo Laura Pentassuglia).

5. Description of the Convent

From the small square-plan[12] portico [1T], one enters the barrel-vaulted entrance [2T], like all the rooms on the ground floor, which leads to a corridor [3T] and disengages the rooms on the north side, which are reached by crossing a passageway [4T] with the staircase to the first floor on the left, followed by the kitchen [5T] and the refectory [6T]. Through the central hallway [7T], one arrives at the rooms on the north-east side of the floor, perhaps intended initially as canova [8T] and storeroom [9T]; here, one finds a large masonry oven, built based on the metric system, thus datable to the mid-19th century. The corridor [7T] disengages: to the south to a room that leads back to the outside [10T], possibly for a tertiary with the function of a guardian; to the east to the large rectangular cistern [11T] adjacent to the north side of the church, which was accessed through an arched fornix preceded by a stone basin/sink; following this to the south was a door, now walled up, that allowed the friars access to the choir of the church [14T]. This, dedicated to Santi Lorenzo and Giorgio, has a single nave [12T] in the best Cappuccini tradition, conceived as a unit with the choir loft behind the altar. The hall has a slightly lowered barrel-vaulted ceiling, divided into two bays by round-headed niches set on square pillars with rounded corners. On the other hand, the hierarchy has a cross-ribbed roof and is separated from the hall by an arch set on capitals and pillars like those in the gallery.

[12] The base of the loggia, measuring 3.70 × 3 metres, and its height of approximately 4 metres, testify to its construction according to the metric system, which dates the artefact to a period after the Capuchins abandoned the site.

Initially, on the back wall at the sides of the altar [13T], of which no trace remains, two passages connected the hierarchy with the choir behind [14T]. The church's interior space is 8.47 x 4.77 metres or 32 x 18 palms; nothing remains of the old floor or the original decorations, probably consisting of canvases. The façade, made of carparo stone[13], has a maximum height of 6 metres; in the centre is the architraved entrance door surmounted by a small arched lunette and, higher up, a small square window through which the rising sun could illuminate the altar. Outside, the church is covered up to the presbytery with tiles protecting the vaults below. On the other hand, the choir loft is incorporated into the first floor occupied by the cells. On this four-sided block, flush with the east wall, decorated with 14 simple corbels, a small bell gable about 12 palms (2.65 metres) high rises at the wall dividing the presbytery from the choir.

On the south side, a round-headed portal [15T] allowed access to the church inside the enclosed area. Next to the entrance door, we find two simple four-sided rooms, datable to the 18th century, with a barrel-vaulted roof [16T-17T], used as storage or community guest quarters. On the west side of the primitive building, we find three rooms, the outermost of which [20T] has been enlarged and limited to the ground floor; in these three rooms were indeed located the workshops and storerooms for the storage of fabrics awaiting fulling and those already fulled [18T-19T]. The large cistern adjacent to the church [11T] measures 15 x 5.30 metres and originally had a depth of about 4 metres, i.e., a capacity of

[13] Carparo is a calcarenitic stone, derived from the cementation of calcareous rock sediments, generally in a marine environment; common throughout Apulia, it is generically referred to as tuff.

Fig. 11
left. Interior of the church towards the altar (Photo Laura Pentassuglia), right. Interior of the church towards the exterior (Photo Laura Pentassuglia).

about 300 cubic metres, a considerable volume of water for the needs of a small community. As a hypothesis, one might think that the cistern reached its current size later when the complex was mainly used for livestock breeding[14]. One arrives at the first floor using a flight of stairs [21P] which starts from the small passageway [21P] on the ground floor and reaches a balcony from which one can access a terrace on the right and, on the left, one of the short arms of the orthogonal corridors [22P] onto which the cells face. At the intersection of the corridors, four decorated columns indicate the dependence of '*Battendiero*''s project on that of the Convent of the Consolation, built forty years earlier. However, everything is more straightforward at Battendiero since the original cells were only eight, as the 1670 document states, and perhaps not even built in one piece. To a phase carried out between the mid-17th century and the beginning of the following century, we owe the construction of the eastern part: the extension of the corridor [26P], the pavilion-vaulted cell [27P], the barrel-vaulted cell in the south-east corner [29P] and the modification of the room possibly used for the 'communal fire' [25P].

opposite page
Fig. 12
left. Interior of the ground floor of the convent; rooms 7T and 3T (Photo Laura Pentassuglia), right. Interior of the first floor of the convent; corridor 22P (Photo Laura Pentassuglia).

Further phases include the ample space of uncertain use [34P], the terrace to the north [35P] and, much more recently, a room used for services [36P]. On the west

[14] In 1979, at the time of our first surveys of the monastery, we found the presence of mangers on the ground floor rooms [18T-19T] and even in the church.


terrace [36P], a small square window opens, one palm by one palm, surrounded by a moulded cornice of fine artistry. The cells were designed only partially following the requirements of the Constitutions, which stipulated 9 palm sides. At Battendiero, the cells towards the south are slightly wider by 9 palms (from 2.60 metres to 2.68 metres wide). At the same time, those towards the north are decidedly wider (from 3.08 metres to 3.17 metres, thus from 10 to 12 palms [23P]), perhaps because they were intended for the Father Guardian of the small community. Usually, the more giant cells consisting of two rooms [28P-32P], a smaller one where the bed was housed, the other larger as a study, were intended for activities related to the Father Guardian or Provincial. We do not believe that, due to its size, cell [30P], characterised by the presence of a large fireplace, could have housed the 'common fire' room. In the central corridor, a narrow staircase [33P] led to the roofs of the convent.

6. Some final considerations

When we surveyed the convent more than thirty years ago, the structure was already in disuse and no longer inhabited. Abandoned by the Capuchin friars, the monument in the early twentieth century was sold to private individuals who used the building for agricultural purposes, overturning, above all, the singular and elaborate system of locks, tanks and canals present on the Cervaro river intended for the fulling of wool and cloths.

Fig. 13
View of the convent from the northwest (photo Laura Pentassuglia). In the foreground, bottom left, the circular well with its annexes.

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Fig. 14
(left) Fra' Cristoforo e Don Rodrigo. Illustration for the 'Promessi Sposi' by Francesco Gonin, 1840.
(right) A Capuchin friar (18th century engraving).

This article is a small contribution to the knowledge and dissemination of some basic information on a minor and peripheral Capuchin site, albeit extremely unique, for scholars of Franciscan architecture

Today the convent of Battendiero continues to be privately owned; in recent years some rearrangement interventions in the area have made the spaces around the convent usable, although the complex system of basins and canals that characterized the place has been irretrievably lost. Other works especially involved the exterior of the convent, such as the facades and roofs. We can only hope that in the future this characteristic example of Apulian Capuchin architecture will be preserved and protected, respecting the original structure.

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FROM ASIS TO EUROPE. TERRITORIAL-URBAN DEVELOPMENT OF THE FRANCISCAN ORDER

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Abstract

The first monastery by Saint Francis in Assisi in 1209 marked the beginning of an extraordinary expansion that reached all the Christian territories of the European continent. It was a historic milestone whose magnitude was magnified by the difficulty of communications and territorial infrastructures in the Middle Age. The Franciscans went from a single settlement in 1209 to more than 1200 towns in a century. The order configured a vast territorial network in provinces, whose delimitations overlapped the medieval political frameworks. Cartographies and spatial data management tools have been used to study this territorial structure during the 13th century. These have allowed a graphically analyse establishing percentages, densities and heat maps of the Franciscan monasteries. The superimposition of this information with geographical, hydraulic or political maps has generated interesting clues for the understanding of the first stage of Franciscan expansion in Europe.

Keywords: Europe, Franciscan cities, Geographic Information Systems.

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Fig. 1
Franciscan provinces and monasteries in 1300. Provincial capitals (dark purple) and other cities (light purple). Own elaboration based on ESRI cartographic base and data from Schenkluhn (2000).

1. Introduction

After the prominence achieved by the Cluny and Cistercian orders in previous centuries, the search within the Catholic Church for a new model of religious life led to the appearance of the mendicant orders on the European scene at the beginning of the 13th century. Until then, monasteries were isolated buildings in the territory where the friars withdrew to an eminently contemplative life. They had no relationship whatsever with the urban world, creating self-sufficient centres. However, the mendicant orders would be configured as a mixture of contemplative and active life. According to Le Goff (1971), they settled in cities based on its economic importance, in order to prosper in preaching and, education and, at the same time to obtain resources for their survival.
One of the first mendicant orders were the Franciscans in 1209. This was followed by well- known and important orders such as the Dominican order in 1216, the Augustinian order in 1256, and the Carmelite order in 1247 (Pounds, 2005). Soon the Franciscan and Dominican orders became political instruments, like the campaigns against the heresy of Cathars. They could be found in pairs in the cities. Wherever a Franciscan or Dominican foundation appeared, another of the other order would soon appear (Braunfels, 1974). The first order mentioned, the Franciscans, had their first foundation by St. Francis in the Italian town of Assisi. The new order would follow a model of life based on the rule and vows of chastity, obedience and poverty (Schenkluhn, 2000). Determined to live on alms and in community among brothers, the newborn institution would adopt the monastic typology always linked to urban life. From Assisi it would spread from this time onwards throughout Europe, and its presence would continue to the present day.

2. Objectives and methodology

2.1. Objectives

The main objective is to understand and interpret the Franciscan monastic expansion during the 13th century through its territorial structural keys in the European political and geographical dimension. This century is the first century of Franciscan development in Europe, key to understand their later foundations on the continent. At the same time, it also seeks to identify the areas of greatest Franciscan monastic density, studying the relationship between the number of cities and the territory where they are located.

2.2. Methodology

The methodology employed is based on the use of geolocation and the superimposition of georeferenced layers. Various layers of a political or geographical nature and relating

to infrastructures are selected and combined. The QGIS tool has been used to manage the different layers. This allows a richer and more complex cross-analysis of information on cities and territory than that of architectural objects (Navas et al., 2018). The location and position of all the Franciscan cities between 1209 and 1300, as well as the provincial structuring in that period, have been obtained. These data have been reflected in a table including the total number of Franciscan provinces, capital cities, total cities and surface area in km^2. This was essential to calculate the settlements density in each territory. The simultaneous layers of Franciscan monasteries, Franciscan provinces, political boundaries and geography have been key to the understanding of the European Franciscan establishment process.

3. European Franciscan expansion

The monk Raul Glaber describes that after the year 1000 there was a true fever in Europe for the construction of churches and monasteries (Mitre Fernández, 2010). In this context, the appearance of the Franciscan order is undoubtedly marked by its first settlement in Assisi. Soon, the strength acquired by the Franciscan phenomenon in the urban areas blurred the political borders of the Order, which restructured the European map into 'Franciscan

Fig. 2
Political borders in 1300 overlapped on the Franciscan provinces and monasteries. Own elaboration based on ESRI cartographic base, data from Lanuza (2003) and Schenkluhn (2000).

provinces'. By 1224 there were already 13 provinces, six in Italy, three in France and one each in England, Germany, Spain[1] and the Holy Land (Schenkluhn, 2000). By the end of the same century, the 13 provinces had grown to a total of 36 major provinces, which were further subdivided into 214 minor provinces, each governed by a See or capital[2] (Fig. 1). The toponymy of the major provinces is diverse. Some are associated with existing kingdoms, such as Hungary, Castile or England, while others are linked to cities such as Cologne, Santiago or Naples. Finally, some provinces, such as Dalmatia, are named like the ancient Roman province. A territorial division that is partially independent of the political European borders at this time. The joint analysis of both territorial structures provides clues to the Franciscan establishment process.
The overlapping of the political layer of the 13th century with the Franciscan provincial system makes visible the logical preferential position in the number of Franciscan monasteries.

[1] References to Franciscan provinces in Italy, England, Germany and Spain correspond to the polititical territorial borders in 2022
[2] Due to the use of the continental scale for the study of Europe as a whole and the difficulty in terms of size and number of smaller provinces, only the larger provinces and their capitals are shown in darker colour in Fig. 1.

These are the regions with the greatest Christian tradition and presence (Fig. 2), the Catholic kingdoms of Castile, Aragon, France, the Holy Roman Empire, the Papal States or Sicily. On the other hand, in the peripheral kingdoms such as Poland, Hungary and Denmark, the processes of Franciscan expansion are also perceptible, but with a smaller number of cities. A singular case would be the south of the Iberian Peninsula of the Catholic kingdom of Castile, where a notable difference between the northern and southern halves can be detected. This is logically a reflection of the recent Christianisation and conquest of the Islamic south, today's Andalusia, with the exception of the Kingdom of Granada. Later, an intense process of Franciscan expansion took place in this region.
From 7 establishments in the 13th century, there were 51 monasteries in the 18th century (Ostos Prieto et al., 2020), multiplying the number of monastic settlements by 7.3, showing a real expansive strength by the order. In contrast to the above justified coincidence, other situations are a reflection of the complex political and religious structure of Europe. The existence of Franciscan provinces in apparently orthodox or Islamic territories is initially strange, as is the case of the provinces of Dalmatia, Greece, Vicaria Tartariae Aquilonaris or the Holy Land. In the first one, partially included in the kingdom of Serbia, the Franciscan monasteries are located on the Adriatic coast in cities that were under the control of the Republic of Venice (López- Davalillo Larrea, 2001). In the same way, the cities of the province of Vicaria Tartariae Aquilonaris in the territory of Khanate of the Golden Horde were governed by the Republic of Genoa (López-Davalillo Larrea, 2001). Part of the once orthodox territories of the Byzantine Empire are now controlled by Christian kingdoms, such as the Principality of Achaia. It was a Catholic kingdom born of the conquests of the Fourth Crusade (Lanuza, 2003), located in the province of Greece, in the Peloponnese peninsula.
The same applies to the province of the Holy Land, which has been ruled by Christian kingdoms since the beginning of the Crusades in the 11th century. In addition to the complex European political and administrative structure, the Franciscan establishment sequence, requires for its analysis the consideration of the physical support of that territory. The difficulty of transports and the incipient communications network of the late Middle Ages would lead to the concentration of most of the Franciscan provincial capitals on the main European river axes, such as the Rhine, the Elbe, the Danube, the Seine or the Po.

4. Results

The distribution of the cities with Franciscan monasteries by provinces is characterised by a notable imbalance between the Italian peninsula and the rest of the provinces.

Fig. 3 Density of Franciscan monastic establishments by province in 1300. Own elaboration based on ESRI cartographic base and data from Schenkluhn (2000).

opposite page **Fig. 4** Franciscan monastic settlements in 1300, European hydrography and the St. James Way by Künig. Provincial capitals (dark purple) and other cities (light purple). Own elaboration based on ESRI cartographic base, data from Schenkluhn (2000) and Herbers (2011).

For a territorial understanding of the establishments of the order, the 35 provinces have been taken. In each of them, the total number of capital cities, the rest of the cities that occupy a second level and the provincial territorial surface in km^2 have been counted (Tab. 1). In order to quantify the importance of Franciscan influence in each province, density has been established as a parameter. Therefore, the total number of cities (capitals and non-capitals) was divided by the territorial area. With these data, a provincial map has been drawn up where a chromatic gradient graphically establishes the densities (Fig. 3)[3]. As was evident, the Italian peninsula stands out from the rest. Provinces like Ancona stands out with a coefficient of 7.80 compared with others such as England, which are at the opposite extreme with 0.25. With the exception of the Italian provinces, in the rest of Europe, territories such as Provence, with a density of 0.53, Aquitaine, 0.45, France, 0.42, or Cologne, 0.40, stand out. The comparison with Italy, which is between 0.47 and 7.80, is nevertheless still overwhelming. These higher density regions occupy

[3] Due to the provinces of the Holy Land and Vicaria Tartariae Aquilonaris are not decisive in the conformation of the Franciscan monasteries, the scale is changed and Western Europe is enlarged.

the central European areas, while the more peripheral ones mentioned above show a lower index. Regions like Santiago, Hungary, or Denmark, have densities of 0.19, 0.12 and 0.008 respectively, much lower than other territories of Franciscan establishments. On the other hand, the distribution of the Franciscan cities, plotted on a heat map, superimposed on the topographic and fluvial layers, provides other results apart from the provincial structure itself (Fig. 4). As it was already mentioned, the riverbeds are going to attract a large number of establishments in their surroundings. Relevant examples are the Rhine and the Danube, where cities such as Bač, Buda, Esztergom, Gyor, Vienna, Ens or Regensburg stand out. The location of these cities is strategic for the structuring of Europe. The size and length of the rivers allow for better mobility and communication in transport, becoming real axes of territorial connection, favouring the urban and monastic development of a city. Secondly, the shadow generated by the heat map makes it possible to locate two longitudinal Ens or Regensburg stand out. The location of these cities is strategic for the structuring of Europe. The size and length of the rivers allow for better mobility and communication in transport, becoming real axes of territorial connection, favouring the urban and monastic development of a city. Secondly, the shadow generated by the heat map makes it possible to locate two

Tab. 1
Franciscan monastic establishmemts in cities in 1300, by province, territorial Surface and destiny. Own elaboration, data from Schenkluhn (2000).

longitudinal axes of Franciscan concentration in what is now France. One in the south, on the *Côte d'Azur*, and the other running from current Belgium to the Pyrenees along the west coast. In fact, if we superimpose the plan with the route described by Künig in the 15th century[4], they practically coincide. It is the Way of St. James, starting in the towns of Einsiedeln (current Switzerland) and Aachen (current Germany) (Herbers, 2011). The previous existence of the road as a European backbone undoubtedly encouraged the establishment of new settlements of the Franciscan order along the pilgrimage route.

5. Conclusions

In less than a century, the Franciscan monastic expansion in Europe was more than remarkable. From the first foundation in 1209, it would reach a total of 1254 settlements in 1300. A clear sign of the potential and strength that the order exhibited in European territories. The high number of urban monasteries reached would make it necessary to structure the territory in a new way. A division that would imply a new territorial characterisation of the continent through Franciscan influence. A superstructure that conceived Europe as if it were a homogeneous territory. The political boundaries and borders of medieval kingdoms and empires are blurred in pursuit of a unitary European territorial reading. A 'Franciscan unity' that would include territories that were initially external to European Catholicism, such as the Serbian Adriatic coast, the Peloponnese peninsula, the Crimea and part of southern present-day Turkey. The constant changes in the political configuration of kingdoms and the transfer of cities from one to another allowed the presence of Franciscans in territories such as these that were under Orthodox or Islamic influence.The original settlement of Assisi and the presence of the Papal States hugely increased the Franciscan monastic density in the Italian peninsula during the 13th century. In numerical terms it would be 5 to 7 times greater than in any other European territory. In the remaining provinces the Franciscan distribution at the end of the century was fairly even and balanced. Only in the more peripheral areas is there less development, as a result of the continuous process of expansion that had yet to reach the more distant regions. In this expansion, territorial infrastructures, whether natural or artificial, proved to be key to monastic development. On the one hand, the great European rivers such as the Rhine, the Elbe and the Danube formed real backbones. The course and length of these rivers made them ideal as communication and trade routes, which is why the cities along these rivers were key points for the establishment of the Franciscans. On the other hand, the infrastructures of European roads such as that the Way of St. James gave

[4] Künig describes the Way of St. James in the pilgrim's guidebook of 1495, *Die walfahrt und Straß zu sant Jakob*.

greater importance to the cities located along them. The pilgrim influx and the creation of roads through different kingdoms and territories gave these land routes a fundamental role in the establishment of new Franciscan settlements. The presence of these infrastructures, the political conditioning factors and the geographical configuration of the territories themselves conditioned the development of Franciscan monasteries. They are indispensable for understanding their quick expansion process during the 13th century.

Acknowledges
The publication has been carried out jointly and equally between all the authors. The different knowledge and experience have contributed to the development of the text and figures.

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INTEGRATED DIGITAL SURVEY FOR THE DOCUMENTATION OF CULTURAL LANDSCAPES. THE FRANCISCAN CONVENT OF CHELVA ON THE 'RUTA DEL AGUA'

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Abstract

The paper illustrates the methodological protocols for the management and dissemination of the tangible and intangible cultural heritage of the Franciscan Observance in the framework of the European project F-ATLAS. The in-depth analysis focused on the Spanish case study of the Convento de Los Franciscanos in Chelva, near Valencia. Funded in 1388, the complex is one of the first Spanish Observant foundation convent. The building is part of an agricultural area characterized by terraced gardens and complex systems of canalization of spring waters. The case study represents many of the identifying characteristics of the Franciscan Observance sites in Italy, Spain, and Portugal. The investigation through TLS and SfM/IM methodologies aim at realise reliable drawings and analysis concerning the architecture of the Franciscan convent of Chelva, in relation with its historical evolution and the territory. The research objective is to highlight mutual transnational influences between the identified Franciscan Observance settlements.

Keywords: Terrestrial laser scanner (TLS), Structure from Motion/Image Matching (SfM/IM), Religious architecture.

opposite page
Fig. 1
Characteristic perspectives of the historic centre of Chelva.

1. Introduction

The research is part of the three-year European project F-ATLAS – Franciscan Landscapes: The Observance between Italy, Portugal, and Spain[1]. The project aims to develop methodological protocols for the management and dissemination of the tangible and intangible cultural heritage of the Franciscan Observance settlements (Bertocci et al., 2023). In particular, through the study of bibliographic and archival sources, the digital survey and the census of the individual complexes, the project aims to investigate the relationship between the Observance architecture and the surroundings, emphasizing how the places of the Franciscan presence have marked cities and countryside, forming an inseparable part of the history, of civil life and the territory (Bartolini, Paciocco, 2000, p. 124). The critical cataloguing and mapping work coordinated by the ISCTE-IUL of Lisbon and the University of Barcelona led to identifying case studies representing an essential testimony of the link between architecture and 'Franciscan landscapes' (Volzone, Genin, 2022).

In Spain – where the Franciscan Observance appeared at the end of the 14th century – two fascinating settlements were chosen to be explored further through integrated digital survey campaigns. The first case study, the Monastery of Sant Miquel d'Escornalbou in Tarragona (Soler et al., 2023), was surveyed in November 2021. The Convento de Los Franciscanos in Chelva, near Valencia – known as one of Spain's first Observant Foundations – has been chosen as the second case study[2]. The complex is part of an agricultural area characterized by large terraced plots of land and by the presence of water canalization systems that underline the close interdependence between built and natural heritage, qualifying the case study as a cultural landscape, where man's work is in union with nature in a system of mutual influences.

The religious complex still maintains the original hermit nucleus of the caves, located on a hill not far from the convent. Its peri-urban position in a strategic point allowed the friars to observe the town of Chelva and the surrounding valley. The agricultural environment implemented by the historical presence of rainwater collection and canalisation system, the proximity to the Chelva and Turia rivers, and the presence of caves, which over time became the home of hermits, make the convent of Chelva an essential reference for understanding Franciscan settlements.

[1] The project, granted by the JPI-CH 2019 tender and started in July 2020, is a collaboration between the University of Florence (PL Stefano Bertocci), the Instituto Universitario di Lisboa (PI Soraya Genin), the University of Barcelona (PI Maria Soler Sala) and the Portuguese Catholic University of Lisbon (PI Maria Filomena Andrade).
[2] One of the first data we have on the origins of the Observance in Spain is a bull of 1390 with which Clement VI authorized the foundation of observance of Chelva and Manzanera, both in the province of Valencia (García Ros, 2000; Martinez Vega, 1996; Soler et al., 2021; Soler et al., 2022).

1.1. The Convento de Los Franciscanos in Chelva

The town of Chelva in the Valencia region is an outstanding example of the overlap between Islamic and Christian urban planning (Benito et al., 2014). The presence of water characterised the territory, defining the landscape and making Chelva an important centre of agricultural production over the centuries. The great Peña Cortada aqueduct from the Roman era lost its continuity in the Middle Ages. It was used by the Arabs as an irrigation system, through diversions that circulated through the streets and vegetable gardens of the city, providing service to the numerous fountains and laundries typical of Islamic Urban Planning[3]. Not far from the inhabited centre, along the paths of the Ruta del Agua, which develop within the historic centre and along the course of the Chelva river, is located the convent of San Francesco, founded in 1388 at the behest of the first viscount of Chelva, Pedro Ladrón de Vilanova[4]. His humble primitive factory, "as if designed by the very hand of poverty"[5], consisted only of nine narrow and small cells and a small church. Already fifteen years before the foundation of the convent, in 1373, three religious from the Franciscan convent of Zaragoza had settled in the caves dug into the rock on a hill overlooking the current convent. Some of these structures are still well preserved today as they served as a temporary retreat for many religious people in those years and subsequent periods.

[3] Among the elements considered immovable property of cultural interest according to the general inventory of the Valencian cultural heritage are the Peña Cortada aqueduct, the parish church of Nuestra Señora de los Ángeles, the turret and the historic city with its terraced orchards.

[4] In the work La Fénix Troyana, Father Vicente Mares Martínez (1633-1695), rector of the parish church of Chelva, reports that the convent was founded in 1388 at the behest of the viscount after a meeting with Father San Bernardino in the city of L'Aquila, Italy. During the meeting it seems that the viscount asked to the saint to send friars to Spain in order to built a Observant convent and Bernardino agreed sending five friars to Valencia. The source is not reliable as at the time San Bernardino was only 8 years old (Catalá Gorgues, 2019).

[5] "*como diseñada por la mano misma de la pobreza*", See Martínez Colomer, 1803, Historia de la Provincia de Valencia ed al regular Observancia ed San Francisco, Valencia, p. 70.

Fig. 2
Aerial view highlighting the close relationship between the convent and the water system that characterised the surrounding landscape (photo by Pietro Becherini).

Fig. 3
Aerial view of the convent with the city of Chelva in the background (photo by Pietro Becherini).

Father Àngel says that around 1400, a conservative friar “driven by zeal” destroyed the convent because its existence was a symptom of the loss of the primitive ideal (García Ros, 2000). The Chelva convent was rebuilt in 1401, reaching up to thirty cells and in 1518, it had a ruinous appearance and was subsequently renovated and enlarged. The works for the construction of the church of San Francisco – which has a late Gothic style and a Renaissance facade – began in 1551 at the expense of Don Francisco Lladró, viscounts of Chelva, and his wife, Doña Inés Manrique. The building, like the rest of the convent, fell into ruin following the expulsion of the friars in 1835 and was reconstructed starting in 1910, based on a project by the master builder and lay Franciscan Fray Maseo Company, inaugurating the church in neo-Gothic style, on October 26, 1913 (Catalá Gorgues, 2019). The complex suffered further damage after the suppression of the Second Spanish Republic (1931) and later during the Spanish Civil War of 1936-39 and is strongly altered from an architectural point of view today. After the abandonment of the last friars, the complex, a place strongly felt by the citizens of Chelva, was used as a farm and is still used for religious meetings hosted inside the guesthouse.

2. The integrated digital survey

The Chelva case study provides many of the identifying characteristics of the sites of the Franciscan Observance, highlighted through a careful comparison between the Italian, Spanish and Portuguese settlements. In particular, we find the strong link with the territory, the functional structure of the complex developed around the cloister and the presence of hermit caves. From a methodological point of view, the research faced difficulties in finding historical documentation due to the losses caused by the events that followed the French occupation (1811-13), the suppressions (1822-23), the exclaustration (1835 and 1865), the confiscation (1855), the ordinance of suppression of the Second Republic (1931) and the Spanish civil war (1936-39) (Mancinelli, 2013).

The research aims to establish the necessary documentation to investigate the evolutionary phases of the Chelva Convent based on analyses of the existing building to develop future requalification and protection strategies while respecting the historical and cultural characteristics of the site.

The documentation methodology adopted envisaged the integrated use of laser-scanner survey (TLS) and close-range and UAV digital photogrammetry (SfM/IM). This documentation campaign aims to create technical drawings on a 1:50 scale, necessary to develop a framework of metric and morphological valuable knowledge for understanding the complex and for developing comparisons with other investigated case studies.

Fig. 5
Digital laser-scanner survey campaign of the hermitical caves.

opposite page
Fig. 6
Texturised mesh model by digital Structure from Motion/Image Matching by UAV.

2.1. Terrestrial Laser Scanner survey (TLS)

The documentation campaign took place from 21 to 28 February 2022 and involved research groups from the University of Florence, the University of Barcelona and the Polytechnic University of Valencia. For the laser-scanner survey, a Z+F 5016 was used for the convent complex and the caves, and a Leica RTC360 was used for San Francesco's church interiors[6]. A Pentax K-1 with a 24-70mm F2.8 lens was used for the close-range photographic survey, and a DJI Mavic Mini 2 drone was used for the UAV survey. The two surveys were integrated using morphological points with coordinates obtained from the point cloud resulting from the laser scanner and topographical targets acquired using the Leica Zeno FLX100 plus smart antenna. Collecting the marker coordinates was necessary to locate the two portions of the complex, the caves, and the convent, collected in two separate sessions.

The survey provided for the acquisition of 185 scans for the convent part, 60 scans for the cave complex and 30 scans inside the church. The acquired data were processed using the Leica Cyclone software. The individual scans were subjected to the filtering process and the registration by roto-translation and overlapping of the single acquisition and alignment through cloud constraints. The scans were acquired with the overlay of the given RGB colour through the HDR cameras equipped with the instruments, returning a highly descriptive 3D point cloud which, integrated with the photogrammetric models obtained from photogrammetry by UAV, returns an overall image and allows to develop further in-depth investigations also linked to the evolutionary aspects of architecture and landscape.

[6] The laser-scanner survey of the interior of the Church and the GPS acquisitions were carried out by Prof. Pablo Rodríguez Navarro and Prof. Teresa Gil Piqueras of the Polytechnic University of Valencia.

opposite page
Fig. 7
Preliminary 2D elaborations representing a cross-section of the cloister and the general plan.
A_entrance square;
B_Church of St. Francis;
C_Cloister;
D_Dormitory;
E_Refectory;
F_Patio;
G_Rectory;
H_Side Chapel.

2.2. The Structure from Motion/Image Matching survey (SfM/IM)

In addition to the laser-scanner acquisitions, a series of SfM photogrammetric survey campaigns were also carried out in parallel, both close-range and at high-altitudes, which allowed us to obtain the global image of the monastic complex in its architectural and environmental spaces. The models obtained allow us to integrate the TLS metric surveys by compensating for the grey areas that can only be acquired at high-altitudes and documenting the information relating to the appearance and state of conservation of the materials, particularly the roofs. The photographic survey campaign was consequently organized according to different levels of scale and detail. An initial mapping of the entire complex and the surrounding environment was initially carried out using UAVs. Subsequently, the external surfaces of the structures and the most relevant internal environments were acquired in more detail using close-range acquisition. As regards the drone photos, although each of them was equipped with geographic coordinates provided by the integrated GPS, the recognition of the targets used for acquisitions on the ground and those via laser scanners was used to integrate the methodologies and obtain a survey with a higher level of reliability.

The photographic data was processed using the photo-modelling software Agisoft Metashape Pro, obtaining a mesh model to which the texture from the photographic data was applied, thus obtaining a mapped 3D model of the external surfaces. The development of this model, integrated with the data from the laser-scanner surveys, allows the extraction of multiple graphic drawings to compare and analyse both the architectural work and the natural environment.

3. Architectural analysis

The drawings realised based on the survey campaign allow us to develop preliminary considerations on the architecture of the Franciscan convent of Chelva concerning its historical evolution and relationship with the territory. The convent is surrounded by a border wall, which delimits and marks the division between the rural environment and the sacred space. Access to the convent complex is via a dirt road that deviates from the Ruta del Agua and reaches a large square (Fig.7A). The external elevation is characterised by the Renaissance facade of the church of San Francisco, with the big round-arched portal flanked by two small columns that support a tympanum. On the left, a door allows access to the partially collapsed cloister, which forms the central point of the complex (Fig.7C). Only the one on the north elevation remains of the perimeter porticoes, built along the south elevation of the church.

The building on the west side of the cloister (Fig.7D), where the friars' cells must once have been, is probably due to the twentieth-century reconstructions and houses on the ground floor service areas, a kitchen, toilets, and an ample space used as a refectory (Fig.7E). A central staircase leads to the two upper floors, consisting of six bedrooms each. The first floor is connected to the choir through a corridor above the cloister porch. A large room is located along the south side of the cloister and is used as storage. Continuing the path, there is a second patio with a three-story rectory, where the reuse of masonry from the original construction is still visible in the retaining walls (Fig.7F-G).

The church of San Francisco is divided into four cross-vaulted bays, three of which are flanked by chapels on both sides, which are also cross-vaulted and framed by pointed arches (Fig.7B). The entrance hall, dominated by the deep choir on the first level, initially gave access to the side chapel on the north front, elliptical in shape, currently inaccessible due to the deterioration of the structure (Fig.7H).
A ribbed star vault covers the polygonal apse, and on the sides of the altar, two doors lead to the sacristy, also polygonal, and to the small bell tower. On the external front, the church walls are reinforced by masonry buttresses arranged in shear, which define the division of the side chapels inside. On the back of the convent, an uphill path leads westwards to a rocky massif characterised by numerous caves and recesses. Some of these hermitages still retain the boundary walls that served as a filter and as a living place for the hermits. In the highest part of the perimeter is the original nucleus of the convent, a small chapel dug into the rock as an apse, later integrated by a three-arched portico structure. Continuing along the path is a large cistern, which allows irrigation of the terraced gardens of the Franciscan complex through complex canalisation and management of the locks.

4. Conclusions

The sanctuary, as well as the numerous Franciscan monasteries documented during the F-ATLAS project, are comparable in terms of assets to the concept of 'cultural landscape', as they represent a union between the work of man and nature, where culture acts using natural elements to define a place configured as a well-balanced synthesis of these two elements. This link between the religious complex and the surrounding landscape is one of the main characteristics of the Chelva convent. Although its architectural structure has come to this day strongly conditioned by historical events, its distribution and link with the territory remain unchanged and allow us to make comparison with other settlements, such as the one today in a state of ruin of Manzanera, built in the same period based on the design of Chelva convent.
We can also compare the structure of the Franciscan convent of Chelva with other settlements investigated during the F-ATLAS project, such as the convent of San Bartolomeo in Foligno (Perugia, Italy), one of the first sites of the Observance, which represents an emblematic case study given its peripheral location and the structural and conservation problems caused by the 2016 and 2017 Central Italy Earthquake (Bertocci et al., 2023; Bertocci, Cioli, 2023). In both the case studies we can find some typical features of the Franciscan Observance architecture.

The first is the peri-urban location in an elevated area that allowed control of the surrounding territory. Both churches are characterized by small dimensions and a central nave structure, well integrated and not emerging from the volumes of the convent, unlike those typical of the Conventual Franciscan complexes. The Observant architecture usually aims to house small local communities and give hospitality to pilgrims along the paths. Both convent complexes are accessible through entrances flanking the church portal. In the case of San Bartolomeo, this entrance is sheltered under the portico of the baroque facade built in the 18th century. The layout of the refectory and dormitory also corresponds planimetrically, located on two sides of the cloister characterized by the presence of the well and the underground cistern.

On a compositional level, it is worth highlighting in the Chelva church the presence of a centrally planned chapel located at 45° concerning the apse, dating back to the first construction phase of the church. There is also a baroque chapel with an elliptical plan, currently partially collapsed, accessed from the right side of the central nave under the choir. Similarly, we find in the complex of San Bartolomeo in Foligno a side chapel which houses a reproduction of the Holy Sepulcher dating back to the 17th century.

These considerations on the architectural conformation of the sites of the Franciscan Observance allow us to understand better styles and trends closely connected to how the friars lived the conventual space. In particular, it is possible to interpret and evaluate historical sources such as La Fénix Troyana by Father Vicente Mares Martínez, which traced the construction of the convent of Chelva to five Italian friars sent to Spain by Fra Bernardino, who may have imported the architectural characteristics of Central Italy to the Iberian Peninsula. What has been highlighted by the European project F-ATLAS is that there are peculiar characteristics that link these places from an architectural, cultural and landscape point of view. These connections are the key to establishing Cultural Routes that can increase awareness about the role of the Franciscan Observance over time.

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A MAP OF THE FRANCISCAN HERITAGE IN THE STATE OF SÃO PAULO, BRAZIL

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Abstract

The text presents research carried out by a group of students and researchers from the Faculty of Architecture and Urbanism of the University of São Paulo on the example of the F-ATLAS project, based on an ongoing educational and scientific collaboration with the Department of Architecture of University of Florence. A historical map of the Franciscan settlements of patrimonial importance in the state of São Paulo was created, in order to indicate the diversity of the geographical, historical and landscape contexts, the construction events and, in some cases, the role they played in the urbanization process of the territory in relation to local and indigenous populations.

Keywords: Franciscan settlements, State of São Paulo, Brazil

Fig. 1
Franciscan route in São Paulo, Brazil.

1. Introduction

This paper presents a research project inspired by the F-ATLAS, begun at the School of Architecture and Urbanism of the São Paulo University (FAU USP) collaborating with Professor Stefano Bertocci and his team at the Dipartimento di Architettura dell'Università degli Studi di Firenze. Participants in this initiative are student members of the 'Abya Yala FAU Group – Decolonial option and Amerindian cultures in art and architecture', coordinated by Professors Renata Maria Martins and Luciano Migliaccio, with the cooperation of Professor Beatriz Piccolotto Siqueira Bueno (Departamento de História da Arquitetura, Faculdade de Arquitetura e Urbanismo da Universidade de São Paulo), Dr. Regina Helena Vieira Santos (Departamento do Patrimônio Histórico da Municipalidade de São Paulo/ Museu da Cidade de São Paulo).

The project aims to study the main historical buildings of the Franciscan Observance which exist or existed in the territory of the current State of São Paulo in Brazil, that is: the convents of Santo Antônio in Valongo de Santos, São Francisco in São Paulo, Nossa Senhora da Conceição in Itanhaém, Nossa Senhora do Amparo in São Sebastião, Santa Clara in Taubaté , São Luís, in Itu, this one no more existing.

All the buildings mentioned were founded between 1640 and 1691. Some characteristics are common to the main Franciscan settlements during the colonial period throughout Brazil:

• Detached location and favorable enhancement of the natural environment: the ocean, the beach, courses of water and mountain;
• An atrium marked by an imposing cross, configured as a space between the sacred and profane universe;
• Presence on the facade of the convent church of a narthex with porch or vestibule protecting access (called in Portuguese Galilé, galilee in English language);
• Chapel of the Third Order located in transversal position in relation to the nave of convent church.
• In the convent, in the center, the cloister surrounded by arcades defined a private sector for the friars on the upper floor, where individual cells are located. On the ground floor with partial access to the public, there were the chapter house, the refectory and the administrative services.
To these convents will be added the Chapel of São Miguel in São Miguel Paulista, the chapel of Nossa Senhora da Escada in Guararema, and the ruins of Abarebebê in Peruíbe, former settlement of indigenous people founded or administered by the Franciscans.
All the mentioned buildings were part of Province of the Immaculate Conception of Brazil instituted on July 15 1675, by Pope Clement X, who dismembered the former province of saint Anthony of Brazil.
The Province has other religious buildings of great historical relevance, in the states of Espírito Santo and Rio de Janeiro, which may be included in an eventual extension of the research.
Below is a brief description of the buildings to be considered through an interdisciplinary approach, integrating the architectural survey and historical documentation with the results of archaeological and historical-artistic research in a decolonial perspective, privileging dialogue with local communities and cultures.

2. Church of São Francisco de Assis and Church of Ordem Terceira de São Francisco das Chagas. Convent of São Francisco de Assis e São Domingos, Faculdade de Direito da Universidade de São Paulo, Largo de são Francisco, São Paulo

The Franciscan friars settled in the town of São Paulo in 1639. They were received in the Church of Santo Antônio, located on the old Rua Direita, still existing in the current Praça do Patriarca. In 1642, they moved into a property donated by the City Council, on the hill on the slopes of the Anhangabaú River, building the Church of São Francisco de Assis and the Convent of São Francisco and São Domingos inaugurated in 1647.

Fig. 2
Monastery of São Francisco, São Paulo.

opposite page
Fig. 3
Monastery of Santo Antônio do Valongo, Santos, São Paulo.

In 1676 the chapel of the Third Order was founded, in an orthogonal position to the body of the convent church. In the middle of the 18th century, the large rammed earth building underwent a radical renovation which gave it the current characteristics. The façade of the convent church acquired the galilee, and a bell tower. Internally, there were changes in the body of the church, with the merger of two chapels and the introduction of paintings on the wooden ceiling. The old chapel of the Third Order was incorporated in the transept of the new Church das Chagas do Seráfico Pai São Francisco da Venerável Ordem Terceira de São Francisco da Penitência, adjacent to the convent complex, inaugurated in 1787. Beside the church of the Mosteiro da Luz, it is one of the two examples of polygonal plant from the colonial era existing in São Paulo.

Since 1827, the most of the convent has been occupied by the Faculty of Law of São Paulo University, and entirely renovated with neocolonial characteristics. The Franciscan ensemble of São Paulo was listed by CONDEPHAAT, the Heritage Council of the State of São Paulo, in 1982.

3. Santo Antônio do Valongo Convent in Santos, SP, 1640

Founded in 1640, it was begun on June 1 1641. It had the characteristic features of the Franciscan architecture mentioned above. All buildings were included inside a fence walls, disposed at right angles, forming a block. The church was the only space in contact with the outside; the facade had triangular pediment, pilasters in stone, the galilee of three arches in the ground, and three rectangular windows above aligned with them. The Third Order built its chapel in 1691, located perpendicularly to the nave of the main church creating also a new cloister and extending the front of the building, on the side opposite the convent. In the middle of the 18th century, the façade underwent renovations, adding ornamental volutes to the pediment, and a curved ridge on the bell tower. It was maintained the alignment with the convent and the tower, having the scenery of the Serra do Mar in the background.

Since the first decades of the 19th century, due to the imperial government's policy against religious congregations, the activities of the convent were declining. In 1859, the Franciscan residence was purchased by the São Paulo Railway Company, with the intention of building a railway station. The church was spared the destruction, due to the popular protests, but not the convent which was demolished in 1861. With the return of the Franciscans in 1922, the remaining buildings have undergone changes, especially in the decorations inside.

Fig. 4
Church and convent of Nossa Senhora da Conceiçao, Itanhaém, São Paulo.

4. Church and convent of Nossa Senhora da Conceição, Itanhaém, SP, 1699

The Church and convent are located on the top of a hill of stone and lime. It is assumed that the complex were already built in the 16th century, due to the presence of very old walls prior to the current construction. In 1659, it was donated to the Franciscan Order. The convent was erected around 1713 by Frei Miguel de São Francisco. Between 1733 and 1734 it was expanded by Frei Rodrigo dos Anjos. In 1833 suffered a fire and was reconstructed only in 1865, when probably acquired the shape and the façade it has today. The building underwent important restorations, the first in 1921, the second in 1941, when it was recognized as a part of the Brazilian National Heritage.

The set brings together a remarkable historical and artistic collection with sacred images in wood and in terracotta, polychromed tiles imported from Portugal, probably Aveiro in 17th century and stained glass designed by the painter Benedito Calixto.

5. Nossa Senhora do Amparo Church and Convent in São Sebastião

Was built in stone between 1658 and 1662. Since 1972 it is listed as a cultural monument by the Historic Heritage Council of the State of São Paulo (CONDEPHAAT).

It is one of the most significant religious buildings on the coast of the state, for its historic and landscape value. Its organization follows the traditional configuration of the Franciscan Brazilian architecture.

opposite page
Fig. 5
Convent of Nossa Senhora do Amparo, São Sebastião, São Paulo.

The spaces of the church, lodgings, sacristy are distributed around the rectangular cloister with arcades. The church has a single nave with a tray ceiling. The original altarpieces were replaced in the reform that took place between 1932 and 1937. The convent has a collection of terracotta sculptures from the 17th and 18th centuries of great historical relevance.

6. Santa Clara Convent in Taubaté

The Vila de São Francisco das Chagas de Taubaté founded on December 5, 1645 was the most ancient town in the area called Vale do Paraiba (Paraiba Valley) in the State of São Paulo. In a 1676 will the first mention is made of the existence there of a Franciscan convent dedicated to Santa Clara. In '*Peregrinação na província de S. Paulo*', from 1860-1861, the writer Augusto Emílio Zaluar, highlights the building, which "although not of gigantic dimensions, is nevertheless, spacious, above all, in relation to the small size of the houses in the town, and the church or house of prayer can hold about a thousand people, and is the largest building in the north of the province". Nevertheless, in 1832 there were only two friars living in the convent, with the last Guardian Friar, Joaquim das Dores, who died in 1868. After his death, the convent was left empty and under the responsibility of a religious association. According to documents of the Municipal Historical Archive, the building suffered a fire in 1843, which almost destroyed it completely. However, since 1847, the Santa Clara Convent housed a Public Lyceum which functioned until 1852.

Fig. 6
Santa Clara convent, Taubaté, São Paulo.

A photograph from 1879 shows the external aspect of the construction that followed the characters described in the others Franciscan building in São Paulo. The convent remained in abandon until 1887 when the Institute of Arts and Crafts was installed there but soon closed due to the country's economic crisis in the early years of the Republic. In 1890, local religious authorities mobilized to bring to Taubaté Capuchin friars from the Italian convent in Trent. The congregation took in charge the reconstruction and occupies the convent presently.

opposite page
Fig. 7
Chapel of São Miguel, São Paulo, São Paulo.

7. São Luís Convent in Itu

The Convent and Church of São Luís began to be built in rammed earth in 1691. It was terminated in the following year. It was renovated and expanded in 1728 but was



in precarious conditions already in the 1780s. Rebuilt in stone again since 1785, it was the headquarters between 1857 and 1872, of Colégio São Luís, a Jesuit boarding school. It was abandoned, destroyed by fire in 1917 and demolished. The only vestige remaining to present, at the Praça Dom Pedro I, is the imposing granite cross from 1795, work of Mestre Thebas, a remarkable Afro-Brazilian master builder and stone carver in São Paulo at that time. The appearance of the edifications in 19th century is documented in a watercolor by Miguel Dutra and in photographs. The important collection of works of art from the old convent is preserved in the churches of Nossa Senhora da Candelaria and São Benedito in Itu.

8. Chapel of São Miguel Arcanjo in São Miguel Paulista

Rebuilt in 1622, the Chapel of São Miguel Arcanjo was part of an ancient network of indigenous settlements established by the Jesuits, still in the 16th century. Today it is a part of the periphery of São Paulo. The period of Franciscan administration in the end of 18th century bequeathed its current architectural configuration. Around 1780, the botanist Frei Mariano da Conceição Veloso (1742-1811) superior in the village of San Miguel, provided the construction of a side chapel, raising about 2.5 meters the rammed earth walls of the nave by an addiction of sun dried bricks (adobe), and the opening of two windows above the front roof.

Fig. 8
Abarebebê ruins, Peruíbe, São Paulo.

Despite having undergone several interventions over the centuries, the chapel still preserves, in addition to its construction in rammed earth, part of its decoration of the colonial period, especially the mural paintings found under the side altars in wood, during the last restoration work, in 2007. These paintings, most likely made by indigenous and mestizo artists, simulate a carved altar of Portuguese Baroque style, without the superior part which is lost. Attributed to a period of transition between the Jesuit and Franciscan administration, they highlight the dimension of the cultural exchanges that took place in the village of São Miguel, especially the intercultural relations between the European and Amerindian traditions, considering their local specificities and global references. Thus, although the paintings were not from the Franciscan period, they remained an integral part of the Chapel, until they were covered by wooden altars.
Regardless of when this occurred, the Chapel of saint Michael the Archangel presents both the Jesuit temporality of its foundation, and the Franciscan one, also evidenced by sculptures still present today and exhibited in the attached museum. Being one of the most ancient remains of colonial period, the chapel was one of the first works to be catalogued and restored by the Instituto do Patrimônio Histórico e Artístico Nacional (IPHAN) between 1938 and 1941.

9. Abarebebê ruins

The site known as the 'Abarebebê', that is, 'The Flying Father' in Tupi language, is located in the municipality of Peruíbe, on the southern coast of the state of São Paulo. It houses the remains of an indigenous people settlement that was under Franciscan administration from 1692 until its extinction in 1803. It is a place of special potential for new approaches in the field of heritage, which bring a decolonial oriented look. This potentiality lies in its history that opens us a window to the shocks, encounters and entanglements of very diverse cultures, involving Jesuit and Franciscan missionaries, representatives of the Portuguese Crown, settlers, and indigenous peoples, Tupi and Guarani, who ancestrally inhabited that territory – and still inhabit it. In the late nineteenth and early twentieth centuries, local elites having as its main spokesman the painter Benedito Calixto, intended to raise these ruins to the status of an architectural monument of the origins of Brazilian society in that region, fruit of the early European occupation and of a 'civilizing' process attributed to it. The identification of the ruins as a Jesuit settlement, credited to the Jesuit Leonardo Nunes, called 'Abarebebê', has its origin in the historical studies carried out by the painter, but we currently know that it does not correspond to reality. Since the 1990s, new studies, based on the critical review of primary documentation and the established bibliography revisited this history, clarifying the Franciscan action in the village and questioning the violence of the colonizing process engendered by it. However, this historiographical renewal was not really reflected in a reconfiguration of the imaginary surrounding this heritage, so that its indigenous occupation continues to be presented as a distant past, despite the existence of three areas of Indigenous Land where hundreds of Tupi-Guarani live. Thus, it is urgent to think about a re-signification of the ruins of Abarebebê, through cultural projects which present counter-narratives incorporating transculturality and the highlighting indigenous presence in the past and in the present time.

10. Church Nossa Senhora da Escada

Localized in Guararema, municipality of São Paulo, was built by the Jesuits in 1652. In the 18th century, the local was left by Jesuits and the Church started to be managed by the Franciscans who built the new chapel where today is the current Church of Nossa Senhora da Escada. In 1941 the church was included in national Brazilian heritage by the Instituto do Patrimônio Histórico Nacional (IPHAN) and in 1972 by the Council of the Historical and Artistic Heritage of the São Paulo State (CONDEPHAAT). In 1982 the building was restored.

Fig. 9
Church of Nossa Senhora da Escada, Guararema, São Paulo.

Credits

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FRANCISCAN CITADELS. STRATEGY FOR CONVENTS IN THE COASTAL LANDSCAPE OF SÃO PAULO

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Abstract

The Order of Friars Minor implemented several convents and villages in Brazil, especially on the coast, between the 16th and 18th centuries. In the São Paulo region, two ensembles stand out: Hospedaria de São João Batista, in the city of Peruíbe, and Convento Nossa Senhora da Conceição in the city of Itanhaém. In these buildings we find, among ruins and intact spaces, the characteristic environments of the headquarters of the Franciscan Order (dormitories, library, study rooms, kitchens, temple with presbytery, sacristy, bathrooms and deposits), however, organized as a block, like fortified citadels, an articulated solution in the landscape of the beaches of the south coast of São Paulo.

Keywords: Franciscan citadels; strategy for convents; Brazil's convents.

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Fig. 1
Nossa Senhora da Conceição Convent in the city of Itanhaém, coast of São Paulo,Brazil (Photo Victor Hugo Mori).

Fig. 2
São João Batista Guesthouse, in the city of Peruíbe, coast of São Paulo,Brazil (Photo Victor Hugo Mori).

1. Historical context

The Order of Friars Minor, a religious group founded by Francisco de Bernardone (1181-1226) in the city of Assisi, central region of the Italian peninsula, became known as the Franciscan Order or, simply, Franciscans. Its approval and confirmation were officially given by Pope Innocent III in 1209. In a few years, the reform movement in the heart of Catholicism, proposed by Francis, spread throughout Europe, establishing itself in the Iberian Peninsula in the first decades of the 1200s.

> "With the desire to break with the monastic tradition that advocated installation in solitude, they set up their convents (which were not monasteries) in the midst of men and, at first, in the midst of those 'new men' whose problems they wanted to take care of and whose deviations they wanted to fight against, the men of the cities" (Le Goff, 1998, p. 48).

A few years after the founder's death, one can already observe the emergence of internal ramifications, such as that of the 'spiritual' friars, who for more than a century fostered discussions on account of poverty, simplicity, detachment and 'sine possession' (without property). Century after century, the Franciscan movement was marked by internal reforms, ramifications and attempts to 'return to the origins', marking the way of life of the friars, the construction of their convents, their architecture and their art (Fernandes, 2013).

The Portuguese friars who left in 1584 for the definitive installation of convents in Brazil, belonged to the Province of Santo Antônio dos Currais, of the branch known as 'Da Mais Strita Observância', the Capuchin or Alcantarine friars (reform movement led by Pedro de Alcântara). The conventual construction of this Franciscan branch was initially characterized by simplicity and poverty, but for Fernandes (2013) it "adapted whenever possible to the climate, turned to the appropriate choice of construction site, seeking the proximity of the bodies of water [...] the elevations of the land". The friars lived on alms and with austere internal rules and focused much more on conventual life than that of missionary life (Marx, 1984).

The convents founded by the Capuchins in the colonial territory of Brazil were structured and a few years after the resumption of the territories occupied by the Dutch, the then Custody of Santo Antônio in the Northeast region was elevated to the category of Province, understood as a set of convents in a certain region, confirmed by Pope Alexander VII. In the same year, the Custody of the Immaculate Conception was established in Rio de Janeiro (Willeke, 1974), which became a Province on July 15, 1675.

The Province of the Immaculate Conception, based in the Convent of Santo Antônio,

started to manage all the convents built in the Captaincy of Espírito Santo towards the South. It also included the cenobia built in the current states of Rio de Janeiro and São Paulo. In the latter, the Province had buildings in the villages of Santos (1639), São Paulo (1639), Itanhaém (1654), São Sebastião (1658) and Taubaté (1674).

2. Franciscans in Itanhaém

The internal changes in the Franciscan movement influenced the friars who arrived in Brazil, as well as the minority evangelizing project in Brazilian lands and the construction of their convents in the first centuries of colonization.

Even before the region 'further to the south' was elevated to the category of Province, in a logic that seemed strategic, the São Vicente Captaincy stood out as a preferred place for the foundation of Capuchin convents. Three of the minorite cenobia had their constructions authorized on the coast, one in the capital and one in the countryside. After the elevation, the friars still built a convent in the village of Itu in 1691 and took over three indigenous villages: the village of São João de Peruíbe in 1692, the village of São Miguel, near the capital, in 1698 and the village of Nossa Senhora da Escada (currently Guararema) in 1735 (Conceição, 1972).

The oldest chronicles written by Franciscans indicate the presence of the friars on the coast of São Paulo, such as the one composed by Frei Antônio de Santa Maria Jaboatão (1695-1779), from Pernambuco, the one composed by Frei Apolinário da Conceição (1692-1760), and the more recent bibliographies, such as the one written by Friar Basílio Röwer (1877-1958), which gathers details pointed out by previous chroniclers and adds elements of primary sources analyzed by the friar himself.

According to the chronicles, the Franciscan residence in Itanhaém took place when the friars received a donation of land on top of a small hill where there was already a chapel dedicated to Nossa Senhora da Conceição, which had functioned as a parish church, and had a residence for the priest. The deed for the Minors was drawn up on January 2, 1654, and for decades they lived in that old 'clay' residence. The works of a convent 'with choir' only began many years later. The chronicler friar of the Province, who visited Itanhaém, mentioned the presence of the convent at the top of the hill, stating that the establishment of a house for the friars was accepted as early as 1653, but the convent was only started in 1700 and finished around from 1714.

The city had attracted devotees of the Virgin Mary since immemorial times and the Capuchins maintained the popular devotion, welcoming pilgrimages and making small improvements to the residence, the church and annexes to welcome pilgrims (Conceição, 1972. cited in Marx 1984. p 81).

The chroniclers are unanimous in affirming the conditions and topography of the land on which the Franciscan convent was built, even taking into account the difficulties encountered in terms of funding and the 'official' or skilled manual laborers for the work.

Friar Miguel de São Francisco, provincial at the time, did not measure efforts to "guarantee the material future of the Convent Community built by him with so much love for Our Lady" (Röwer, 1957).

Since the end of the 17th century, the Franciscan Order in Brazil grew numerically and reached its peak with more than four hundred friars in the 'Southern Province'. It is during this period that they accepted the administration of indigenous villages, as it is the case of São João de Peruíbe, which administratively was linked to the community of Itanhaém and which gained further reinforcement with the increase in number of friars in the convent built. It is interesting to note that poverty and hermit principles, so characteristic of the Alcantarine reform, gradually gave way to more constant missionary activities and more imposing convent buildings.

Of all the cenobia present in São Paulo, the one in Itanhaém, given the conditions of the terrain, seems to have been the one that demanded the greatest efforts, and the hill where this enclosure was implemented "represented a challenge and forced the adoption of a compromise solution between the convent dependencies traditionally arranged in a 'block' and the local orographic conditions" (Marx, 1984), and unlike the other Capuchin buildings present in the region, Conceição is the only one that has only 'two flights of stairs and the use of a basement', which may explain its construction delay as the last to be finished.

Decades later, there was an attempt to expand the convent space by "a house that comes out of the alignment of the front of the church and the flight of stairs on the right, which was not completed. Its ground floor, partly dug into the hill, is at the level of the others, and the work of 1733/34 was supposed to function as a 'Chapter House'" (Röwer ,1957).

A few decades later, it was time to build a new access slope ramp to the Sanctuary and Convent of Itanhaém, a request made by the friars in 1752 with work coordinated by Friar Antônio de S. Tomás that "was built in two stories, or inclined planes, with walls and parapets, reaching the geographical plateau at a distance of about 25 meters from the church door" (Röwer, 1957, p. 284).

The village of São João de Peruíbe or Aldeia de Nossa Senhora dos Itanhaéns, was the first indigenous settlement taken over by the Franciscans in the Captaincy, being the origins of a concentration of indigenous people in that region, considered very obscure, as they appear cited in different sources in an 'uncertain way'. What can be said is that it was never administered by the priests of the Society of Jesus, even though they "often visited the Aldeia de Peruíbe (today known as the ruins of Abarêbebe) on missions" before being forced to leave São Paulo and Santos in 1640 (Röwer, 1957).

The village was in charge of the civil administration since the beginning of the 17th century, it was an '*Aldeia de El-Rei*'.
At the end of the 17th century, when the Franciscan expansion in southern Brazil was consolidated with new convents, the civil administration began to delegate to the Capuchins several indigenous villages that were subtracted from the administration of seculars. This is the case of São João, passed on to the friars in 1692. At the time, there were 119 indigenous people in the village and a few others remained dispersed. The space could be managed peacefully by the Capuchins who had already taken up residence not far from there (Conceição, 1972).
Regarding what remains of the buildings that are there, it is possible to read in the Franciscan texts the mention of the existence of a church, because when they took care of the place, the friars carried out an inventory that appears in the Tombo Book of the Convent of Itanhaém researched by Röwer. It mentions the "few garments, towels and some candlesticks", as well as the images "of S. João (patron), of Nossa Senhora da Assunção and of S. Luzia" (Röwer, 1957).
The friars left the administration of the place, little more than a century later. The last (superior) guardian of the Aldeia de Peruíbe, Friar João de S. Genoveva, left in 1805, who was transferred in the Chapter of October 8, 1805 to the Convent of Itanhaém, also taking over the role of guardian in that cenobium. When he wrote his 'Pages of Franciscan History in Brazil' in 1957, Friar Basílio Röwer, insisted on emphasizing the presence of the Friars Minor both in the Convent of Itanhaém, detailing the buildings, and in the village of São João Batista, limiting himself to mention that "there were only ruins left in 1940, surrounded by bushes and scrubland", but that they allowed "to know more or less the size of the buildings". According to him, "experts attributed them to the 18th century, from which it can be inferred that they were made at the time of the Franciscan administration, perhaps by Friar Manuel da Conceição Cunha".

3. Franciscan citadels: a strategy of resilience and monumentality

So, the new conventual constructions in the nascent Franciscan province of southern Brazil, after the great trauma of the Batavian conflicts, will strongly resent the nightmare suffered by the Friars Minor with the 'Dutch heretics' in the Northeast: how to establish a construction that allowed, with its monumentality of white walled structures, to impress possible unwanted invaders on the beaches of Itanhaém and Peruíbe?
A fortified acropolis, a citadel cohesive in its volumetry on a hill, an architectural mass capable of submitting to warrior inferiority those who arrived from the flat horizon of the

Atlantic. Here is the example of the fortified convent of Penha, in Vila Velha, significant for the Espírito Santo coast, as evidenced by the report by Friar Jaboatão (1761).

In fact, we can attribute to the hospice[1] of São João Batista in Peruíbe and to the Nossa Senhora da Conceição convent in Itanhaém another, more significant and inspiring reference: the Franciscan mother house in the '*collis paradisis*' of Assisi, the great convent of the Order of Friars Minors.

Amidst the mountainous landscapes of Umbria, a gigantic convent acropolis rises since the death of the '*poverello*' in the 13th century, detached from the urban core, rising with two overlapping basilicas and whose high frontispieces leave no doubt as to the seraphic and exemplary monumentality of its founder. Its urban accesses, starting from the city of Assisi, are true 'promenades' that prepare the pilgrim to an intense experience by progressively approaching the complex, starting with the umbra landscape to the frescoes by Cimabue and Giotto.

As the headquarters mirrored in the architectural and landscape composure of Assisi, the Franciscan headquarters of Peruíbe and Itanhaém are located on natural hills, indicating a well-defined ascension path through ramps and stairs, always maintaining a strategic distance from the sea and, most intriguingly, in both we noticed a longitudinal orientation, that is, from the chancel of their respective temples to the main entrance portal, frankly oriented in the Southwest-Northeast direction. A deference to the other side of the Atlantic, to the mother house that houses the tomb of the founding friar?

The Peruíbe hospice and the Itanhaém convent no longer have the wide, generous plan of several headquarters in the first two Franciscan provinces of the Lusitanian colony, whose built front extends into the land space, a strong obedience to Philippine ordinances from the 16th century (Ribeiro, 2011; Silva, 2017); Peruíbe and Itanhaém present us with constructive typologies closed, compact, strong houses, therefore, implemented under the 'Batavian trauma' suffered by the Northeastern convents. Thus, the Vila Velha model, the Penha fortress convent, would present itself as the typological convenience attested in the confrontation with the Dutch.

Advancing on the respective constructive configurations of these Franciscan houses, whose ruins allow the elaboration of chronologies (Santos, 2018), technical variations in the manufacture of the '*opus caementicium*' can be observed, as well as constant sizing patterns in foundations, masonry and openings in the evaluated rhythmic sections in Peruíbe (Sunega, 2020).

[1] Hospice: "A kind of small convent belonging to some religious family, in which guests of the same religion are kept warm when they pass by and which does not have a convent in shape" (Bluteau 1728, vol. 4, p. 64).

We can conclude that, despite the ruins, these Franciscan monuments still dominate the landscape, still prevail in the territory: an ascending monumentality, vigilant and harmonious with the coastal geographical attributes, structures that honor the rebel from Assisi and stand out without fearing the growing urbanization and without great qualities of our current seaside towns.

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PART IV

Dissemination, Management and Promotion of Cultural Heritage

DOCUMENTATION AS A TOOL FOR ANALYSIS AND DISSEMINATION OF THE CULTURAL HERITAGE.
THE CASE OF THE FRANCISCAN OBSERVANCE IN PORTUGAL, ITALY AND SPAIN

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Abstract
The importance of mendicant orders in shaping urban and rural landscapes is recognized worldwide. However, several sites are degraded and abandoned, instead of being valued and reused in a sustainable way. This is often related to their ignorance.
This study aims to fill in this gap, through the documentation of the Franciscan Observance convents. It is presented the multidisciplinary methodology developed in three work packages coordinated by ISCTE, in the scope of the F-ATLAS project, for the documentation of the Italian, Portuguese and Spanish convents: census and case studies mapping (i), architectural and environmental analysis (ii), 3D digital prototyping (iii). The results obtained in the preliminary analysis reached 901 convents. 14 cases were selected for a detailed analysis in each country: 9 in Italy, 3 in Portugal, 2 in Spain. This represents the first step for the knowledge of these religious heritage sites and the starting point for their dissemination and valorization.

Keywords: Franciscan Observance, documentation, dissemination.

opposite page
Fig.1
Datasheet template (Soraya Genin) and selected case studies (Rolando Volzone).

1. Introduction

This research refers to three different Work Packages (WPs) of the F-ATLAS Project[1]: WP1 – Preliminary Census and Case Studies Mapping; WP4 – Architectural, structural and environmental analysis; WP7 – 3D Printing.

The aim of the first WP is the inventory of the Franciscan convents, through online and offline surveys, to identify the existent convents and a preliminary evaluation of the state of conservation, their main data, and characteristics, in particular the case studies and the area of further analysis.

The second one aims to analyze the selected cases in detail, the architecture, the structure, and landscape, principally regarding the state of conservation and the relationship with the territory, to define their potential and risks.

The goal of the third WP is to produce 3D surface models of the select case-studies for exhibitions, studies, and dissemination.

Firstly, we introduce the historical evolution of the Franciscan Observance movement in Portugal.

2. Historical Framework

Franciscan Observance is a reformed branch of the mendicant order of St. Francis of Assisi, proposing the return to the strict Observance of his Rule and Testament (14th century). This movement reached Portugal in 1392 through the Galician group led by Gonçalo Mariño (Teixeira, 2010; Fontes et al., 2020), who founded the first observant hermitages south of the Minho river. These first foundations settled in isolated places propitious to a solitary and penitent life: Santa Maria de Mosteiró in Valença, Santa Maria da Ínsua in Caminha, São Francisco de Viana in Viana do Castelo, and São Paio dos Milagres in Vila Nova de Cerveira (Fig. 1). In the same year, São Clemente das Penhas was founded on the coast of Matosinhos, less than 100 km to the south. The Franciscan Observance gained an increasing visibility in the second part of the 15th century; several works took place in the hermitages and convents founded in the previous phase. At the same time, some of these were abandoned.

In 1517, Pope Leo X issued the bull *Ite vos*, decreeing the division of the order into two. In Portugal, two branches were created: *Província de Portugal da Regular Ob-*

[1] The European project 'F-ATLAS. Franciscan Landscapes: Observance between Italy, Portugal and Spain' is funded, within the JPI Cultural Heritage programme, by the European Union's Horizon 2020 research and innovation programme under grant agreement nº 6995237. The project is led by the Università degli Studi di Firenze, in partnership with the ISCTE-Instituto Universitário de Lisboa, Universitat de Barcelona and Universidade Católica Portuguesa. Additional information at: https://www.f-atlas.eu/.

servância, which integrated the settlements of the island of Madeira, and *Província de Portugal dos Conventuais* (or *Claustrais*), integrating five settlements from Azores islands. However, in 1584, the Conventual Franciscans were definitively suppressed by Pope Pius V through a brief dated 1567, being integrated into the Observants.

At this time the Franciscan order was divided into two groups: the Regular Observance, which included the Province of Portugal and the Province of Algarves; and the Strict Observance, more rigorous than the first one, which included five provinces: Piedade (1517), Arrábida (1560), Santo António (1568), Soledade (1668), and Conceição (1705). The gradual abandonment of convents, culminating with the Portuguese dissolution of religious orders in 1834, led to the loss of their original function and values. Unfortunately, a large percentage of the former convents is, currently, underused, unused, or even endangered and with redundant churches. Significant studies on Franciscan Observance in Portugal have been carried out (García Oro 2006; Teixeira 2010a; Fontes et al., 2020). However, knowledge of their architecture is rarely deepened (Medinas 1994; Figueiredo 2008). The documentation and analysis of the current physical evidence is, for this reason, timely and urgent.

3. Census and Mapping

To identify the cases studies in the three countries, the methodology starts from the consultation and analysis of primary sources in municipal, district and national archives. Moreover, an exhaustive analysis of the literature review, comprehensive of national publications, result of previous scientific research on the foundation and evolution of religious orders in Italy, Spain and Portugal[2]. Altogether, the following masculine case studies, belonging to the Franciscan Observance, have been identified: 209 in the Portuguese territory (related to the whole ancient Franciscan provinces), 640 in the Spanish territory (related to the whole ancient Franciscan provinces); 52 in the area of the former '*Provincia S. Francisci*', including the Italian Umbria region and the surrounding area.

A datasheet census was created, to inventory the Franciscan Observance convents. It is based on international recommendations (English Heritage, 2006) and the Portuguese inventory form and manual developed by the former Portuguese entity for the management of cultural heritage[3]. The template is structured in 19 different fields and produced in Excel format, useful for scholars and others, applicable to different built structures. In Portugal, more than 400 convents, male and female were identified and inventoried, thanks to an exhaustive work carried out within the framework of the program "Summer with Science 2021" funded by the Portuguese Foundation for Science and Technology. The datasheets have been filled in by scholarship students, firstly, through the literature review, regarding the historical evolution of the convents in terms of religious community and construction. The geographical coordinates were found. Online sources have been very useful, principally Google Earth, Google Maps, and national platforms. Moreover, interviews (via email or phone calls) with public administrations, at national, regional, and local level, have been essential to identify property contacts and functions. The Information System for the Architectural Heritage (SIPA)[4] was a powerful tool. In some cases, data were missing or not updated, so they were confirmed. A preliminary information on the state of conservation was also possible. The template of the inventory sheet was studied and designed, considering the future publication of all inventoried data[5].

[2] In Italy: Di Giampaolo F. (2013). Pietre che parlano. Conventi chiusi e Conventi aperti della Provincia Serafica di San Francesco. Assisi: Provincia Serafica di San Francesco dei Frati minori dell'Umbria. In Portugal: Campos, Fernanda Maria Guedes de (2017) A ordem das ordens religiosas. Roteiro identitário de Portugal (séculos XII-XVIII). Casal de Cambra: Caleidoscópio; Sousa, Bernardo Vasconcelos (dir.) (2016) Ordens Religiosas em Portugal – Das Origens a Trento. Guia Histórico, 3.ª ed. Lisboa: Livros Horizonte.

[3] Two manuals developed by the Instituto da Habitação e Reabilitação Urbana (IRHU) and the Instituto de Gestão do Património Arquitectónico e Arqueológico (IGESPAR) were consulted: the KIT01.Património

[4] http://www.monumentos.gov.pt/Site/APP_PagesUser/Default.aspx

[5] More than 400 Portuguese Datasheets were filled. The template is structured in 19 different fields: 0. Pictures;

After the inventory the GIS was implemented by the University of Barcelona. This allowed an overview of the whole case studies and a comparison among Italy, Portugal and Spain[6]. The preliminary analysis of the 901 case studies, by crossing the literature review on the Franciscan Observance in terms of diachronic evolution of the built structures and the surrounding landscape, and the national prescriptions in the cataloguing of cultural heritage, allowed the definition of common features. Indeed, the convents are mostly formed by three different parts: the church, the dependencies, and the enclosure. These have a common layout but the whole structure is adapted to the landscape. The exact location of the convents enables planning on-site visits in selected cases of the Franciscan Observance movement in Italy, Portugal and Spain.

4. Architectural analysis

The architectural analysis of major case studies has been carried out. In Portugal, 3 case studies have been selected: Nossa Senhora da Ínsua, Santa Maria de Mosteiró, São Francisco do Monte, São Paio do Monte; in Italy, 9 case studies have been delved deeper: Sacro Speco di San Francesco, Porziuncola in Santa Maria degli Angeli, Santissima Annunziata, San Bartolomeo, San Damiano, San Francesco del Monte o Monteripido, San Francesco di Monteluco, Eremo delle Carceri, La Romita di Cesi,. In Spain, 2 case studies have been studied in-depth: Castell Monestir de Sant Miquel d'Escornalbou, San Francisco[7].

On-site surveys took place. An in-depth photographic survey has been developed. Elevation maps, obtained from the 3D survey with laser scanning, have been elaborated by the University of Florence[8], which served as a basis for the analysis of the architecture, structure, and surroundings. To identify the material and degradation analysis, multiple methods were combined: literature review, to understand the historical evolution of the

1. Identification (an ad hoc sheet code is defined); 2. Designation; 3. Category (religious built structures and building); [4] Typology (Religious orders, Specific branch, Gender); 5. Protection (cultural heritage protected and classified, the type of classification, the legislation for the protection approval); 6. Location (State, Region, District, Municipality, Civil Parish, Coordinate System, Geographical coordinates); 7. Access (Typology of access, Name, Number); 8. Historical frameworks (Dates of foundation, reformation and dissolution); 9. Period(s) of construction (the first one, and the additional ones); 10. Property (separately for the church and the conventual dependencies); 11. Owner (separately for the church and the conventual dependencies); 12. Owner's contact (separately for the church and the conventual dependencies); 13. Occupation (separately for the church and the conventual dependencies); 14. Current functions (separately for the church and the conventual dependencies); 15. Conservation state (separately for the church and the conventual dependencies); 16. Sources (Bibliography, Webgraphy); 17. Author; 18. Data; 19. Observations.

[6] Moreover, these data have been introduced in the online F-ATLAS Webmap available at: https://www.f-atlas.eu/case-studies-map.

[7] These cases have been targeted of on-site surveys with traditional and digital techniques. The last ones included Terrestrial Laser Scanner (TLS) and Terrestrial and Aerial Digital Photogrammetry (Structure from Motion – SfM).

[8] This operation was integrated in the third Work Package of the project F-ATLAS. Santa Maria de Mosteiró (Valença), Santa Maria da Ínsua (Caminha), São Francisco de Viana (Viana do Castelo), the first convents of the Franciscan Observance, were the targets of this activity, which took place in April and June 2021.

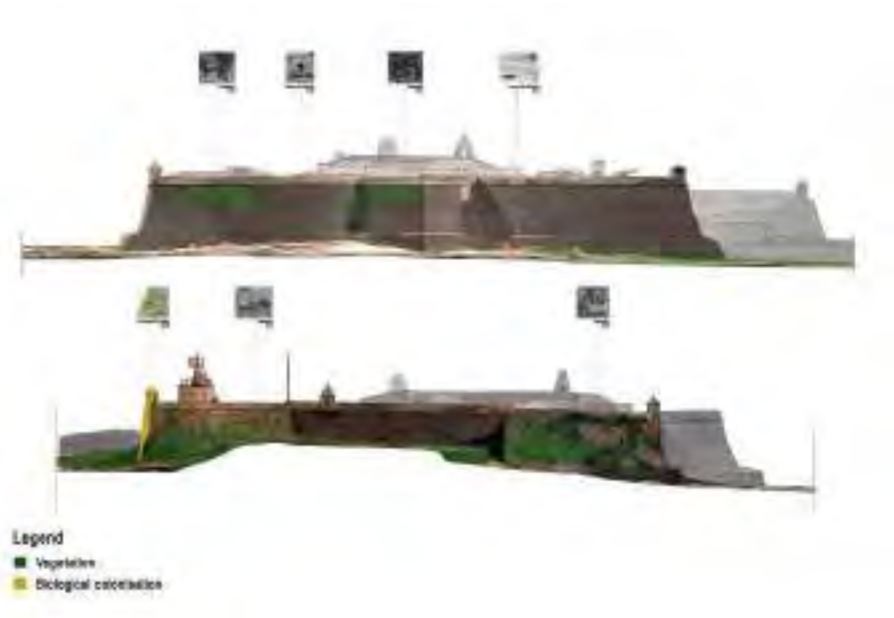

Fig. 2
Anomalies mapping. Nossa Senhora da Ínsua in Portugal. Drawing by Margarida Correia based on digital survey from the University of Florence.

construction and interventions (i), 3D visualization of the photogrammetric surveys that took place along the WP4 (ii); Direct observations in situ (iii); Analysis of high-resolution pictures captured during the on-site surveys. Materials and anomalies were mapped with specific hatches in the plans, based on international norms (Normal 1/88, 1990). Different decays have been identified: chromatic alteration, crust, cracks and fissures, exfoliation, disaggregation, detachment, erosion, lacuna, biological colonization and presence of vegetation. Different materials were identified: stonework and masonries (vertical elements and vaults), structures in wood, concrete, and metal (floors and roofs); covering with mortar and stucco (walls and ceilings); coverings with ceramic tiles or plaques of other materials (roofs). A simple graphical representation of the materials, constructive techniques, and anomalies was used to allow for reading by specialists and non-specialists in the field.

Finally, the landscape analysis has been developed through a four-step process, joining online (GIS platform) and offline (cartography) tools. Firstly, the analysis of the convent at a macroscale: data about altitude and specific point on the hillside, orientation and solar exposure, water system (rivers, streams), vegetation (with the typology), surrounding circulation system, accessibility, among others, have been collected.

Moreover, data about the cultural heritage in the analyzed areas (either religious heritage or not) has been collected. Secondly, a more detailed analysis, zooming into the enclosure area of the convents, has been carried out. A final map was designed with the exact geographical coordinates.

5. 3D Printing

Eight case-studies here selected for producing 3D printable mesh models at the 1:200 scale. The input data for this work were the point-clouds produced in the surveys which were conducted in the WP4. Initially, only the aerial photogrammetry (PHG) models were to be used to produce the surface models. Yet, issues with vegetation coverage in some buildings led to the inclusion of point-clouds collected in Terrestrial Laser Scanner (TLS) survey campaigns of those case-studies. A workflow was developed to process each of the case-studies, considering the possibility of different sources of the input data, to obtain watertight meshes for 3D printing. Care was taken to maximize the number of processing steps strictly using open-source software, and to minimize the variety software involved.

The workflow to process the available input data was composed of 4 major steps which were applied depending on the type of survey data and the missing information to fully reconstruct the building model: 1) Pre-Processing; 2) Alignment; 3) Surface Reconstruction; and 4) Subdivision. The pre-processing step involves clipping, subsampling, and filtering the point clouds. Depending on the type of point-cloud, adequate normal orientation and noise removal processes are applied. Step 2 involves aligning the clouds with the world axis and then between themselves with the ICP algorithm. In Surface Reconstruction missing data is filled either by automatic or manual processes and the implicit surface is constructed with Screen Poisson Reconstruction. A specific subprocess is used to construct auxiliary surfaces to close the mesh. Lastly, hole-filling, mesh decimation and smoothing algorithms are used, and the mesh is scaled and subdivided as needed for 3d printing (Fig. 3).

6. Results and conclusions

The research develop by ISCTE within the framework of the European project F-ATLAS, displays different methodologies, traditional and innovative techniques, resulting an unprecedented inventory and preliminary assessment of the state of conservation of more than 400 Portuguese Franciscan mendicant convents. The present project contemplates only male convents, a total of 901 Italian-Portuguese-Spanish convents, documented by all the partners. 14 cases were analyzed in detail and 8 were produced in 3d printing. The works followed a

Fig.3
The closed watertight mesh model of Santa Maria de Insua monastery and the surrounding fortification prepared for 3D printing.

pre-defined structure relating different tasks of the global project. A protocol was developed for the documentation of the Franciscan convents, which served as the basis for the digital survey and GIS mapping, tasks carried out by the project partners. The digital survey was used for the architectural, structural and landscape analysis, as well as to produce models for 3D printing.

The results obtained are an important tool for the establishment of an interactive digital database of the Observance Franciscan Architecture and for the management and monitoring of this cultural heritage at regional, national, and European level. Expected outcomes of the whole project will facilitate awareness of European citizenship based on the sharing of common values and achievements and will promote an understanding of Europe's history combining cultural and natural heritage.

Acknowledgements

This research is funded by the European Union's Horizon 2020 research and innovation programme within the JPI Cultural Heritage programme. The authors thank the students who collaborated in the investigation. The filling in of the Portuguese datasheets and mapping was made possible thanks to the one-month scientific initiation grants under the programme "Summer with Science" in 2021 and 2022, financed by the Portuguese Foundation for Science and Technology (FCT) and coordinated by Genin and Volzone. Additional studies were developed in academic context, in two curricular units coordinated by Genin, Construction Systems I in 2021 and Conservation and Sustainability in 2022, from the Integrated Master in Architecture at ISCTE.

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DIGITAL TOOLS TO DISSEMINATE CULTURAL HERITAGE

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Abstract

In this paper, we will explain the methodological procedures in the paradigm of the digital humanities that have allowed us to combine different disciplines to offer a product for research and dissemination of the Observant's cultural heritage research in the context of the project F-ATLAS. We will explain the decisions behind the creation of a georeferenced database, how the combined use of database and geographic information systems (GIS) has allowed us to obtain historical information about observation, and, finally, how the programming of a web map we have managed to bring the research to a non-specialist public.

Keywords: Database, Geographic Information System, Observants, Web Mapping.

1. Introduction

The use of computer tools in the field of social sciences is increasingly widespread, and many researchers use them to some extent. However, more specialized programs, such as 3D modeling, geographic information systems (GIS), statistical programming languages, and database management systems (DBMS), although offering enormous possibilities for research and dissemination, are still viewed with some trepidation. This is partly because they are complex tools focused on the technical sciences rather than the humanities and require a significant investment of time. Consequently, these tasks can sometimes feel like they are taking us away from our studies. In an interdisciplinary project with several European universities, such as F-ATLAS, intensive use of different specialized programs is necessary to link academic research with dissemination tasks.

Databases (DB) are a fundamental tool as they allow for the storage and processing of a diverse set of structured information, always maintaining consistency between the elements that make it up. In projects involving several researchers, it is necessary to have a database that allows different users to work simultaneously, regardless of their location and the device they use. Above all, it must work without compromising previously stored information. For this reason, it is crucial to invest some time in planning the structure of the DB to properly exploit the information stored.

Geographic information systems are multidisciplinary tools suitable for the production of data, analysis, and representations that have the territory as the object of work. The most obvious and widespread task is the creation of thematic maps that represent a series of variables over a territory, such as capturing the location of observation convents in different centuries. Another common use is to locate ancient sites and structures using orthophotography and LIDAR mapping. However, the usefulness of GIS goes much further, allowing us to perform statistical operations and complex geometric constructions, such as creating heat maps, calculating zones of influence, studying visibility, drawing optimal paths, etc. To carry out these analyses, it is necessary to have a good understanding of the geographic and mathematical methodology behind each of these algorithms, both to interpret the results and to know which algorithm is valid for each data set.

The possibilities of DB and GIS are not limited to scientific production but are also powerful tools for transferring research to society. The idea of web mapping is not merely to offer a series of maps uploaded to the Internet, but to create interactive cartography that allows the user to obtain useful information from each point on the map, discover nearby heritage, or create their own maps. This digital cartography, distributed on the network, allows us to bring our research to society without the latter needing to know how to use a GIS or a database.

2. Data Base

The first task was to create a relational and georeferenced database to store all the information from the F-ATLAS project. It was necessary to have a relational, multi-user, multi-platform database that allows easy and secure data entry. Relational databases[1] are not only used to store information; we can also explore the information by performing complex searches with several joint rules or define new table structures from a previous set of data without modifying the original content, among other possibilities (Foster, Godbole, 2016, pp. 3-13). For this reason, we used MySQL (MySQL, n.d.) as a container and engine for the database, along with a web portal based on Adminer (Adminer, n.d.) to access and enter data in the database. We chose this software because both are published following the Open Source model, which allows the program to be used freely, modified from its source code, and redistributed without restrictions (Laurent, 2004, p. 4).

Open-source software has several advantages. For example, we can modify part of the program's code to adapt it to our needs, and since they do not depend on renewable licenses, we can guarantee their operation over time.

The F-ATLAS database is structured from a main table that contains information about each monastery, along with several auxiliary tables that define part of the data that will be entered. These auxiliary tables are key to ensuring an error-free introduction and allowing the correct exploitation of the data. For example, in the case of the study of Observance, there is an obvious problem in the nomenclature of the different branches in different countries, which also depends on the historical moment and the region where these branches can be found more or less unified or separate.

For these reasons, it is essential to define a homogenized and structured terminological set that incorporates these issues beforehand. The main table contains, in addition to the basic data of the monastery such as the name, NUTS-2 region, or the coordinates in EPGS:4326, the historical chronology of the different monastic orders that occupied it. Fields dealing with material heritage have also been defined, such as the state of conservation of the cloister and the church, the level of protection of the building, the bibliography, and fields to add images.

[1] In the relational model, data is stored in unique tables made up of a set of records or tuples that have a series of specific attributes. The user must previously define the different attributes, restrictions, and the main key that will identify each record in a table. Thanks to this, we can establish different relationships between the tables that allow us to dynamically work and manage the entire data set.

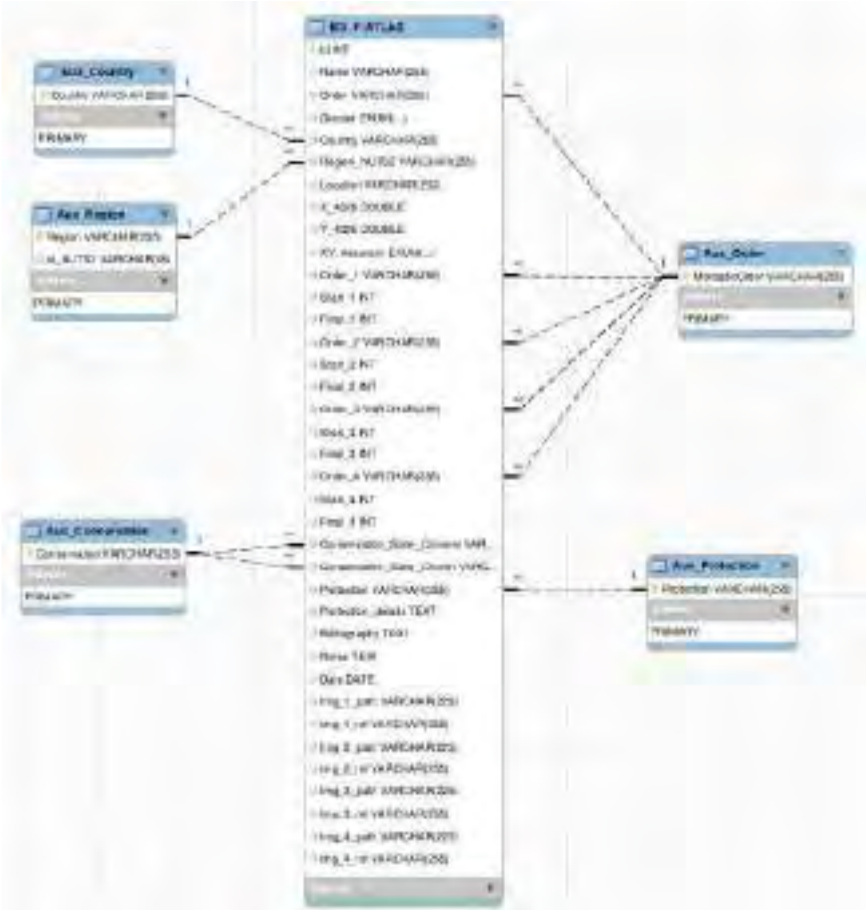
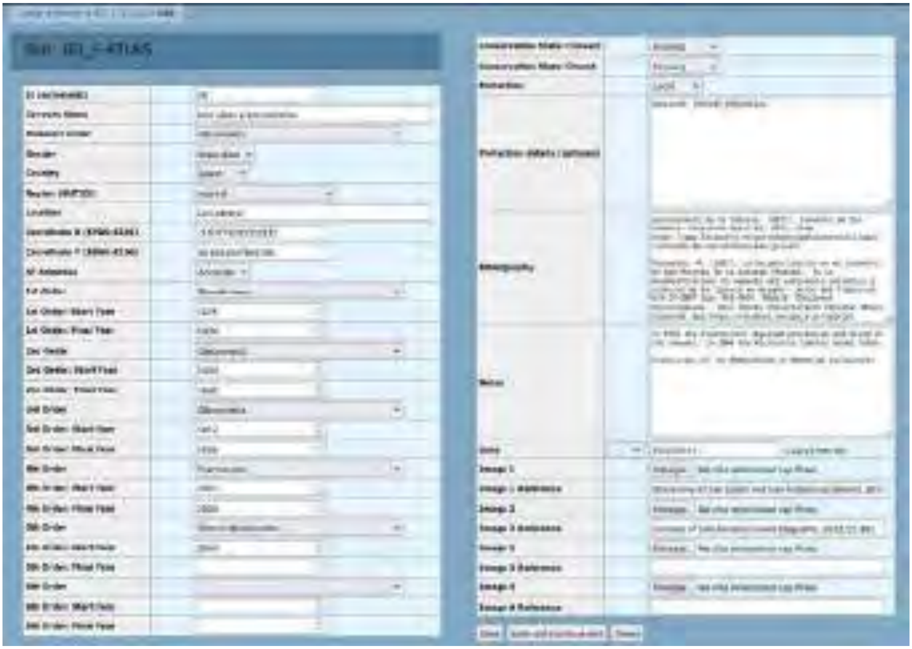


Fig. 1
EER Diagram of our F-ATLAS Database.

opposite page
Fig. 2
Screenshot of a record from a web portal record.

Once the structure of the database has been defined, it is incorporated into a MySQL server, and a web page is created with a simple interface for entering data. This prior computer work may seem of little relevance within the context of the humanities, but we must bear in mind that being able to adapt these computer tools to our needs allows us to facilitate the introduction of data, as well as subsequent tasks such as working with GIS. The database has allowed us to georeference and characterize up to 898 existing Observant monasteries in Spain, Portugal, and the Italian region of Umbria.



3. Geographic Information Systems

Once the database has been completed, the second task was to create a Geographic Information System (GIS) that contains all the information in the database, while also being useful for research and for disseminating cultural heritage. Following the same principles for choosing database software, we opted for QGIS (QGIS Development Team, 2002). Thanks to its continuous evolution, QGIS is one of the most popular and comprehensive programs on the market (Temes, 2020, p. 235). The program has good online documentation for learning and is highly extensible thanks to the creation of scripts programmed in the Python language. However, despite constant efforts to improve its usability, it remains a program with a steep learning curve.

The GIS of F-ATLAS is structured from a point vector layer connected to the project database. As data is entered, we can visualize changes in real time and select different monasteries on the map to obtain all necessary information for contextualizing the heritage. Our GIS also contains various topographic maps, orthophoto maps, ancient cartography, and maps of the main medieval and modern communication networks. This entire

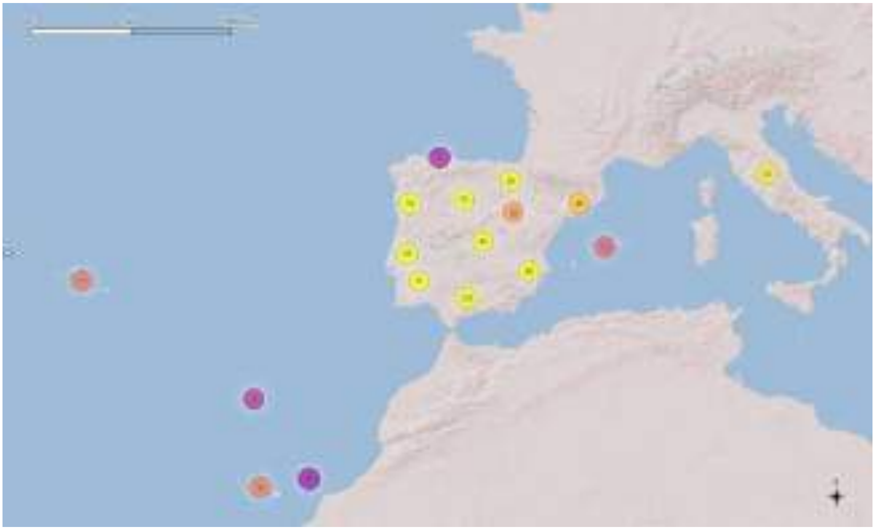


Fig. 3
Map with the clustering of all the Observant convents.

cartographic set is essential when locating monasteries whose location was unclear, as well as observing their current state of conservation or relating the convents to other establishments. With all this, several thematic maps have been created to analyse the monasteries of the Observance. A map of clusters facilitates visualization of the whole at a state level, maps with the implementation of the Observance since the 15th century in spaces of 25 years, or maps that answer specific questions, such as which monasteries had been Franciscan Conventuals before becoming Observants.

In addition to creating thematic maps, GIS allows us to work with geospatial data and obtain new information for our research. The QGIS program has hundreds of geostatistical methods that help us insert layers with land-use information, calculate the best routes to travel, and incorporate layers with different facilities such as water sources, pharmacies, parking lots, etc. Information and analyses that allow us to deepen our historical knowledge of the subject and spread the cultural heritage of the Observance. Spatial heat maps are a very useful method to identify areas with a greater or lesser density of points, especially when the overlap of different elements makes their visualization difficult (Netek et al., 2018). For example, the heat map of different Observant monasteries existing in the Iberian Peninsula in 1750 allows us to observe some sectors a with high density of convents, such as around cities like Badajoz, Granada, Lisbon, Madrid, or Seville, and in coastal areas such as the Rías Baixas, the Costa Verde, or the Costa Blanca. Similarly, we highlight the low implementation of the Observance in certain mountainous areas such as the Pyrenees and the Cantabrian Mountains, and in some sectors of Aragon and Castilla-La Mancha.

4. Web Mapping

GIS and database software are typically designed for use within scientific or professional fields, so their environments must be adapted to facilitate the dissemination of cultural heritage to a wider audience. As such, we have decided to create a web map featuring the location of the convents and a selection of the information from the database. This web map is simple, interactive, and accessible to all via the internet (Fu, 2018, p. 16). Although QGIS has made strides in this field, extensive programming knowledge is still required to create a web map that goes beyond the basics. For this task, we primarily used Leaflet (Leaflet, n.d.), an open-source computer library[2] programmed in JavaScript.

We have created two different versions of the web map to better tailor the content and available tools to the device and type of user. Both versions allow the user to view the complete file for each convent, choose background layers featuring topographic maps or satellite images, and conduct a search based on the name of a convent, a postal address, or the user's current location. The first version is intended to be simple and user-friendly for those seeking a quick

[2] A computer library is a set formed by the code of subroutines, templates, interfaces, and data used to develop other software. Libraries are usually organized around a functional theme (for example, the creation of interactive web maps), this allows a more standardized and modular implementation of the different projects.

Fig. 5
Screenshot from the F-ATLAS web map with the detail of a card.

visualization, whether from a computer or mobile device. We have implemented a cluster-based visualization where the different points are automatically grouped based on the scale, allowing for improved visualization and user experience on small screens. The second version is designed for those interested in creating their own thematic visualizations, and thus we have added several controls that enable personalized searches and real-time filtering. In this second version, we have included a bar allowing users to visualize the evolution of observance in 25-year periods from 1375 to the present day. We have also added the ability to filter the observing monasteries based on the state of conservation of the church, the state of conservation of the convent, and the level of legal protection for the buildings. Finally, we have included a filter enabling the selection of existing convents in various European regions.

opposite page
Fig. 6
Screenshot of the version with filters of the F-ATLAS web map.

4. Conclusions

The main objective was to develop a set of tools that would be useful to us in our research and the dissemination of cultural heritage. We believe that the results obtained demonstrate the power and great possibilities of the joint use of computer tools such as DBMS, GIS, and web technologies.

The database management system (DBMS) is a powerful tool that maintains the consistency of the information contained and, at the same time, facilitates the introduction of data with multiple users and streamlines subsequent tasks. It is essential to spend the necessary time thinking about how the information will be structured in the database. It is advisable to use data fields as specifically as possible and define in advance the use of auxiliary tables and related tables for the different elements. Only in this way will we avoid errors in the entry of files, and in addition, we will facilitate the use of the database to continue expanding it in the future. Geographic information systems (GIS) have proven to be a powerful tool both in research and dissemination. Specifically, QGIS, because of its ability to connect to our database and the number of algorithms and plugins available, makes it an excellent tool for creating thematic maps and for helping to test our research hypotheses. As a dissemination tool, its composition editor allows us to make complex maps designed for final publication. To disseminate the material created in the previous two points, we opted to program two web maps. The evolution of integrated development environments (IDE) tends towards a visual design model, an indicator that in the future, it may not be necessary to know how to program to complete the tasks described here, just as it is no longer mandatory to know how to program to create a personal website. But, until that moment arrives, it is mandatory to know software programming to take advantage of the possibilities they offer us, a fact that represents an great barrier for researchers away from the IT field. When designing web maps, we must always keep in mind the type of user we are targeting and remember that currently, the majority of internet traffic is done through mobile devices that have their peculiarities.

From the approach to the structure of the database, the emptying of the different sources, the creation of a GIS model, and finally, with the programming of a web map, we have closed a circle where the use of different digital tools feeds back on each other and forms an efficient working model for the research and dissemination of cultural heritage.

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INCLUSIVE HERITAGE COMMUNICATION. INTEGRATED METHODOLOGIES CROSSING 3D PRINTING, MARKETING AND COMMUNICATION FOR THE FRANCISCAN OBSERVANCE CONVENTS

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Abstract

Digitalisation, in all its forms, is nowadays a crucial tool part in the analysis, reproduction, preservation and dissemination of Cultural Heritage. All over the centuries, the human being has invented different mechanisms in order to preserve and transmit cultural values. From writing, painting, photography, architecture and engineering, to the latest technologies such as Additive Manufacturing (AM). Indeed, 3D printing has been increasingly used by experts in the field of cultural heritage. However, how 3D printing can be communicated in order to become a driver for increasing accessibility to cultural heritage? This article proposes a methodology for the inclusive dissemination of cultural heritage, by crossing 3D printing with the field of Marketing and Communication, in order to complete studies in the field of additive manufacturing. The Franciscan Convent of Montecorvino Rovella (Southern Italy) will be the pilot case for the application of the methodology. This is selected due to its peripheral location. First results will allow a more inclusive access to cultural heritage, increasing the knowledge and awareness by the local community.

Keywords: inclusive, heritage, communication.

1. Introduction

The present methodology approaches the use of 3D printing as a way to enrich and complement the communication of cultural heritage, stimulating inclusion and engagement by local (or not) communities, enhancing and promoting knowledge. The challenge is to subvert the relationship between cultural heritage and visitors with new cognitive processes (Meschini, 2011) based on the technological innovations of 3D printing that allow for active experiencing, establishing broader accessibility (Bonacini, 2011). The art historian Elkins (2000) states that visual-tactile arts must provide for a type of fruition in which sight and touch coexist in order to enhance the user's experience.

Moreover, research in the cultural heritage field is moving towards the definition of a shared scientific methodology for communication through Additive Manufacturing, as the integrator of the collected transdisciplinary knowledge.

Indeed, 3D printing paves the way for future scenarios: it will be necessary to adopt a new paradigm, new languages, new products and services as well as to propose a renewed way of accessing and enjoying heritage. Among other things, proper communication based on community building strategies can promote a dialogue with the socio-economic, research and educational worlds.

The proposed methodology aims, on the one hand, to the construction of a communication strategy for cultural heritage, through 3D printing, expanding the scope of this research field and moving beyond discipline-specific approaches, in line with the most recent European guidelines. The inherent multi-sensoriality of the 3D medium can enable access to cultural heritage for a disadvantaged population, based on these parameters: age, educational level, geographic origin, and disability.

On the other hand, the methodology aims to complement existing research on the topic and create the foundations for future research. Previous research on the application of 3D printing to cultural heritage lacks of a communication perspective. The methodology will cover the following steps: i) Critical analysis of the state of the art; ii) Study of 3D printing forms, features and materials; iii) Communication plan; iv) Measurement of results; v) Marketing Personas; vi) Communication methodology.

The research findings will highlight the importance of 3D prototypes as a support for an integrated understanding and inclusive dissemination (or to a wider audience) of cultural heritage assets. Among other contributions, the methodology aims to promote learning opportunities for all by enabling users' accessibility, both physical and cultural, to the assets, and engaging them in an emotional experience of knowledge and exploration.

2. State of Art

Studies on cultural heritage communication, to date, are focused, essentially, on digital technologies. This results in insights for documentation and educational purposes, along with 3D models for virtual visualization and real-time navigation – Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR). Equally, it was possible to ensure accessibility of the historical-artistic heritage to people with disabilities, though, for example, Virtual tours. Moreover, Serious Games (SG) applied to the enhancement of Heritage sites (Bercigli, 2019) represent a learning tool related to the world of cultural heritage (Bellotti et al., 2012; Mortara et al., 2014).
Specifically, the main applications of Information and Communication Technologies (ICT), digital technologies for the representation and communication of historical and artistic heritage, are of various types: outdoor guides, interpretive mediation, storytelling or visual storytelling (cultural heritage narrated through images) and media art/virtual exhibitions with internationally relevant examples of such applications to different projects.
Added to this are immersive perceptual experiences created through Oculus: the user experiences an interactive fruition of the digitally reconstructed space with the ability to orient the gaze 360° and virtually move through the 3D scene (Desai et al., 2014). Likewise, 3D models are denoted that propose a research experience aimed at the construction of acoustic virtual reality environments (Picinali et al., 2014).
Studies on edutainment should be highlighted: cultural heritage between education and entertainment; an extensive, multisensory approach and innovative understanding of the cultural value of the asset in question (Cervellini, Rossi, 2011).
Designing communication that emphasizes accessibility to heritage means implementing targeted and strategic levers to make it qualitatively better for potential users. The solutions adopted to develop the proposed objective have been different, explicated as best as possible although all lacking a shared communicative methodology: promotion of museums with casts of original works, two and three-dimensional reproductions in innovative materials, to scale or full size; APPs and dedicated management software; multisensory stations with tactile and olfactory stimuli; edutainment technologies and establishment of routes designed for an audience with visual impairments.
Equally commendable is the project supported by a private research and education organization, Global Digital Heritage (GDH), which is dedicated to 3D documentation of cultural heritage. Using digital visualization, 3D virtualization, geospatial computing and open access solutions, GDH provides digital data and 3D models of places, monuments and collections, to governments, regional institutions, museums, local scholars and general users.

opposite page
Fig. 1
Methodology flow. ©Michele Carucci, 2023.

Although the service provided is in total support of heritage, its management and public access, it lacks, to date, a specific communication strategy.
In the same field of ICT, at present, as far as 3D printing technologies are concerned, they are used for cultural heritage for the purposes of reproduction, reconstruction, transformation and dissemination (Scopigno et al., 2017; Balletti et al., 2017). In terms of reproduction, the goals involve creating replicas to carry out specific research without the risk of damaging the originals (Wachowiak, Karas 2009; Vranich 2018), often creating scale models (Balletti et al., 2016); producing a copy of an artifact missing from archival photography. In terms of reconstruction, 3D printing is useful in processes such as repairing damaged artifacts or components (Arbace et al., 2013). In terms of transformation, on the other hand, it can be useful in the creation of derivative works that include elements, as in the case of audio-tactile experiences (Balzani et al. 2004; D'Agnano et al., 2015).
Finally, several cases of application of 3D prototypes used in learning and communication are denoted (Pantazis,Priavolou, 2017).
Among the few studies that have enabled inclusive access, we note the work aimed at creating an exhibition with 3D models containing tactile pieces for the visually impaired (Neumüller et al., 2014) and the provision of special sensors on the 3D print connected to specific multimedia content viewing systems capable of offering the user a visual-tactile experience (Luigini, Panciroli, 2018).
Beyond these sporadic or specific cases, there is, to date, a gap in the literature, namely the lack of systematic research aimed at identifying a scientific methodology for the communication, addressed to a diverse target audience, of historical-artistic heritage through 3D printing.

3. Methods

A first step (Fig.1) develops a surveys of the different 3D printing methods and techniques, in order to increase accessibility to historical and artistic heritage. Moreover, design scales, prototype colors, and features such as texture, weight, odor, and mechanical specifications will be defined to provide a more holistic appreciation of cultural heritage. New solutions capable of attracting audiences by stimulating curiosity in a simple way and understanding emerging needs for knowledge, insight, and involvement will be scouted. At the end of this phase, summary sheets will be produced that will include the following items: description; type of material and printing technology to be used; design and heritage representations for communication (dimensions, surveys, 3D scanning,isual communication, etc.); aesthetic features; technical specifications.

The development of a database for archiving will be essential for managing data and enhancing the potential of the produced documents. It will also represent a proper tool for future insights and updates, as well as a resource for quick reference and easy specific searches.
Steps of the communication plan, adapted to the research aims, are identified. Firstly, starting from the scenario analysis: geographical and socio-economic contexts that could hinder the enjoyment of historical-artistic heritage. The use of tools, such as the SWOT Analysis, will enable the understanding of elements to focus on, those to be improved, the opportunities in terms of technologies that could favor the achievement of the objective or the threats that could slow it down.
Communication objectives will be identified: i) to understand how to communicate 3D printing as a driver for accessibility to cultural heritage; ii) to survey special features; iii) to bring out the use of the technology, by educating (through the reminder of the existence of this specific service) and retaining users.
The decisive point, then, will be the identification of target audiences to which communication activities should be addressed. Macro identikits will be produced on the basis of: geographic segmentation, socio-demographic segmentation, user behavior, sought benefits.

opposite page
Fig. 2
The Franciscan Convent of Montecorvino Rovella (Southern Italy). ©Nunzio Di Rienzo, 2019.

Building on it, strategies and related communication styles and content will be drafted.
An integral part of the research will be the contribution of qualitative evaluation methods: an initial brainstorming with experts from different fields will allow the development of a questionnaire to be submitted to the focus group (consisting of the target group surveyed in the previous phase), with the support of local public administrations. Previous contacts and synergies with the last ones will be essential in order to root the research in a concrete territory. During the focus group, users' behaviors, when in contact with 3D prototypes, will be directly observed.
A following phase will define the creation of fictitious personas (minimum of three), with the characteristics of real users of the good/service.
Moreover, in order to facilitate the development of marketing strategies, the creation of personas will serve for the production of personalized contents. This methodology will help in understanding: i) what the potential audience is looking for; ii) how to improve the fruition experience; iii) how to optimize efforts in order to produce the most efficient contents. 3D printing becomes a key support for the recovery of cultural heritage, through its communication, its ability to attract new demand and expand the existing one, and the dissemination of its cultural, social, with a strong impact on the territorial economy and the tourism. The principles of Universal Design and Inclusive Design can be stably adopted, in order to ensure access to the greatest number of people, creating diversified experiences based on key factors.
At this stage, the ability to design and consider a friendly fruition, and an easy logistics, will be crucial. This can take place through: in loco exhibitions, awareness days, setups in strategic areas (municipal museums), en plein air events in major squares. Best practices will be incorporated as deemed valuable in the course of the in-depth studies (example: storytelling and edutainment). Moreover, the ability to design and consider logistically simple fruition at this stage will be crucial: location exhibitions, awareness days, installations in strategic areas (e.g., municipal museums), open air events in major squares. Specific techniques, such as storytelling and edutainment, will be considered.

4. First Conclusions

This article represents the first step in the investigation of 3D prototypes as support for an integrated understanding and inclusive dissemination of built cultural heritage. In the specific case, the first draft of a theoretical framework is carried out.
This will be applied to a specific case study, the Franciscan Convent in the municipality Montecorvino Rovella (Southern Italy) (Fig. 2).

This framework emphasizes how the needs for an interdisciplinary (crossing Art with Communication, Marketing, Architecture, and ICT) and intersectoral team, promoting synergies between universities, administrations (at different levels, such as local, regional and national), and the local community. Regarding the last actor, the proposal promotes also learning opportunities, by enabling physical and cultural accessibility of users to cultural heritage, and, simultaneously, engaging them in an emotional experience of knowledge and exploration. In this way, the right to be part of the cultural heritage, benefitting from it, and contributing to its enrichment, allows local (or not) community to play an active role in recognizing both tangible and intangible values.

Futures research will show the application of this framework to the identified specific case study.

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INNOVATIVE TOOLS TO IMPROVE THE ACCESSIBILITY OF CULTURAL HERITAGE. THE EXPERIENCE OF THE FORMER CONVENT OF THE CLARISSES IN LECCE

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Abstract

In order to make Lecce an inclusive, comfortable and safe city, the research activities of the Accessibility Plan focus on interdisciplinarity and citizen participation, thus becomes an opportunity for a generalized improvement of life in the city, an experience of knowledge and socialization to help create a more accessible cultural heritage. The paper reports some partial results about the former Convent of Clarisses.

Keywords: accessibility, inclusion, convent of Clarisses, Lecce Accessibility Plan

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Fig. 1
Localization of the building within the Pilot Area and top view (Google Maps, 2023).

1. Introduction

The Municipality of Lecce (Italy) has launched a series of actions aimed at drafting an Accessibility Plan, i.e., an innovative programming tool, already tested in other Italian contexts, aimed at enhancing the PEBA[1] conceptual and methodological evolution. The Municipality of Lecce has established a technical-administrative structure[2] for guiding the implementatioIn order to make Lecce an inclusive, comfortable and safe city, the research activities of the Accessibility Plan focus on interdisciplinarity and citizen participation, thus becomes an opportunity for a generalized improvement of life in the city, an experience of knowledge and socialization to help create a more accessible cultural heritage. The paper reports some partial results about the former Convent of Clarisses. the 'Accessibility Lab' – and entrusted the drafting of the Plan to four researchers through the assignment of research grants by the Department of Architecture of the University of Florence and the Departments of Engineering for Innovation and History, Society and Human Studies of the University of Salento.

The research is inspired by the concepts and methodology of the Accessibility Plan, understood as "an operational program aimed at improving the degree of accessibility of existing places, services and collective assets by means of a plurality of coherent planned actions and interventions based on shared priorities" (Laurìa, 2012; Vessella, 2022).

The Plan is developed in the medium-long term according to five 5 phases: (1) establishment of the Accessibility Lab; (2) knowing; (3) planning; (4) designing; and (5) monitoring.

After a close discussion with the Municipal Administration, a portion of the city was identified as 'Pilot Area' (Raimondi et al., 2022), on which to start the experimentation of the Plan. The Pilot Area is representative of all the urban and social cases of the city (streets, public spaces and buildings of municipal property) thus configuring itself as a case study on which to define and testing the strategic lines of intervention that will be extended to the rest of the city. It is an inductive process which, starting from the specific case of a Pilot Area, will define guidelines, principles, methods and methodological tools which will be extended to the rest of the municipal territory and portions of the territory will be progressively made more accessible according to a vision and a coherent project.

[1] The Plans for the Elimination of Architectural Barriers (PEBA) were introduced into Italian legislation with Law no. 41/1986 and Law 104/1992. Although the Administrations are obliged to elaborate them, the majority are still non-compliant today, or in many cases the Plans have turned out to be a mere formal fulfillment.

[2] Prof. Antonio Lauria, Coordinator of the Accessibility Plan draft and responsible for the Research Activity; Ing. Giovanni Puce, Director of Public Works and Coordinator of the Municipal Laboratory for Accessibility; Sonia Cappello, Sole Responsible for the Procedure. LCA team: Arch. Monica Bercigli, Arch. Francesca Raimondi, Arch. Dora Uricchio, Dott. Giuseppe Gaballo.

2. The former Convent of the Clarisses in Lecce

The monumental complex of the former Convent of the Clarisses is located in the heart of the historic centre, adjacent to the ancient Roman theatre. There are two hypotheses regarding the foundation but the most accredited is the tradition according to which the Monastery of Santa Chiara was founded around 1410 by friar Tommaso Ammirato, religious of the Order of the Conventual Fathers of San Francesco, Bishop of the City of Lecce since 1429 to 1438. A testimony of the link between family and monastery are some bequests and the presence of some nuns belonging to the same family.

There were twenty nuns' cells and that there were three dormitories, a refectory and a pantry. Around the 1930s. the building, in precarious conditions, needed massive renovations and during the works the nuns were transferred to a few rooms adjacent to the monastery.

Fig.2
Composition of images: cloisters and internal space of the museum MUST.

In 1837 the old building was demolished and with the decree of suppression of the religious Orders of 17 February 1861, the monastery was deprived of its assets and its administration passed partly to the state property and partly to private citizens. The last Clarisses remained in the monastery until 1866. In the nineteenth century massive interventions were made by the Jesuit Giambattista Jazzeolla and today few traces of the older monastery remain: the façade on Via Arte della Cartapesta traces of older wall facings while the nineteenth-century façade on Via degli Ammirati is marked horizontally by a slightly protruding string course separating the two floors. The complex consists of two floors, there are two courtyards and today houses the MUST (Historical Museum of the City of Lecce) as well as the Cultural Policies Office of the Municipality of Lecce.

The building, owned by the municipality, is one of the case studies within the Pilot Area defined by the Municipal Laboratory for Accessibility where the Accessibility Plan was tested.

3. Knowing and planning phases

After a initial inspection of the building, a preliminary survey was made of its attitude for adaptation.

Census Sheets were compiled in which a judgment was given by sight survey of three indicators:

- Reachability of the entrance: it is necessary to evaluate, also in relation to the presence of regulatory requirements, the possibility of reaching the building and accessing it in safety and autonomy. Furthermore, the possibility of creating near the main entrance (≤ 30 m) accessible parking spaces and public transport stops connected to the building via accessible and safe routes should be evaluated.
- Reachability of the places: it is necessary to evaluate, also in relation to the presence of regulatory requirements, the possibility of modifying the internal distribution scheme to make accessible the places where public functions are performed.
- Reachability of at least one accessible toilet: it is necessary to evaluate, also in relation to the presence of regulatory requirements, the possibility of creating an accessible toilet, conveniently reachable through an accessible route.

A second phase of study took place through an in-depth survey of the building using census sheets and traditional measurement tools for verifying and updating the existing plans.

The digital database, developed on the FileMaker software, has been divided into thematic sections: accessibility of the entrance, horizontal connections, vertical connections, toilets, furniture and equipment, signage, functions and services.

Within each section relating to a different theme, there are elements, defined as items, which are identified through a unique code; for each one, the localizetion and characteristics are recorded in order to verify the user-friendliness and if they constitute a source of danger, obstacle or distress for users (taking into account regulations but also recommendations not prescribed by law).

After a phase of data consolidation (verification and possible updating of the acquired information), Intervention Sheets have been compiled (planning phase) which can then

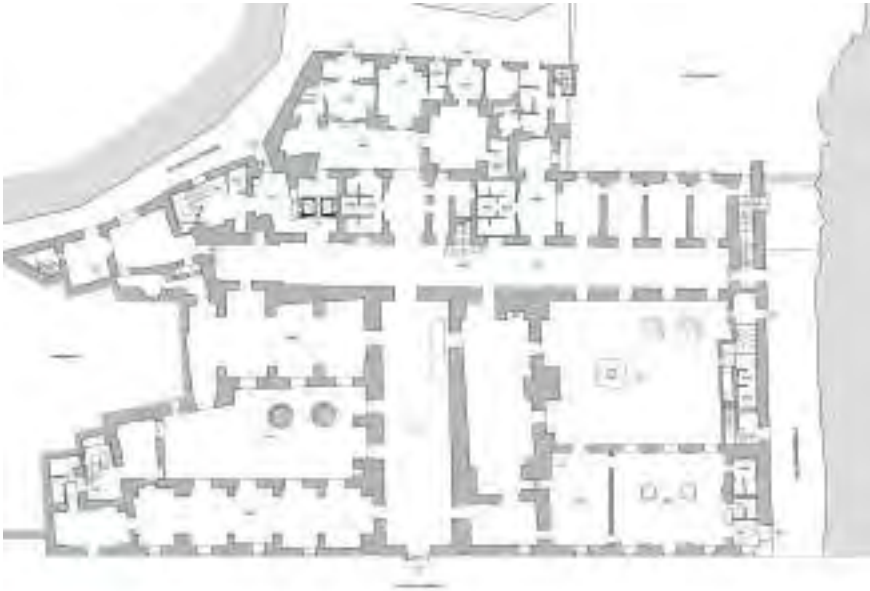


Fig. 3
Plan of the ground floor with the identification codes of the items surveyed.

be used as a basis for carrying out the necessary interventions both to eliminate the architectural barriers present and to raise the degree of accessibility of the building. Within each sheet there are different sections:

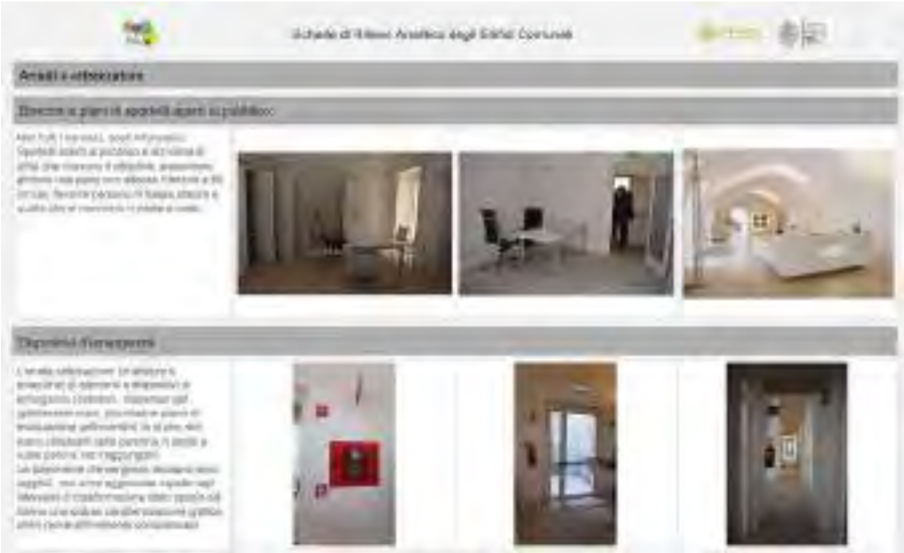
- General description: general information about the location of the building, the description of the functions, the main architectural features and some historical notes.
- Brief assessment of the accessibility: refers to the degree of accessibility based on current legislation, with particular attention to two large classes of users: People with Reduced Mobility and People with Sensory-Perceptual Difficulties.
- Proposed adaptation actions: describes the objectives of the actions that will be specified in the Intervention Sheet in accordance with the protection, enhancement and redevelopment strategies of the Municipal Administration.

opposite page
Fig. 4
Example of Census Sheets (furnishings and equipment sections) made in FileMaker.

The different sections are divided into columns which contain the following information:

- Type of actions:

1. Architectural actions (F): permanent or temporary projects solutions, in line with the procedures imposed by the current legislation, that transform the space adding



quality and performance standards missing by choosing solutions appropriate to the context (retrofit strategy)

2. Management actions (G): Interventions that act on the localization, organization and implementation of spaces and services without changing the physical structure of the places.

3. Communicative measures (C): projects solutions aimed at promoting individual autonomy and overcoming sensorial and perceptive accessibility problems by providing digital technologies for the improvement of the wayfinding and the content accessibility

- Description: provides strategic and operational indications to be explored in the planning phase.
- Images: schematic drawing or images of good practices.
- Laws of reference: in addition to the laws in force on accessibility, guidelines and recommendations are indicated.
- Priority.

1. High: actions required by law and regulations in force and to avoid dangerous situations for people or to give access to essential services (e.g. hanging elements that invade the pedestrian path, pavement in a bad way, street furniture in a bad state of maintenance, dangerous crossroads).

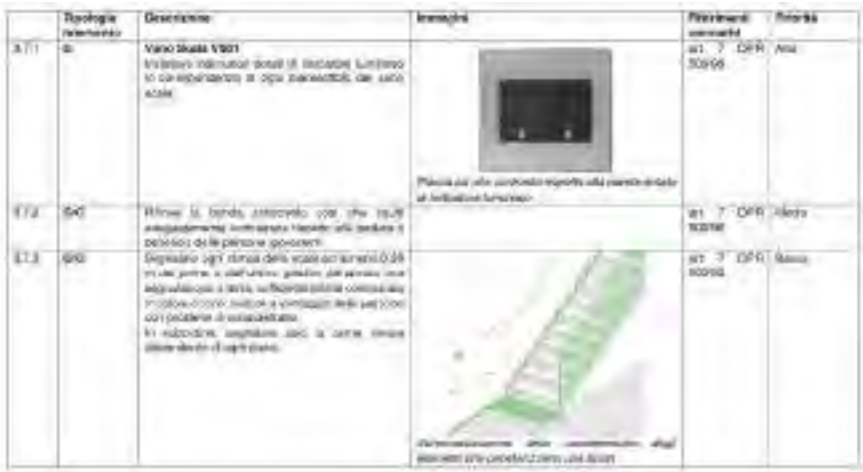


Fig. 5
Example of a section (vertical links) of the Intervention Sheets.

2. Media: actions required by law and regulations in order force to favor different categories of users (e.g installation of lifts, creation of accessible parking).
3. Low: actions aimed at improving environmental comfort and people's independence (e.g. installation of benches, creation of shaded areas in a public garden).

4. Conclusions

At the end of the planning phase it is possible to draw some conclusions on the major problems in terms of accessibility regarding the former Convent of the Clarisses, but which can be found in most religious buildings, generally reused for public functions (exhibition spaces, spaces for events , offices etc.) (Germanà et al, 2021; Maietti et al., 2021). For example, people with reduced mobility often have reserved and secondary accesses, and are forced to use mechanized systems, even other than elevators, which are specifically installed. Monumental buildings are often accessible with assistance as some essential aids are missing for people with reduced mobility to use spaces and equipment in conditions of autonomy, safety and comfort (e.g. handrails, railings, emergency bells, etc.). Buildings such as the Complex of the Clarisses, from a sensory-perceptual point of view are difficult to read and understand for everyone and, in particular, for people with visual impairment. First of all, it must be emphasized that the repetitive and symmetrical layout typical of monastic architecture, combined with the large dimensions of the complexes, create an alienating and bewildering effect especially in the absence of precise landmarks. Other difficulties in the perception of space and in the distinction of architectural elements are due to the absence of chromatic/achromatic contrast between the surfaces.

The difficult legibility of the elements is due to the common practice of choosing architectural components, like glass doors with white profile on a white wall or electric switches, and 'tone on tone' furnishings that blend in with the surfaces, creating discomfort to people with vision problems.

Furthermore, the directional and informative signage present is not always well designed so that it can facilitate users' orientation. In general, there is a lack of devices and design solutions that can facilitate orientation and wayfinding.

The subsequent phases of the work concern the planning and monitoring of the interventions, and in parallel the definition of a complete workflow that can be used to extend the Accessibility Plan to the rest of the municipal territory. In fact, each building needs a structured and coherent program so as to make cultural heritage accessible to all.

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WOODEN TABERNACLE CRAVED BY THE MARANGONI FRIARS. A PROJECT TO ENHANCE AN 'UNTOUCHABLE' HERITAGE OF THE CAPUCHINS OF ABRUZZO

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Abstract

One of the most precious elements of the historical and artistic heritage of the Capuchin province of Abruzzo consists of a series of wooden tabernacles produced between the 17th and 18th centuries. Many of these tabernacles still retain their original use, while others have been replaced on the presbyteries, or, as in the case we are dealing with, come from convents that no longer exist. The valorisation project starts with the digitisation of the tabernacle using Structure for Motion technologies (SfM) and the subsequent three-dimensional modelling, followed by the optimisation of the 3D model and the subsequent prototyping, and concludes with the implementation of an Augmented Reality application (AR) for the use of the mapped 3D model and other queryable information. The current state of the research is at the prototype stage and is the first step towards the realisation of a travelling exhibition with some prototyped models of various tabernacles, since as in many cases objects are still used for liturgical purposes, they could not be transported to a different location than their original location. Another important goal of the project is the haptic experience of the prototyped models, because being liturgical objects, they are in fact excluded from the direct perception of blind persons.

Keywords: Wooden Tabernacles, digital Heritage, 3D model, augmented reality application, Franciscan Heritage.

opposite page
Fig. 1
General views and details of the tabernacle of the Capuchin friars in Pescara. Note in the central image the inappropriate location for the artefact.

1. Introducing

One of the most precious elements of the historical and artistic heritage of the Capuchin province of Abruzzo consists of a series of wooden tabernacles produced between the 17th and 18th centuries. Many of these tabernacles still retain their original use, while others have been replaced on the presbyteries, or, as in the case we are dealing with, come from convents that no longer exist.

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1.1. Historical notes

As is well known, the Order of Capuchin Friars Minor was founded between 1525 and 1528 – date of the recognition of the Order by Pope Clement VII with the bull Religionis zelus – and among its distinguishing traits it immediately showed a rejection of materiality that led to the prohibition – from the original Constitutions of 1536, revised in 1575 following the Council of Trent – of the

> “recettione di qualsiasi cosa, ancorchè minima, d’oro, d’argento, di velluto o seta: eccetto il calice, la bossola del Santissimo Sacramento et tabernacolo et il velo da tenere sopra il tabernacolo”[1].

It is clear from these notes that the only tolerated use of valuable materials and decorations is in reference to the sacrament of the Eucharist, and as some authors state, the “religious motive and legal justification” for the creation of wooden tabernacles – a poor material – finely crafted by Capuchin carvers can be found in these notes[2]. Framed

[1] Constitutiones Ordinis Fratrum Minorum Capuccinorum saeculorum decursu promulgatae, vol. I: Constitutiones antiquae (1529-1634). Editio anastatica, Roma 1980, cap. XII, p. 48 delle Cost. (p. 198 del vol.). See also Regola e Testamento del P. S. Francesco con le Costituzioni dei Frati Minori Cappuccini, Roma 1938, nn. 104-105.

[2] Cfr. Del Vecchio L. 1998, Frati cappuccini «marangoni» e tabernacoli lignei in Abruzzo, Italia Francescana. Rivista di cultura francescana quadrimestrale, anno LXXIII, n.1, p. 38 and note 14.

within wooden structures composed on the high altar, usually with classical lines, the tabernacles represent the focal point of the spatial construction of Capuchin churches, and it is here that the Order's craftsmen applied themselves most.
The lay friars dedicated to carving and cabinet-making between the 17th and mid-18th centuries are referred to as the *marangoni* friars, although the term *marangone* is originally dedicated to craftsmen dedicated to carpentry – and during the decades of peak activity they held an important school of carving in which they trained other brothers as well as laymen.

1.2. The tabernacles of the marangoni friars

The compositional reference of the tabernacles of the marangoni friars is an architectural model of a small temple with a central plan – as a metaphor for the dwelling of the Blessed Sacrament – with usually two superimposed orders. The reference to the tabernacle in the Chapel of the Blessed Sacrament in St. Peter's by Gian Lorenzo Bernini, clearly inspired by Donato Bramante's tempietto in San Pietro in Montorio, is very likely, albeit in a version normally leaning against the wall of the ancon separating the choir from the presbytery, thus not being 'in the round'. The most widespread structure in Abruzzo, and in other provinces

Fig. 2
Detail of the tabernacle of the Capuchin church in Campli (TE).

of central Italy, especially in the Marche, is composed of four parts: a base, two superimposed orders and the dome. Tabernacles mades in Abruzzo normally use twisted columns – which make the structure slender and dynamic – simple or paired, scanning the hexagonal base (incomplete due to the leaning against the ancon) and interspersed with niches with statues of saints or apostles. In the central façade of the first order is the Eucharistic cell, normally identified with a small door finely inlaid in wood, ivory and mother-of-pearl. The second order, which replicates the first on a smaller scale, is surmounted by a dome – more appropriately a hexagonal-based vault – with an 'onion' section, the parts of which are interspersed with ribs that cluster at the top to support a small globe topped by a cross or a figurine. The woods used are very varied, ranging from walnut to boxwood, cypress and ebony in some cases, to increase the chromatic contrast and thus achieve ornamental value. Only in rare cases is the tabernacle painted gold, while in almost all cases it is the variation of the wood that is the only chromatic element used by the carvers. In the Abruzzo province, there are four tabernacles that can be considered variants of the model just described – defined in the literature as model A – or, in the case of the tabernacle in the Church of the Capuchin Friars in Penne – model D or fourth-generation – a new model: the tabernacle of the church of Saint John the Baptist in Chieti – model B – is similar to model A, but has an enlargement of the first order with the addition of two lateral turrets and a finely inlaid dome; the tabernacle of the church of St Benedict Abbot in Teramo – model C – is structured on three superimposed orders instead of two, has an inlaid dome and is considered the masterpiece of one of the greatest exponents of the tradition of the Marangoni brothers, Fra Giovanni Palombieri; the aforementioned tabernacle of the Capuchin church of Penne – model D – is instead structured in a more organic and complex manner, with a base, a compound order in the form of a triumphal arch, a drum that continues the rich inlaid friezes of the underlying order and an inlaid dome with balustrade, without a globe but with a lantern perhaps deprived of a cross or a statuette; the tabernacle of the Capuchin church of Atri – model E –, the second order of which is open like a canopy or ciborium.

2. Research methodology

Having laid the objectives of the project and the contextualisation of the artifact, the research team then set out to outline a methodology that could reconcile a replicable and scientifically verified workflow with the use of low-cost technologies.
The choice therefore fell on the combined use of technologies and tools such as expeditious photogrammetry, conducted with the SfM technique, 3D printing and Augmented Reality in order to create a physical artefact that can be easily coupled with digital data acquired in

Fig. 3
Structure from Motion acquisition: Dense Cloud's general view and details.

opposite page
Tab. 1
Project datasheet.

the field. As is well known, in fact, Augmented Reality allows digital elements to be superimposed on a real scene: this feature generates an enhanced vision of reality by applying, through the use of specific devices, a digitised information layer that modifies the real scene in order to deepen its knowledge. The technology is therefore based on the use of mobile devices such as smartphones and tablets to acquire the real image, which is then integrated, thanks to specific software, with the simulated image in a combined vision of real and virtual.

2.1. SfM survey and digital modelling

During the acquisition phases, a sufficient number of shots were taken to describe all parts of the surveyed object (for full details on the number of photos and the acquisition and restitution parameters, please refer to the attached table): the acquired photos were processed with the Agisoft Metashaspe software.
The three-dimensional restitution operations carried out resulted in the creation of a highpoly (high polygon density) model useful for accurately describing the surveyed

SFM ACQUISITION			3D PRNT	
Reflex		Nikon D700	*Model scale*	1:5
Camera lens		Nikkor 18/55	*Model high*	36 cm
Dataset		390 photos	*Subdivision*	9 pcs
Processing	*Allignement*	High	*Layer high*	0.15 mm
	Dense Cloud	High	*Infill*	10%
	Mesh	High poly	*Printing time*	61 hh

geometries[3]. The meshing phases were then completed by removing all unwanted portions of the surface from the models and repairing those parts that were damaged or incomplete (as a result of incorrect reconstruction). The smoothing process, which takes place through the elimination of asperities formed due to the noise generated during the acquisition phase, finally ensured the uniformity of the 3D surfaces: even in this case it was necessary to pay due attention to applying the right amount of smooth while maintaining the geometric details of the returned fronts intact. Having completed the three-dimensional modelling of the surveyed geometries, it was finally possible to apply the textures and prepare the model for the subsequent 3D printing.

2.2. From digital model to 3D printing

Additive manufacturing (or 3D printing) allows us to make physical objects from a digital model. Although different printing systems are available on the market, we can say that the production process is in many cases similar: the 3D digital model is 'converted' into a physical object through a process of overlaying and layering the material used for printing. Once the 3D digital model has been generated, the next step is to choose the most suitable printing technology for the specific needs of the project: printers that operate according to a Fused Deposition Modelling (FDM) process involve the use of a plastic filament (composed of thermoplastic polymeric material) that, once heated, is extruded from a nozzle and released onto a platform following a constrained movement pattern, which is useful for achieving the desired shape. FDM printers are certainly among the most popular in the consumer and prosumer market, probably due to their relative ease of use and their affordable cost that allows project budgets to remain low. In spite of these advantages, however, it must be emphasised

[3] The final 3D model was appropriately scaled by referring both to the dimensional parameters acquired in situ through direct survey and to the information reported in the monographic sheet contained in Del Vecchio 2001 (p. 94).

Fig. 4
The 3D digital model of the tabernacle: on the right the geometric model, on the left the mapped model.

opposite page
Fig. 5
3D print prototyping: general view and details of the printed model. The prototype has some printing defects that will be corrected for the final version of the model.

that, at present, this technology still has very long printing times and, above all, requires an appropriate preliminary preparation phase for the digital model.

Having determined the optimal printing method to be carried out, we then proceeded to the generation of the G-Code, i.e. the software operation that allows the geometry of the 3D model to be 'translated' into instructions that the printing machine is able to interpret and execute: by subdividing the model into horizontal layers, the software generates the printing path that the machine body will have to follow, thus determining the time required to complete all the printing operations. Depending on the shape to be printed, in order to obtain a print result that is faithful to the original object, it may be advisable in many cases to divide the model into parts so that it can be printed without the aid of removable media. Removing the print media, i.e. the auxiliary material that the press extrudes to make it possible to create parts of the model, could prove difficult or damage the final product. In the case study presented here, the first step was to print the model in a single block with the aid of the print media. The result was optimal from an overall solidity point of view, but, as the original object was rich in slender details such as the twisted columns, the high presence of the print media rendered the final product

unusable. A second test was instead carried out by dividing the digital model into a sufficient number of sections to guarantee a print without the presence of the supports. In this way, the three-dimensional print was able to reproduce all the details present in the real object.

2.3. Augmented Reality

In the design of applications integrating Augmented Reality functions, one of the most important design nodes is certainly the target choice, i.e. that real element that has a dual function: activating the digital content and, at the same time, providing the spatial reference on which to project the information. For example, graphic markers (Image Target) consisting of two-dimensional digital images that are then printed and thus become physical targets are very common. The Model Target function, available for Vuforia software libraries, on the other hand, allows us to recognise and trace a specific object positioned in a real scene: based on its shape and orientation in space, and to project the desired digital information content onto it.

The advantages deriving from the use of this particular function become evident in the case study proposed in this research: one of the project outputs concerned the realisation of a

Fig. 6
The Augmented Reality APP.

3D print of the detected tabernacle which, despite faithfully reproducing the geometric characteristics of the object, nevertheless lacks the chromatic data associated with the object. The use of Augmented Reality solutions applied to a printed object thus allows us to superimpose the digital model with photorealistic texture on the 3D print created, thus increasing its level of detail. The Augmented Reality functions in the APP have therefore been realised using the Model Targeting methodology with which it has been possible to create an Advance Model Target Database: this database guarantees a high level of object recognition and an accurate level of object tracking regardless of the point of view from which the real object is being viewed.

3. Conclusions

As anticipated, the research project is at a late stage of advancement but not yet concluded: the prototype printed and presented in these pages is the first prototype printed to final size, and still has clear margins for improvement, especially for optimisation for haptic use: some printing defects, in fact, superficially affect direct visual use and do not affect AR use in the slightest, but would limit correct use by blind people. These

considerations demonstrate how well the workflow already works, even under difficult shooting conditions and with prototyped models, which for able-bodied users would already be fully effective.
The AR application works well and showed very good targeting stability, while additional information for interactive use needs to be implemented. The project will continue the development first with the optimisation of the model also for blind users and then with the digitisation of further tabernacles – one per type – to realise a travelling exhibition in the second half of 2023. Finally, the project will be validated by collecting user data and standardised questionnaires that will be analysed using quantitative methodologies.

Credits

The Project was developed by the EARTH_LAB laboratory for digital environment for Education, ART and Heritage of the Free University of Bozen-Bolzano in cooperation with the ICT service of the Faculty of Education. Alessandro Luigini conceptualised and coordinated the Project, Alessandro Basso carried out the photogrammetric shots, Giuseppe Nicastro processed the photogrammetric shots, elaborated the model, prepared the model for printing and implemented the AR application, Daniele Frusone collaborated in the preparation of the model for printing and supervised the prototyping process.
We would like to thank Alessandro Peroni, Head of ICT at Brixen campus, for allowing his office to collaborate with our laboratory.

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REMOTE SENSING ARCHITECTURAL SURVEY EXPERIMENTS FOR HISTORICAL HERITAGE: COMPLEX OF SANTA CROCE IN FLORENCE AND THE CHALLENGES OF DOCUMENTATION

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Abstract

The Department of Architecture at the University of Florence has a strong focus on monumental architectural heritage documentation and conservation. They collaborate with organizations managing heritage sites, responding to requests like the one from the Opera di Santa Croce. The department embarked on a project to survey the Basilica of Santa Croce in response to the Opera's needs, aiming to create a digital database for architectural and art descriptions. Simultaneously, they began experimenting with remote sensing documentation systems, primarily to support traditional architectural surveys and assist Federico II University lecturers in developing a BIM-based maintenance plan. These experiments, conducted in 2020 amid the pandemic, aimed to showcase the potential of three-dimensional documentation tools and the integration of point cloud databases with parametric BIM models. Specific portions of the Santa Croce complex were chosen for experimentation, including the external façade, the internal side aisle, the Pazzi Chapel for two-dimensional graphic restoration, and a portion of the Chiostro Grande for BIM modeling. These efforts demonstrate the department's commitment to preserving and documenting architectural heritage.

Keywords: Santa Croce, remote sensing, digital survey, architectural survey, architectural drawing.

Fig. 1
Aerial view of the Basilica and the Santa Croce area.

1. Introduction

The interest of the Department of Architecture of the University of Florence in monumental architectural heritage, aimed at its documentation and conservation, is traditionally one of the main lines of teaching and research (Bertocci, Parrinello 2015); there are frequent contacts with the companies that administratively manage places of high patrimonial value, for these reasons. The project to survey the Basilica of Santa Croce stems from our Department's response to the requests of the Opera di Santa Croce, which recently concluded a research agreement aimed at the bibliographic documentation of texts describing both the architectural features and the works of art within the complex (Verdiani, 2002). At the same time, for technical and design requirements, our research group was asked to begin experimentation on morphological remote sensing documentation systems, with multiple purposes: on the one hand, dialogue with the Opera's technical office, for the drafting of traditional architectural surveys using data from a digital database; on the other hand, to support the work of some lecturers at the Federico II University in charge of drafting a maintenance plan to be applied through the BIM methodology, an initial account of which you will find in a text within these proceedings.

Therefore, in 2020, at the height of the pandemic crisis, a series of experiments began to demonstrate the potential of three-dimensional documentation tools and to verify the possibilities of dialogue between point cloud databases and parametric BIM models (Coli et al, 2022). In order to carry out these experiments, some portions of the Santa Croce complex were taken as examples, and in particular: as regards two-dimensional graphic restitution, the surfaces of the main external façade as well as the internal side aisle on the south side, and the adjacent Pazzi Chapel were involved; as regards BIM modelling, a portion of the Chiostro Grande was used.

2. Methods

2.1. Digital documentation

The portions of the Santa Croce complex that were taken into consideration to test the digital survey, provided for different digital acquisition systems that would allow for different levels of in-depth graphic rendering, both two and three-dimensional, of the architectural qualities and material qualities of the architecture of the complex; for all the case studies, a base was created using range-based methodologies, integrated with image-based survey supported as needed by UAV, drone instruments, so as to allow for the mapping of surfaces not visible from human height (Bertocci et al., 2020). The architectural surveying process was developed following a workflow that envisaged the articulation of operations over several phases: the planning of the survey is the first part of the process, fundamental for planning the activities in the field, understanding what instrumentation, what techniques and what precautions will be most suitable for data acquisition. This phase is preliminary to the survey campaign.

During this phase, drawings, diagrams and eidotypes were produced, which were useful in setting up the survey strategies, in order to clarify the surfaces to be mapped through remote sensing. After having planned the operations to be carried out, the field survey phase began; as mentioned above, for this phase, with the interest of combining the needs of the client and those of the research, it was decided to experiment different image-based and range-based digital acquisition systems in order to give an overview of the possibilities of representing the different methodologies applied in the monumental field on portions of a religious complex of high patrimonial value (Pancani et al., 2020). A number of case studies have been chosen to verify and present the potential offered in the documentation and representation of this monumental architecture; before addressing the actual survey methodologies, it is worth listing the case studies and the main architectural characteristics and representative requirements that allowed for a tailor-made survey design.

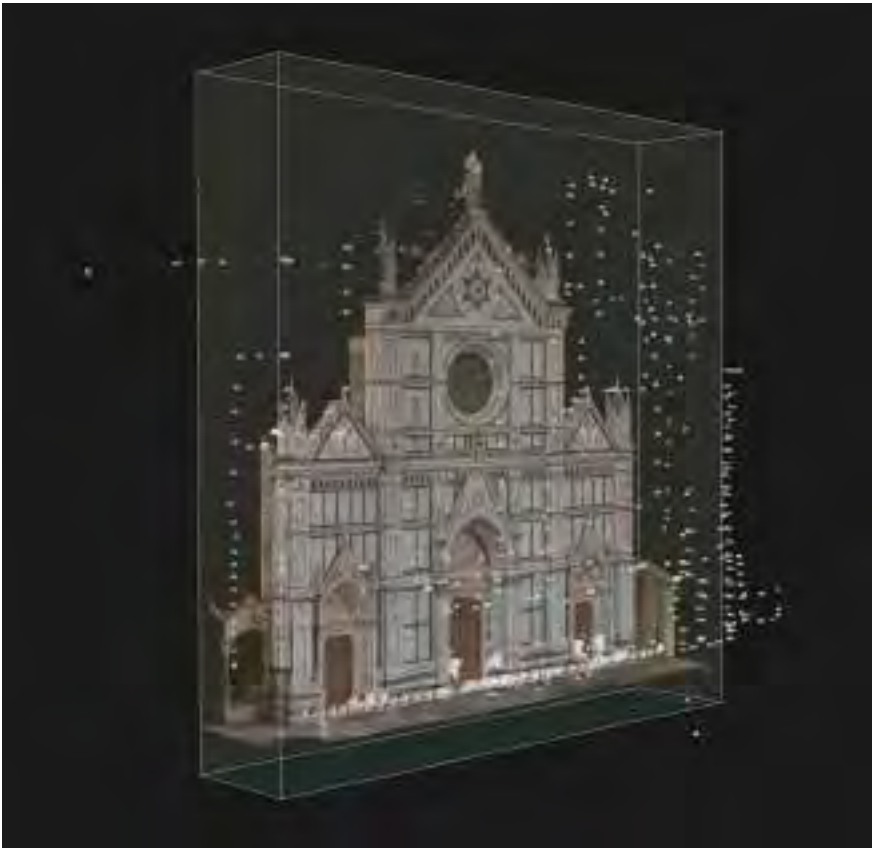

Fig. 2
Aerial photogrammetry by drone of the the façade of the Basilica di Santa Croce.

opposite page
Fig. 3
Cross-section of the side aisle of the Basilica of Santa Croce, superimposed view of wireframe and orthoimage.

2.2. Basilica

With regard to the fulcrum of the religious complex, the Basilica, only a portion including the volumes of the south-facing side aisle facing the cloister leading to the entrance of the Pazzi Chapel was chosen as a case study; in addition to the Basilica's interior surfaces, all the exterior surfaces were also surveyed with an acquisition campaign that involved the entire exterior cloister and the Chapel itself itself designed by Brunelleschi.
For the basilica's interior, laser scanning was used right from the start, and the stations were designed to be dense enough to provide data rich in details, so as not to leave any shadow cones or undetected parts of the architectural structures and altars and their decorative apparatus; then the walls photogrammetrically surveyed from the ground, with particular attention paid to all the decorative elements of the basilica's nave, from the altars to the tomb slabs.

opposite page
Fig. 4
Orthoimage of the façade of Santa Croce.

For the exteriors too, the first phase of the survey was by laser scanner; in this case, the less articulated decorative apparatus made it possible to position the less dense stations. In the external part, the photogrammetric survey from the ground was supplemented by drone survey, fundamental for surveying the highest areas that cannot be reached from the ground. In the final phase, two-dimensional drawings representing the floor plan and sections, both longitudinal and transverse, were produced, visualising both the entire nave internally and externally as well as the rooms within the side aisle and the external portico.

2.3. Basilica's facade

The façade of the Basilica di Santa Croce was surveyed with particular attention to the decorative apparatus present on the entire front; at first, laser scanning was carried out, and strategic points very close to the façade were chosen for the positioning of the stations, remaining with all of them on the portion of the churchyard; this choice was dictated by the great crowding of Piazza Santa Croce, which could have affected the clarity of the data surveyed. The choice of acquiring close points resulted in the positive aspect of having a very dense point cloud in the lower part of the façade, but negatively affected the numerous shadow areas especially in the upper part. The deficiencies found in the laser scanner survey were subsequently integrated with the SfM survey; in this case the photographic campaign was very detailed and focused on drone shots of the upper parts, as well as the lower parts not detected by the few ground scans.
In the final phase, the one in which the 2D drawings were drawn, in this case the focus was shifted to the materiality and the façade, with detailed descriptive drawings that could help the study of both the material and structural state of conservation of the surfaces.

2.4. Chiostro Grande

The Chiostro Grande was treated in part differently from the previous examples; the objective of the survey in this case was in fact the three-dimensional modelling of the building, to be subsequently also treated with BIM modelling. The survey in this case consisted of an initial phase of detailed laser scanning survey, both of the exterior and of the interior spaces such as that of Cappella Pazzi. This was also followed by the photogrammetry part, concentrated on the buildings facing onto the cloister, for the material restitution of the environments, also in this case useful for the understanding of the three-dimensional models (Parrinello, 2018).

2.5. Workflows

The laser scanner acquisition method, used for the creation of an accurate descriptive model of the Basilica's morphology, is able to provide a measurement within predetermined error parameters: the single scan, in fact, depending on the instrument model, guarantees high reliability, in our case millimetric. Unfortunately, the same cannot be said of photogrammetric reconstructions: the SfM (Structure from Motion) survey from the ground and from

Fig. 5
Drawing of the façade of Santa Croce, wireframe view.

opposite page
Fig. 6
External section Pazzi Chapel, wireframe drawing, point cloud and orthoimage.

a drone, used for the creation of three-dimensional models descriptive above all of the materiality of the walls concerned, does not guarantee the correct reconstruction of the point clouds, which are influenced by numerous and diverse problems linked to the light source. For this reason, after an accurate control of the registration process, the laser scanner survey was taken as the morphological basis, whose polar coordinates were used to verify the control points of the photogrammetric survey, both from the ground and from drone (Bertocci et al., 2020). The data from the different acquisition systems were used to create the technical drawings (plans, sections and elevations), through a consolidated methodology involving the extraction of geometries from the laser scanner's point cloud

data, and the materiality of surfaces from photogrammetric acquisitions: both databases were appropriately subjected to data certification protocols in order to verify the reliability of both the registration of the scans and the calibration of the photoplanes on the point cloud (Pancani, Bigongiari, 2020).

The laser scanner survey of the Basilica of Santa Croce was designed to obtain an adequate datum to allow the description of all the elements characterising the building, with a distinction between interior, exterior and façade due to the different morphological and decorative features. The design of the survey was also fundamental for the placement of the positions of the instrument's shooting points; these were studied so as to be able to provide, once the individual scans were combined, a complete overall datum. The scans were also evaluated in the light of the various planned survey campaigns, which took place several times over the years. The scans were therefore designed in such a way as to ensure a high point coverage for the complex surfaces, such as the façade and the parts concerning the Pazzi Chapel, with a consequent increase in the size of the morphological database of the complex; this required the correct data acquisition design, which was possible using an instrument that guarantees a

high reliability of the measurements. The external part of the nave of the Basilica and the interior spaces that are not richly decorated required a less dense datum and were acquired more quickly. The management of the scan data included an appropriate filtering phase to further limit errors in the acquired points; the recording phase of the scans, thanks to the modern technology of the instrument used, begins as the acquisition of the scans proceeds: once the data has been acquired, it is transferred directly via wi-fi to a computer and pre-aligned with the previous scans, which allows the field survey to be finished with all the scans correctly oriented in a single reference system.The registration phase in post-production therefore required the optimisation of the pre-alignment and a subsequent certification phase of the data through the analysis of the section profiles of the scans. From the general model obtained, high-definition orthoimages were extracted that were useful for polishing the main sections on autocad, leading the point cloud back to a CAD drawing that was able to subdivide both the objects from a semantic point of view and the graphic weight of the lines in the representation (Bigongiari, 2021).
The photogrammetric survey was divided, as mentioned, into two parts: close-range from the ground and aerial via drone. For the close-range photogrammetric survey, several digital cameras were used: a Canon EOS 1100D SLR, all equipped with various lenses, but always set in manual mode with settings as constant as possible (ISO 100-F7), in order to obtain sequential shots with colours and tones as similar as possible. For the aerophotogrammetric survey, a DJI Mavic Pro drone was used, with a built-in 12 Mp camera that allowed the capture of high-definition aerial images, providing a global mapping of the architectural and environmental complex (Bigongiari et al., 2022).
During the shots, great attention was paid to the entry of light, trying to maintain a diffuse light to avoid shadows of its own and those brought onto the building; care was also taken with the distance from the basilica during the shoot, trying to keep it as constant as possible, even though the quality of the finishes of the architecture surveyed obliged some detail shots for the more articulated parts, especially on the façade, to ensure a better three-dimensional rendering of the complex objects. With regard to the methodologies of the shots, they were taken while maintaining an overlap percentage between successive shots of at least 50 per cent, in order to guarantee alignment during processing.
For drone photogrammetry, a linear path with parallel strips was studied to ensure that every point of the facades taken into consideration was included (Arrighetti et al., 2022). These, supplemented with data collected from the ground, which were more detailed in their scope, allowed us to obtain complete models despite the differences in altitudes at which the shots were taken.

The huge amount of photographic material produced by integrating the two acquisition systems led to the consequent reorganisation of the photographs; they were divided by structuring diversified datasets for each macro-environment, in order to create an organised digital archive well prepared for digital processing. For this last part, the potential of the SfM Agisoft Metashape Pro photomodelling software was exploited; it allows the reworking of the data from the photogrammetric survey campaigns, and subsequently the creation of mapped three-dimensional models. The processing of the photogrammetric data for each surface of the complex was produced following the same methodology. It involves the development of four phases: alignment, creation of the dense cloud, creation of the mesh, application of the texture. Once these phases are completed, the result will be the photogrammetric data, which, once exported, will become the photoplane (Parrinello, Picchio, 2013).
Once the production phase of the photo-planes has been completed, the assembly and integration phase of the elaborates produced can be carried out. The elaborates obtained from the polishing of the point cloud, which are rigorous and precise, will be used as the basis for the photoplanes. The latter will be affixed on top of the flush drawings and thanks to them, extraneous elements or noise, points exported by the software but extraneous to the described architecture, will be eliminated.

3. Conclusions

The graphic elaborations obtained show a complete spectrum of possibilities in the field of architectural design coming from digital surveying. These drawings and models will be useful to the administrations to proceed with the survey project of the complex interior, in the same way the historical and architectural research will have a useful database necessary for the correct drafting of in-depth scientific studies based on accurate morphological knowledge.

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ALGORITMIC APPROACHES FOR HBIM. THE GREAT CLOISTER OF THE OPERA DI SANTA CROCE IN FLORENCE

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Abstract

The common goal of preserving the existing historical heritage makes it necessary to have knowledge of artefacts not only from a formal point of view, but also in terms of information management. The digitisation of processes therefore tends towards the BIM approach that enables a data collection environment through parametric modelling. Historical heritage, given the heterogeneity of its elements, aligns poorly with the standardisation of forms, so there is currently a move towards the identification of modelling flows capable of automatically encoding complex entities. The opportunity to test new solutions has arisen from a research collaboration between the Universities of Naples and Florence on the Opera di Santa Croce, focusing on the colonnade of the Great Cloister, for which the parametric-algorithmic approach is proposed, which is increasingly in use as a suitable tool for the manipulation

Keywords: opera Santa Croce, algorithmic-parametric modelling, cultural heritage.

opposite page
Fig. 1
Workflow of the experimentation: from the numerical model developed by University of Florence, to the information model through VPL, finally checked with historical data.

1. Introduction

The conservation and protection of historical heritage are most effective if the understanding of the building is deepened through the correct construction and management of its information structure. For this purpose, the BIM (Building Information Modeling) approach serves as an environment for gathering and coordinating information through modelling by parametric elements, selected within families of objects, framed within a set of already categorised semantic entities (Di Luggo and Scandurra, 2016).

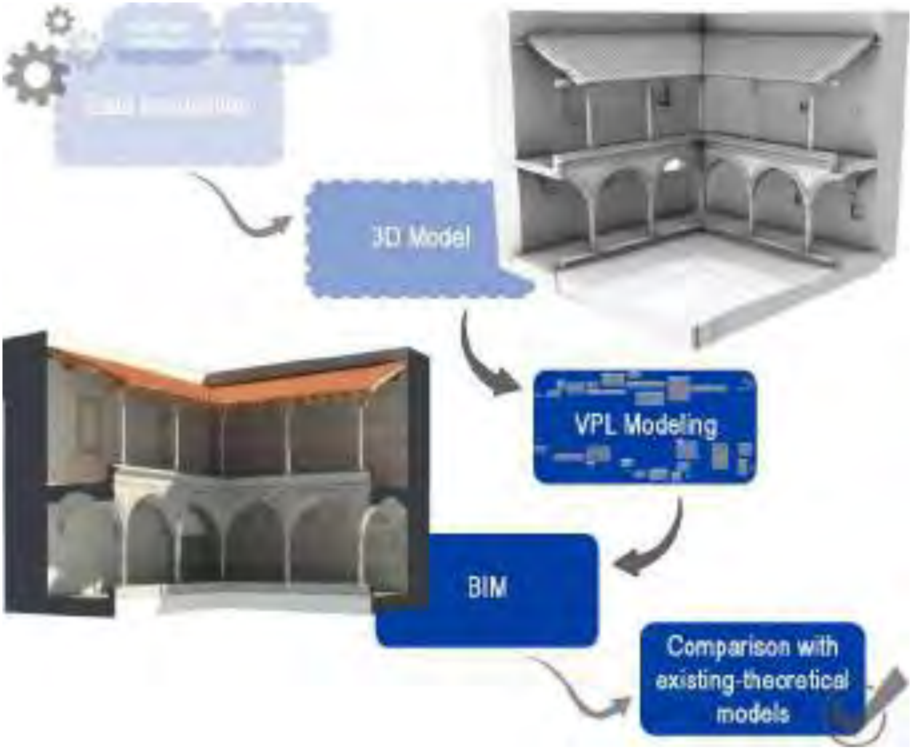
Nevertheless, in the field of historical heritage, the heterogeneity of its constituent elements explains the uncertainty of the semantic description of architectural forms, which follow rules and parameters that are extremely linked to the specificity of the heritage (Campi and Cera, 2019). Moreover, while the parametric management of historicised realities on the one hand facilitates the analysis of the heterogeneity of data relating to individual elementary architectural units, the modelling process retains a high degree of complexity due to the high degree of typification of elements.

The richness of the historical fabric and the heterogeneity of its constituent elements lead to uncertain descriptions of the data, or the oversimplification of the models to cope with the complex parametric modelling approaches of their components.

Therefore, there is a current interest in the identification of processes to automatically manipulate families of objects encoding graphic entities and languages related to the composition of minimal instructions to generate forms that evolve from data acquired through integrated image and range-based surveying techniques (Murphy et al., 2012).

Among the applications of this very active field in current scientific research, parametric-algorithmic modelling is becoming increasingly pervasive as a tool underlying BIM digitisation process, useful for the management and use of existing cultural heritage.

With a view to contributing to the automation of modelling approaches, the occasion of a research collaboration arising from the parallel interest in the Opera di Santa Croce on the part of the University of Florence and the University of Naples Federico II gave impetus to a prototype experiment. The joint work between the two universities was characterised by the implementation of integrated survey data within a parametric model that is coherent not only in the geometric component, but also in the information enrichment of the architectural elements. In this context, the implemented experimentation deepened the virtualisation starting from the segmentation and parameterisation of its architectural elements, making use of an approach specifically based on visual scripting. The focus was placed on the Great Cloister of the Florentine Complex, characterised by architectural elements with such peculiarities that the digitisation process maintains a high degree of complexity.



For this reason, specific approaches to visual algorithmic programming for the recognition and modelling of the architectural orders were considered, starting from a metric-informative acquisition that led to consistent and verified instances, in the proportional analyses with an always parametric approach, with respect to the rules described in the classical codes.
The approach to the reconstruction of architectural orders, with global and generalisable value, used the digital Visual Programming Language (VPL) grammar (Calvano, 2019). A new library was produced that can be implemented with non-standard parametric column objects, introduced in the digital environment of the Cloisters of the Florentine Complex, but which can also be adapted to other types of existing historical artefacts in relation to the metric data acquired in advance.

1.1. Towards an HBIM model of the Great Cloister of the Opera di Santa Croce

In line with the directions described above, the research conducted on the Great Cloister on the Opera di Santa Croce, part of the Convent of the Franciscan Order, is part of the joint

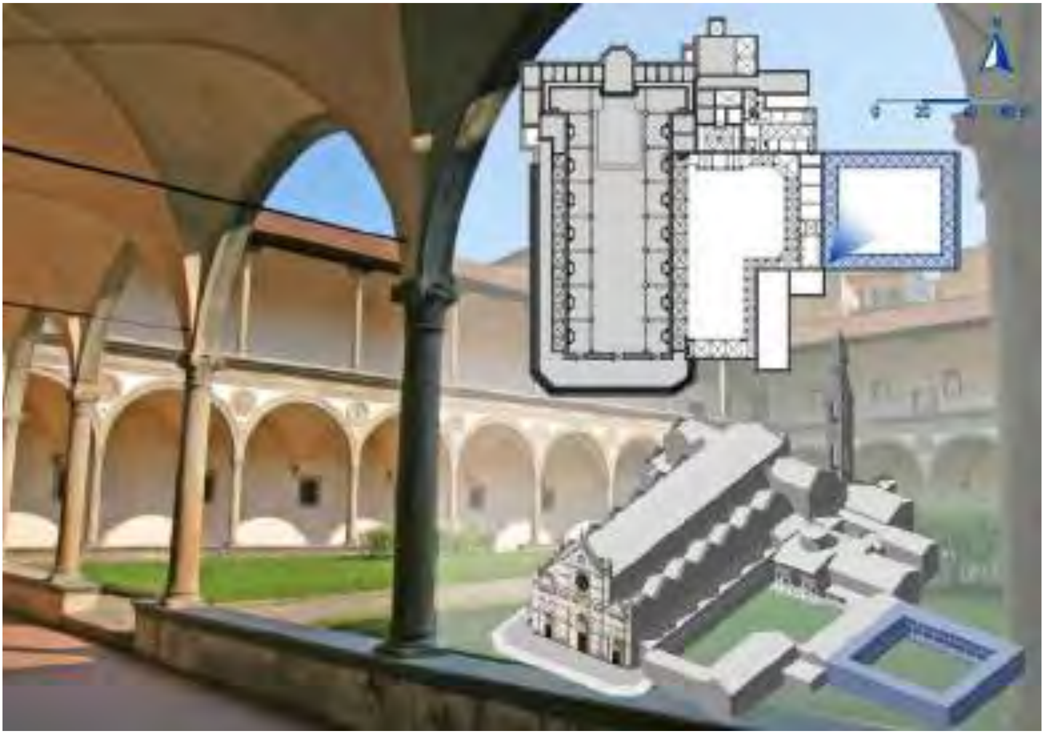


Fig. 2
Case study: the Great Cloister of Santa Croce in Florence (Edited by the authors).

action conducted by REMLab – the survey and modelling laboratory of the Department of Civil, Building and Environmental Engineering of the Federico II University – and the Department of Architecture of the University of Florence, which proposes the ambitious project of multi-scalar and multi-disciplinary structuring of a parametric model at the service of both the phases of maintenance intervention and the more exquisitely conservative restoration phases, aiming in this sense to guarantee a concrete and rigorously scientific response to the description of the elements found in the digital. The open space of the Great Cloister, bordered on either side by two-storey porticoes with rounded arches and Pietra Serena columns – around which the various rooms of the monastery are articulated – is one of the outstanding elements of the Complex and one of the largest monastic cloisters in Europe, built between the 13th and 14th centuries.

The Great Cloister is the result of a long process of construction and decoration, which involved various artists and architects over the centuries. It does not present a single architectural order, but a mixture of decorative and structural elements of different architectural styles characteristic of Romanesque architecture. In the lower portico, the cylindrical-shaped *Pietra Serena* columns, in composite style with acanthus leaf capitals, make up the round arches supporting the second order characterised by more slender and slim columns to create a lighter and more airy structure in the upper portico of the cloister. In order to recreate the digital image of the space, the methodology has seen a preliminary phase of instrumental acquisition and normalisation of the metric information (Lo Turco, 2012), as a result of the survey campaign conducted by the University of Florence research group under the coordination of Prof. Stefano Bertocci, useful for the reconstruction of a parametric semantic model in a BIM key, which must include an analysis of the grammar of forms, with the identification of the variants and invariants that define the elements and the architectural language under examination.

The occasion prompted the testing of a new VPL approach for the parametric modelling of architectural elements, specifically trying an approach for the digital reconstruction and geometric-proportional verification of first and second-order columns. This involved work on interpreting the rules that make up the architectural order for the possibility of parameterising their shapes into elements that can be traced back to common geometric matrices. This made it possible to define a prototypical approach to constitute a real implementable library of elements adaptable to the geometric conditions of the historical artefact.

2. Algorithmic approach for modelling and verification of column orders

In the process that from the knowledge of the artefact leads to the realisation of coherent digital models, the so called 'digital twins' of the existing work, there is a need to implement the processes of automation of operational flows in the processes of recognition and management of unstructured data derived from a digital survey and the related generation of solid instances within BIM platforms (Caetano and Leitão, 2018).

In particular, the research focused on structuring an algorithm for the segmentation and modelling, from a point cloud, of the columns of the case study, with reference also to the geometric and proportionality rules of the constitution of the orders (Guadagnoli et al., 2021). The comparison with historical manuscripts, from that of Vitruvius to 18th-century architectural manuals, has made it possible to derive all those geometric rules that are as useful for the automation of digital reconstruction as they are for evaluating compliance with the canons in the proportional analysis of the orders of existing elements, contributing to the evaluation of any significant deformations and/or irregularities (Bruno and Roncella, 2018), due to the craftsmanship of their construction, also opening up the issue of the implementation

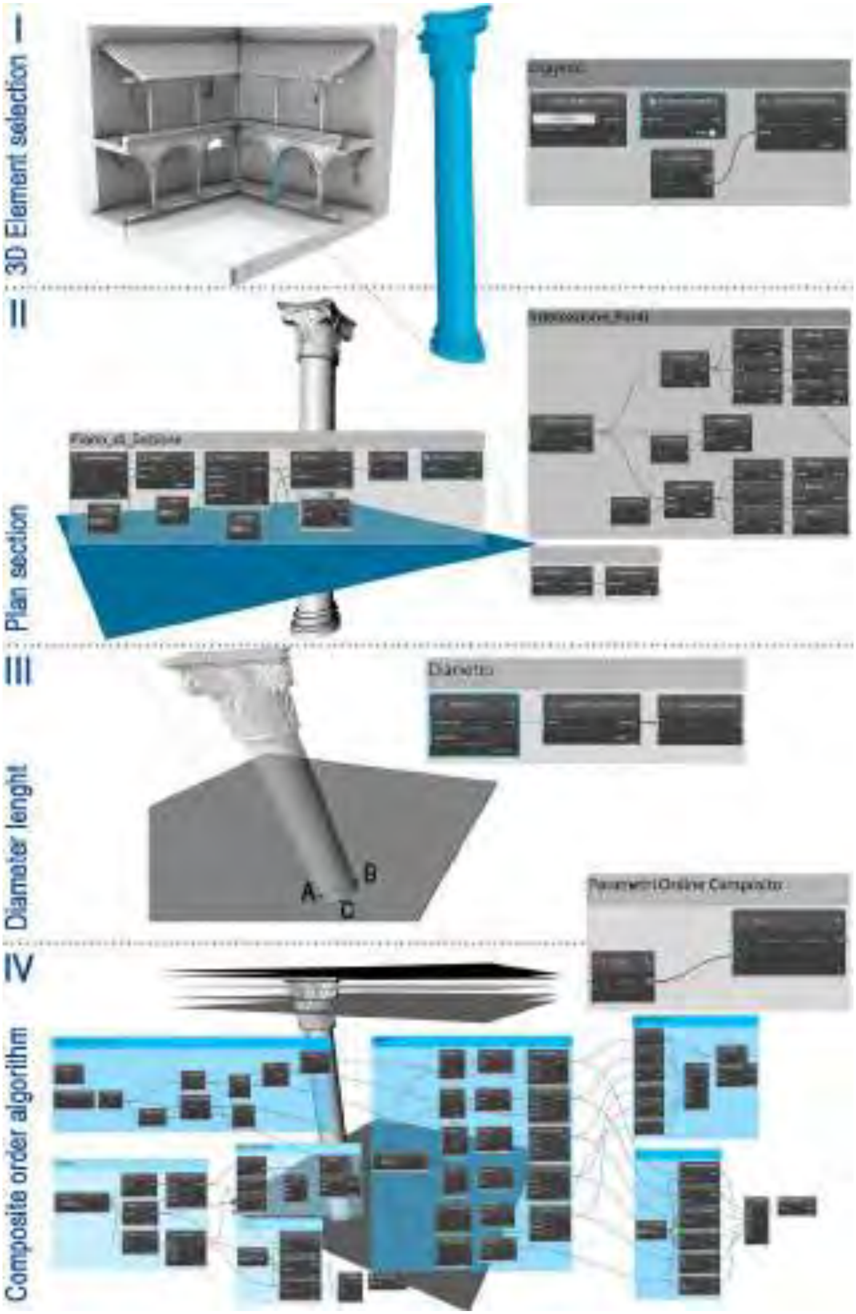


Fig. 3
Segmentation algorithm from mesh surfaces. (Edited by the authors).

opposite page
Fig.4
Modulation of architectural orders: the 'method of successive partitions' by Prof. Riccardo Migliari. (Re-edited by the authors).

of information useful for the management and maintenance of the same artefacts (Carbonari et al., 2015). Specifically, those indications summarised as the 'method of successive partitions' by Prof. Riccardo Migliari were implemented (Migliari, 1991), which facilitated the description of the modelling processes of the elements by means of algorithmic scripting. The method of successive partitions consists of correlating parts of the order starting from the module corresponding to the base diameter of the column, defining a set of rules that modulate the correct proportioning of the three main elements of the decomposition: pedestal, column and entablature. From this initial categorisation, the geometric recomposition in the digital domain necessarily took into account a further breakdown with: the pedestal consisting of cymatium, dado, plinth; the column from capital, shaft and base; the entablature from architrave, frieze and cymatium. Added to this there is the reading of the hierarchies of each architectural order according to three main levels, the structure, the functional and the decorative. The structural level is that which concerns the general proportional organization, necessary to guarantee the static characteristics, which relates to a proportioning of the elements linked to the unitary reading of the whole.

For example, the module is used to determine the height of the column, its base and capital, as well as the thickness of the entablature above and the intercolumn, i.e. the space between the pedestals or adjoining columns. The functional level looks at the definition of the dimensions of the individual component elements: the pedestal, the column and the entablature.

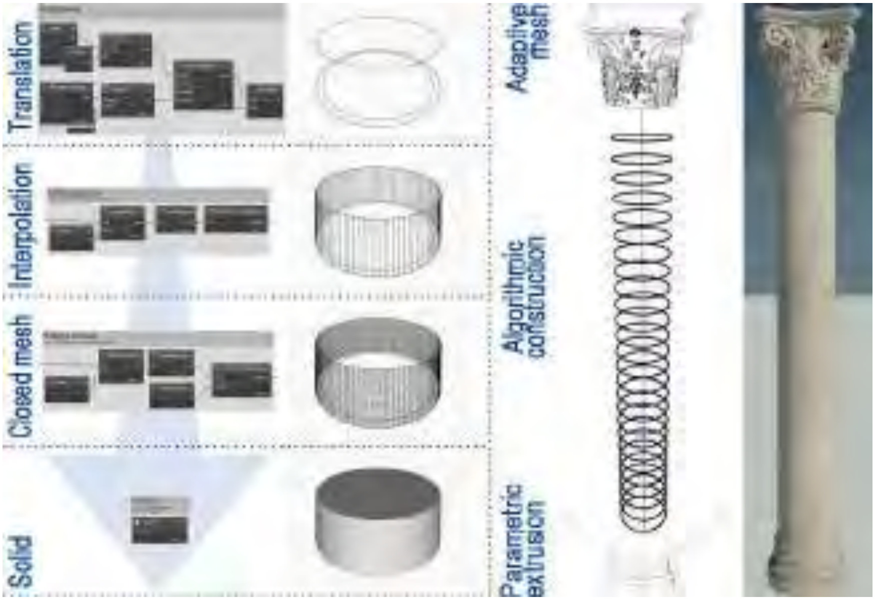


Fig. 5 Integration of parametric extrusion, algorithmic segmentation and adaptive mesh (Edited by the authors).

In particular, once the base module has been determined, the height of the column is obtained as a repetition of the unit size on the central axis of the shaft, a certain number of times depending on the architectural order under consideration. Next, the diameter and height of the pedestal and entablature are described according to the distribution of the height of the column, according to the rules specific to each order. Finally, the decorative level defines and proportions each moulding with differentiations between the different orders. Even the most complex decorations are made up of the assembly of mouldings, generated by a series of type profiles that are used singly, or repeated or superimposed with variations in scale. For the construction of the parametric reference model, the starting point was the elaboration of the surfaces translated in a reverse engineering approach from the dense cloud, capable of returning key information about the real conformation of the surveyed surface, as the first datum to derive the diameter d of the base circumference of the column shaft. Therefore, the mathematical model was reconstructed from the geometric matrix of the column shaft, parameterised according to those compositional rules that dictate the proportioning of the base and capital. In particular, the model of the shaft was generated from the succession of profiles belonging to planes orthogonal to the defined axis by highlighting the variety of the entasis along its height. According to an approach that takes into account the variables and relationships

between the shaft and the summit and base element, the progressive reduction in the diameter of the column modifies the relationships between the various parts, scaling the capital and re-proportioning the base solid reconstructed on the basis of the conformative qualities of the architectural order, that is, the elements that can compose it in the variability of styles. Thus, with particular reference to the research conducted in the composite order, the entire colonnade was elaborated by referring to a single parametric model adaptable to the conditions of historical architecture. The model, although simplified, integrates the mesh surfaces of the decorative parts into the parametrisation, making them adaptable to the varying characteristics of the element, overcoming the limits of a mere polygonal representation that is often unable to return useful information on the formal matrices that are at the basis of the project for the valorisation of a given historical architecture.
The modalities described so far not only facilitated the modelling of the parametric object, which in different digital copies can be adapted to the different variables linked to the metric survey input data provided, but also helped the verification of the canonical criteria from the same geometric modulation rules. The setting of horizontal cutting planes makes it possible to identify the variability of the parametric model, a virtual copy of the existing one, revealing whether or not the proportional rules expressed in the historical treatise are respected.

3. Conclusions and future developments

The experimentation, although limited to the colonnade, demonstrates that it is possible to pursue new operational methods in relation to the different problems of interaction between digital data obtained with 3D shape acquisition techniques (now widely consolidated in the architectural survey panorama) and the processing and management mode of the new HBIM models. A careful reading of the geometric elements that make up an architecture (especially an architecture of historical value) allows the identification of basic geometric elements that can be more easily translated according to a parametric-algorithmic approach in the BIM environment. This favours the research and control of the geometric and formal qualities of an element, even in the consistency with ancient models, in view of an implementation increasingly oriented to the complete architectural transcription of space in the digital environment.

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COMMON DATA ENVIRONMENT FOR KNOWLEDGE MANAGEMENT OF HISTORIC BUILT HERITAGE. THE STUDY CASE OF THE PIEVE DI SANTA MARIA IN AREZZO

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Abstract

Building Information Modeling and Management methodologies has been emerging also in the field of cultural heritage, bringing out the need to define a specific approach to the processes of information production, which characterize the activities of protection, conservation and maintenance of built heritage. In this case the process of digital models authoring have to deal with both the particular methods of acquiring the geometric data in the different digital survey techniques, and implementation of information content not only related to technical parameters, but also to the historical and cultural values through semantic connections referable to proper ontologies of historical analysis and architectural codes of the past. The proposed work shows some results of the experimentation of a common data environment aimed at the knowledge management of the ancient parish church of Santa Maria in Arezzo, developed through the design of a relational database capable of exchanging data and information with the H-BIM model, creating a Relational Database Management System (RDBMS).

Keywords: H-BIM, RDBMS for built heritage, Pieve di Santa Maria in Arezzo, CDE for Knowledge Management.

Fig. 1
The Pieve di Santa Maria, apse front.

opposite page
Fig.2
The Pieve di Santa Maria, main façade.

1. Towards information knowledge management

Information management led with the use of Building Information Modeling and Management methodologies has been emerging also in the field of cultural heritage, bringing out the need to define not only specific approaches in the creation of digital models, but above all to outline a different structure of the processes of information production, which characterize the activities of documentation, conservation, management and maintenance of the historical built heritage. In general, the proper implementation of a BIM model starts with the prior identification of objectives, BIM uses and related exchange information requirements (EIR), then proceeding by successive levels of development to the geometric and information modeling of the building. In the case of assets of cultural interest, however, the process of digital models authoring can significantly increase in complexity, having to deal on the one hand with the particular methods of acquiring the geometric data in relation to the different digital survey

techniques, on the other hand, taking on as information content not only the technical and technological parameters of the various constructive elements, but also the historical and cultural values, tangible and intangible, of which the building is an expression through semantic connections not always referable to the commonly understood building system, but rather to different ontologies proper of historical analysis, of significance assessment and of the architectural codes of the past (Simeone et al., 2014). As part of a broader research aimed at the historical-critical knowledge of the monumental complex of the Pieve di Santa Maria in Arezzo, some results of the experimentation of a data sharing environment aimed at the knowledge management of the built heritage are exposed, developed through the design of a relational database capable of exchanging data and information with the H-BIM model, creating a Relational Database Management System (RDBMS), whose access modes to the information content are oriented to the end user through appropriately defined consultation sheets.

1.1. The Pieve di Santa Maria in Arezzo

The Pieve di Santa Maria is considered one of the most important medieval buildings in Arezzo (Fig. 1). Fragmentary documentation is available on its origins, and uncertain is the date of its foundation, which is traced back to 1009. It is assumed that, with the exception of the bell tower and presbytery completed around 1330, the construction of the church, including the entire exterior facade with the three orders of overlapping loggias, was completed around 1250 (Fig. 2). Subsequently from the 16th to the 18th century, this underwent profound transformations, which were then almost completely erased by the massive restoration work in the second half of the 19th century (Mercantini, 1982).

The medieval layout of the building, achieved through complex constructive stages, is therefore only a part of the history of the structures, which over the centuries underwent further incisive modifications, constituting today a palimpsest that is very difficult to understand in its own varied formation. The study of the parish church, based on a laser scanner survey, has made it possible to highlight the singularity of the structure of the basilica body and transept, showing the inclination of walls and columns, variations in wall thickness, significant deformations of some arches, cracks and unevenness in the textures of the wall shell (Matracchi et al., 2021). These composite characteristics common to every ancient building confront us with a peculiar epistemological condition, which eschews simplifications and requires, every time, deep and complex studies closely related to the problems of the architecture. Therefore, knowledge management supported by BIM methodologies and more generally by Integration Data Management configures today a line of research of great interest to address the complexity of problems related to the protection, conservation and enhancement of cultural heritage.

1.2. Data and sharing environments for the built historical heritage

For an effective application of BIM information management methodologies to cultural heritage, it is necessary to fully understand, from a methodological and operational point of view, the changes induced in technical communication by the new ways of managing information in all related processes, which involve multiple actors with different roles, each within their own competencies and established operational procedures. In particular, the issue of continuity in knowledge management, a fundamental prerequisite for the proper development of conservation activities on buildings declared to be of cultural interest, when approached in terms of BIM poses the problem, still little investigated today, of the transition to communication strategies capable of replacing the traditional means of representation of the survey/project with more complex virtualization systems supported by information models and data sharing environments.

In fact, activities in the field of restoration are characterized by an extreme heterogeneity of objectives, and can range from a single intervention on a degraded building element, to systematic interventions on the entire building aimed at conservation and/or functional, structural, energy, etc., improvement consequent to new use requirements or regulatory provisions, up to the management of planned maintenance. Therefore, information modeling planning must be able from time to time to identify an operational workflow capable to address the objectives set by the investigation or intervention program. For example, for some specialized activities (structural analysis, energy, operation activities, etc.) it is possible to make appropriate simplifications of the information model, sometimes imposed by the complexity of the problem to be faced, to optimize data exchanges between different software. For other activities a high level of geometric and information development is indispensable, since singularities that are irrelevant in some computational analyses can assume decisive relevance for design choices (UNI 11337-4 2017).

Information management with H-BIM based methodologies must also be able to guarantee an effective continuity of knowledge management, aggregating not only standardized *machine readable* data derived from new acquisitions, but also information elaborates of other nature (digital and non-digital) derived from previous interventions or from archival research (drawings, photos, old documents, etc.).

For this reason, the issue of defining a Common Data Environment (CDE) for cultural heritage constitutes a fundamental methodological premise that, if not well understood, can greatly limit the effectiveness and development potential of integrated knowledge management aimed at the conservation activities of the built historical heritage. In particular, the objectives of an CDE will have to refer not only to the usual areas of the efficiency of data sharing and exchange systems, but also to ensure model management procedures, information processing and data integration conformed specifically to the field of cultural heritage. We can enunciate some of them:

• automation of information coordination among operators of cultural heritage;
• management of BIM object libraries for the built historical heritage;
• possibility of data and information extraction through interface modules based on knowledge approaches or operational roles;
• availability of information from H-BIM through data aggregation criteria aimed at analysis and interpretive studies of the built historical heritage;
• management of information exchange on the basis of open-source formats (e.g., IFC) through the definition of specific Information Delivery Manual (IDM) and Model View Definition (MVD) (ISO 29481-1, 2016) configured for cultural heritage.

2. H-BIM and Data Integration

An operational methodology for H-BIM model authoring is illustrated below, aimed at subsequent information management through a Relational Database Management System (RDBMS), which allows the extraction of data from the information model or stored in the CDE and their aggregation according to semantic structures designed for the analysis and interpretation of the built historical heritage.

2.1. H-BIM authoring: Scan-to-BIM procedures

Information modeling of the historic building begins with the geometric survey phase using laser scanning techniques, which are capable of generating dense point clouds that reproduce the geospatial data with a high degree of accuracy. The Level of Accuracy (LOA) must be calibrated in relation to the uses and objectives established for the modelling, which in the present case are represented by research purposes.

The modelling accuracy is divided into measured accuracy e represented accuracy: the former involves geospatial data acquired through geomatics instrumentation and depends on sensors and adopted data capture procedures; the latter involves how the measured data is transformed into a parametric object (USBID, 2019).

The point cloud forms the basis for the generation of the H-BIM model, using a combination of software, such as Autodesk Recap and Autodesk Revit, capable of exploring the cloud and extracting the necessary morphological information of the investigated element for its parametric digital reproduction. In order to get numerical feedback on the geometric accuracy of the result obtained from the modeling process, Cloud Compare software is used: this is a process of geometric validation of the model, which allows the modeled element, or set of elements, to be superimposed on the starting point cloud (assumed as a reference), so as to determine the mutual deviation between corresponding close points (Biagini, 2022). BIM objects are also populated with alphanumeric data and information, defined at the start of the modeling process through p-sets of parameters. Additional parameters are also associated with the objects that allow linking to archival documents, photos, technical reports on the state of preservation of individual real elements, allocated appropriately in the CDE.

2.2. Information modeling and management

An information management system has been implemented to make full use of the information content stored in the H-BIM model. This management system is based on a relational database (RD) developed through the open-source software DiaPortable, proceeding initially with the design of the database architecture.
An E-R Scheme (Entity-Relationship Model) capable of identifying and visualizing the macro associations established between the main classes of modeled objects has been prepared: this scheme constitutes the fundamental reference for the subsequent design of the logical model, which will define the Relational Database Management System (RDBMS) and in which the connections, that are established between the various information contained within the BIM objects, are described in detail. In particular, a number of keys sets (Primary Keys and Foreign Keys) are defined, allowing the prepared attribute tables to be linked together. Having completed the design of the RDBMS system, the data contained within the H-BIM model are extracted using the Revit-DB Link plug-in, with which it was possible to export the parameters of each individual object to the Microsoft Access software. The next operation was to reorder and adapt the relational database obtained from the information transfer process in Microsoft Access, so that the designed RDBMS was operable. Custom mask layouts were set up at this point, able of making information content accessible to various types of users through appropriately defined consultation sheets. The structure of each individual mask was created by employing the SQL programming language, dealing with a complex combination of queries, capable of querying the database and providing the specific information for each individual investigated element of the historic building.

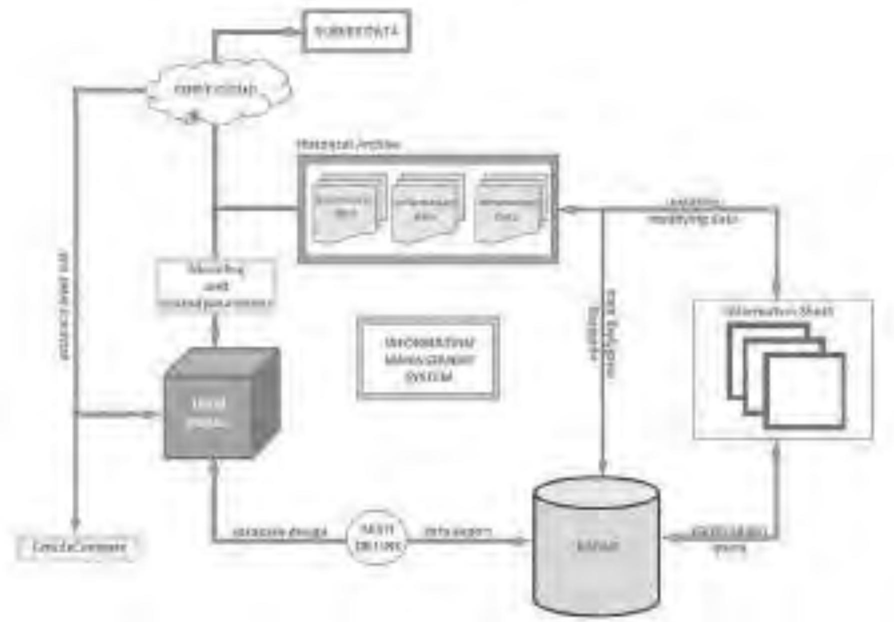

Fig. 3
RDBMS interoperable process.

The system is characterized by a high degree of flexibility and considerable ability to implement and update the information in the database, either through direct modification of the value of tabular fields within the management system in Microsoft Access, or by acting on the parameters of the information model. This also ensures bidirectionality and interoperability of the information exchange between the BIM model and the RD.

3. Information management system test for the study case

The operating methodology described in the previous chapter has been applied to the case study of the Pieve di Santa Maria in Arezzo. The architectural survey of the parish church, was carried out with a phase-shift laser scanner and a digital reflex camera (Z+F 5006h). 189 scans were performed for generating the 3D model of the church: 180 of them with high density and normal quality, lasting 5-6 minutes; the remaining ones with super high density and high quality, lasting 13-14 minutes. Vectorial drawings of plans and sections were then created from the 3D model. For the implementation of the information model the point cloud has been converted into Autodesk Recap Project files

(.rcp) in order to proceed with the creation of BIM objects directly within the Autodesk Revit software. For a better geometric control in the various phases of modeling, it was decided to start with the realization of external walls and internal pilasters of the architectural complex, using the functionality sectional panels to generate axonometric views and vertical sections; the secondary decorative elements and/or morphological completion of the main elements were created, using generic models. The use of the system families was in fact very limited due to the extreme geometric complexity of the components of the wall structure: custom families were modeled for lobed pillars, pilasters, decorative columns, arcs and vaults, made with a combination of extrusions and subtraction of solids.

The geometric validation of the model was conducted by parts, both for computational limits of the available hardware and for the verification of relative deviations between individual modelled elements of the architectural complex and the corresponding elements defined in the numerical model of the point cloud. In particular, the interest was focused on the facade of the Pieve because its morphology was considered a test bed suitable for the experimentation of the geometric validation procedure. This prospect is in fact composed of three overlapping bands of columns placed side by side, each of which differs in shape and condition of preservation. The different modelling strategies used for the creation of BIM objects (full modelled, hybrid, segmented point cloud) were compared to evaluate their advantages and disadvantages in relation to the set objectives.

After the geometric modelling phase, the implementation of the alphanumeric and documentary information in the H-BIM model was particularly concerned with the state of conservation of the facade elements, assuming that the degradation of stone surfaces was one of the most significant information to manage in the database. The assignment of this information content could be done through the introduction of shared parameters (also called customized), which can be added to the various families of elements. They have multiple modes of use and provide information cells attached to the parametric object of a graphic, numerical or textual nature. In the present case, 27 shared parameters have been introduced, each of which is able to receive different information on the state of conservation of the single component, the interventions performed, the level of historical knowledge, etc.. In this way, it became possible to structure an information management system, which would go beyond the strict classification of the building system defines by the BIM authoring software, superimposing on this a different conceptual model more adequate to the semantics of the built historical heritage.

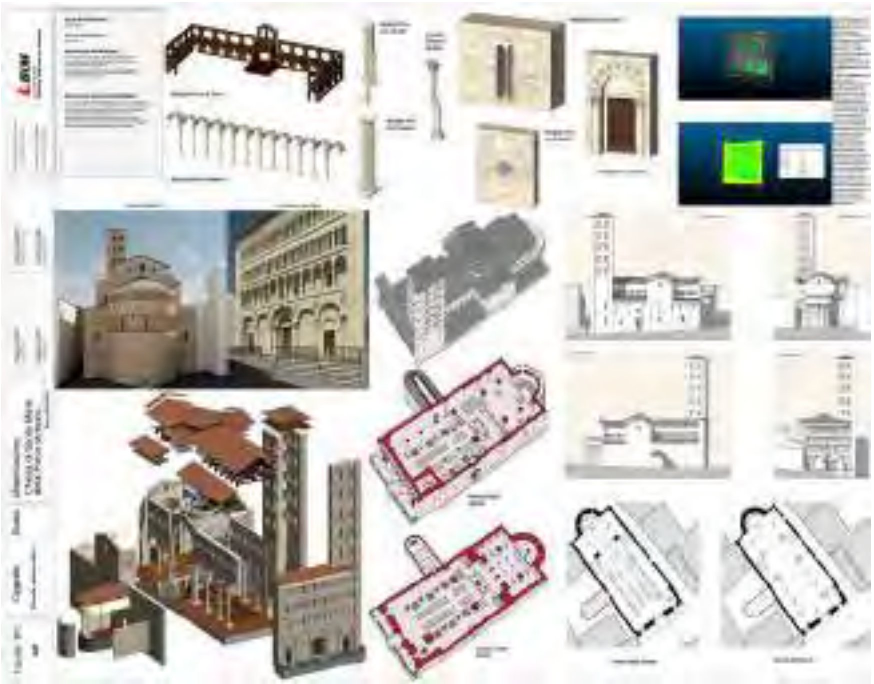

Fig. 4
H-BIM model of the Pieve of Arezzo.

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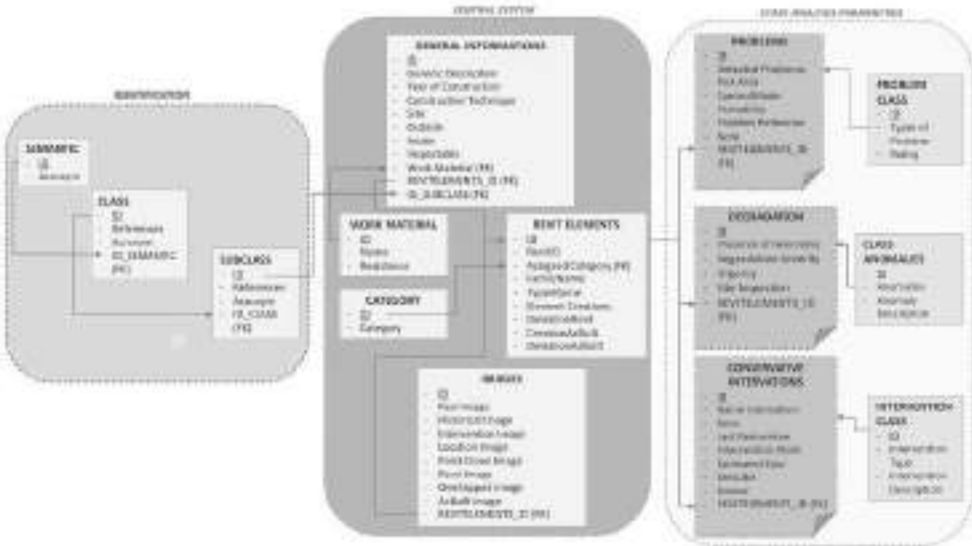
Fig. 5
RDBMS Diagram - Logical Model.

3.1. RDBMS for managing the information content of the H-BIM model

The design of the relational database was carried out within the DiaPortable open source software, which allows to create block diagrams for displaying the database schema. The first phase consists in the preparation of the Schema E-R, defining various types of relationships (1:1, 1:N or N:N) capable of generating associations between entities, consisting of tables containing information, which are:

1) Objects belonging to the informative model of the Parish; 2) Generic information; 3) Building materials in the parish; 4) Semantic classification, class and subclass, identification of the element; 5) Problems and class of problems; 6) Degradation and class of degradation; 7) Interventions and class of interventions.

With the identification of tables and relative relations, it is possible to pass from a simplified relational model to a logical model RDBMS in which, through the predisposition of primary keys, a unique connection between entities (tables) is defined. Some data (called attributes), able to confer a uniqueness binding and link, were then selected: this operation is fundamental to do not generate redundancy of data and information within



the information system. In this way, it is possible to implement a new classification system free from the one imposed by the BIM authoring software, while continuing to extract information from the information model.

Once the RDBMS system was completed, the data of the H-BIM model was exported to the database designed through the plug-in RevitDB Link, which allows you to exchange information in a two-way and then to make changes and updates indifferently in the two databases. In the export, a set of tabular entities are automatically generated, representing all types of families of the H-BIM model linked by many relationships. These are then reduced appropriately, maintaining only the links related to the objects that make up the church grouped into categories (24 entities in all). To generate connections of different significance between these entities than those established by the Autodesk Revit software, RDBMS system queries have been set via the SQL programming language, composing mainly combination of 'merge' queries, 'selection' and 'entity creation'.

The last phase of implementation of the system concerns the definition of the reference sheets of the information to be developed within Microsoft Access: because of this, the

Fig. 6
Consultation mask of the DBMS.

lay-out has been set out of masks, composed of information boxes that refer to specific parameters contained within the database. In particular, sheets of five different types were composed and labelled on the basis of the themes identified:

1) General information: data sheets for the classification of the object investigated with historical references, archive images, etc.;

2) Problem analysis: evaluation of the general conservation status of the selected object on the basis of inspection and survey activities;

3) Analysis of the degradation of stone materials: data sheets on alterations and macroscopic degradation of stone materials with reports on visual investigations;

4) Analysis of conservative interventions: descriptive data sheets of interventions performed over time on the observed element, taken from historical archives, etc.;

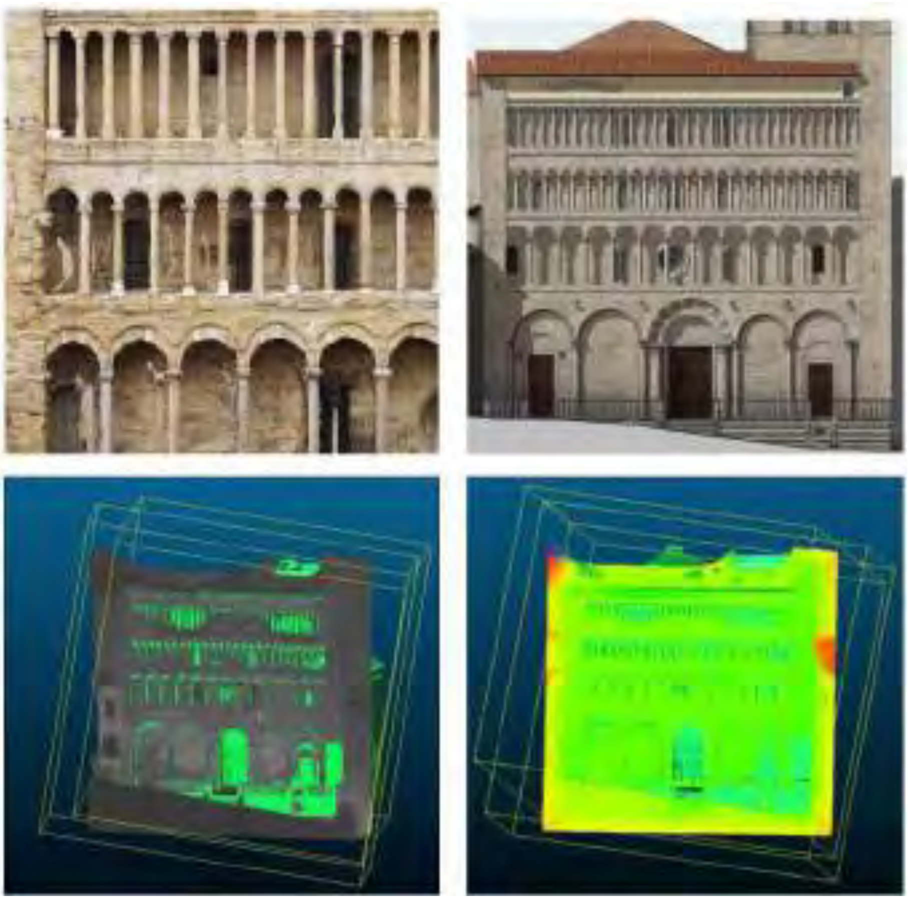
5) Geometric modelling analysis: geometric validation cards of the model objects and mapping of the deviations from the point cloud.

It should be noted that the choice of themes, which structure the information within the fact sheets, can be modified based on different needs for analysis and in relation to the specific conservation activities that it intends to develop.

4. Conclusions and future developments

opposite page
Fig. 7
Main facade: orthophoto, HBIM model and validation of geometrical accuracy by Cloud Compare software.

Building Information Modelling and Management tools and methodologies, applied to the field of cultural heritage, are opening new scenarios for the management of knowledge of the historical heritage built. The processes of modeling the geometric data from point clouds acquired with survey techniques by laser scanning and/or digital photogrammetry (Scan-to-BIM) have reached a substantial stability in the operating procedures, although improvements are expected in the automated generation of parametric



objects and in the vertical exchange of data between different disciplinary software. On the contrary, the implementation and management of alphanumeric and documentary information through H-BIM models are not yet in full agreement with the information processing, which characterize the activities of documentation and preservation of the built historical heritage. Through the definition of an operational workflow for the creation of a common data environment (CDE) structured in the forms of an RDBMS system powered by the H-BIM model, the present work has tried to experiment with a more appropriate ontological scheme for the information management of knowledge of a monumental historical complex. The results encourage further insights into the definition of more complex semantic models and information standards in the field of cultural heritage.

Credits

The laser scanner survey of the Pieve di Santa Maria in Arezzo was performed by Andrea Sadocchi and Matteo Valieri. The H-BIM model was created by Niccolò Arrigo, Valentina Cecchi, Tommaso Ciardi and Norberto Mincarone.

Author Contributions: conceptualization, B.C. and M.P.; methodology, B.C. and A.N.; data acquisition A.N. and C.T.; data processing A.N. and C.T.; writing-original draft preparation, B.C., M.P. and A.N.; writing-review and editing, B.C. and A.N.; supervision, B.C. and M.P.. All authors have read and agreed to the published version of the manuscript.

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THE PARISH CHURCH OF SAN LEONARDO IN ARTIMINO. INTEGRATED DIGITAL SURVEY METHODOLOGIES AND APPLICATION PERSPECTIVES FOR DOCUMENTATION AND VIRTUALIZATION OF THE ARCHITECTURAL HERITAGE

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Abstract

The paper describes the results of a research project aimed at the virtual reconstruction of the Parish Church of San Leonardo in Artimino (PO). The workflow of this research consisted of several phases of work, the first of which involved a thorough documentary investigation aimed at reconstructing the historical evolution of the architectural complex.

During the next phase, laser-scanning and SfM photogrammetric survey campaigns were conducted with the aim of documenting and acquiring the metric-morphological data of the religious complex according to integrated digital survey methodologies, in order to obtain a digital twin of the Parish Church. Finally, on the basis of the heterogeneous digital outputs developed by the integrated digital survey, a series of applications were tested, which on the one hand support actions to analyze, document and increase knowledge of the architectural site, and on the other promote the development of assets and virtual fruition systems to increase its visibility and attractiveness.

Keywords: digitalization, 3D Modeling, drone, photogrammetry SfM, cultural Heritage.

Fig. 1
Montalbano overview and identification of the Parish Church of San Leonardo and other relevant structures.

1. The Parish Church of San Leonardo in Artimino

The Parish Church of San Leonardo is located in Tuscany in the municipality of Carmignano (PO) to the south of the medieval borgo of Artimino, from which it stands in a separate and isolated position.

Placed on a plateau of a hill ridge, it belongs to the territories of Montalbano, a geographical area already very important in Etruscan times with many evidences found within it: sacred areas, necropolis and urban settlements, as probably also the Artimino one (Cerretelli et al., 1994) (Fig. 1).

The Montalbano area consolidated also during the medieval period its historical-geographical relevance despite a great fragmentation from a political and religious/diocesan point of view, which led it to be characterized by a proper system of parishes and suffragan churches scattered throughout its territory and subject to various bishoprics or centers of power (Somigli, 2021) (Fig. 1).

The presence of this extensive system of parish churches is officially documented in 998 AD, thanks to a diploma issued by Emperor Ottone III to the Pistoiese bishop Antonino to confirm the list of properties over which he had jurisdiction.

opposite page
Fig. 2
Aerial view of the Parish Church of San Leonardo in Artimino.and its surroundings.

The information within this important document thus offers a detailed picture of the parish churches present in Montalbano, among which can be mentioned those of Greti, Lamporecchio, Seano and also the very one of Artimino (Rauty, 1988).
The Parish Church of San Leonardo, built around the 11th century according to a typical and widespread Tuscan Romanesque style with Lombard-Ravennate influences, presents a basilical plan with three cross-vaulted naves, of which the central one is the largest, terminating in semicircular apses with parastas, blind arches and single lancet windows.
The façade, salient and accessed by a staircase, features a central and massive round blind arch and appears partially concealed by a 16th century portico (Fig. 2).
The masonry of the church and the bell tower leaning against it, is exposed and made of small irregular blocks of barely hewn local ochre sandstone (Somigli, 2021).
The site, which in its actual state consists of an ecclesiastical complex (church, bell tower and rectory with courtyard) and some nearby modern housing units, has retained its original structures (attributable to a single construction phase) substantially intact despite multiple interventions and restorations that have changed its appearance (Somigli, 2021).
The first major intervention, in the 14th century, involved the replacement of the wooden beam roof with ribbed cross vaults and the 'gothization' of the pillars whose corners were chamfered.

Fig. 3
Comparison views of the Parish Church between its pre-restoration state (A-B) and current state (C-D).

In the 16th century, as mentioned, a portico with quadrangular pillars and wooden roofing was placed against the facade.
In the late 17th century the interior wall faces and pillars were plastered and decorated with stuccos, later described as "a strange mixture of 14th century faux and Baroque" (Morozzi, 1966) (Fig. 3A). Between 1964 and 1971, with a radical restoration conducted by G. Morozzi, these plasters and decorations were removed, as well as some minor buildings leaning against the church, thus bringing to light the underlying Romanesque structures and giving the church an appearance as close as possible to the original one (Cerretelli et al., 1994) (Fig. 3).

2. Integrated digital survey methodologies

Together with the geographical and historical investigations conducted on the religious complex of the Parish Church of San Leonardo, an extensive metric-morphological documentation project was carried out based on the use of specific integrated digital survey methodologies. The choice of using different devices for data acquisition allowed, as will be seen, not only to obtain a faithful 3D virtual reconstruction of the object of study in all its elements, but also to develop a reliable and extensive range of digital assets aimed at different application perspectives. On such type and relevance Architectural Heritage it is indeed of fundamental importance to develop a heterogeneous database containing

opposite page
Fig. 4
Axonometric and exploded views of the complex obtained from integrated digital survey methodologies.

all the historical, metric, morphological and chromatic information of the current state of the asset, in order to establish a solid basis for documentation, diagnostic, virtualization or enhancement activities. (Fig. 04). These data were obtained over a series of digital survey campaigns carried out on site, during which acquisitions were conducted using methodologies based on Terrestrial Laser Scanner (TLS) and Structure from Motion (SfM) photogrammetry, the latter both close-range with professional photographic instrumentation and aerial with the use of a UAV device.

2.1. Acquisition and processing of TLS survey data

The first digital documentation activities of the Parish Church of San Leonardo involved the use of TLS technology. Specifically, a Z+F Imager 5016 instrument was used, a stationary phase-difference laser-scanner equipped with an integrated HDR camera. The latter allowed that the 70 scans taken in the exterior and interior spaces of the church complemented the metric data with the color data of the surveyed surfaces by the mapping on the point cloud related to each scan with a 360-degree panoramic photo of the surveyed environment (Fig 5A-B). Additional 40 scans, this time in B/W given the lesser architectural significance, were instead taken for the virtual reconstruction of the interior rooms of the rectory.

The large amount of data obtained from the laser-scanner survey campaigns were subsequently imported and processed within a specific point cloud management software, Leica

Fig. 5
Acquisition phase through TLS and processing of the global colored point cloud of the Parish Church.

Fig. 6
Capture phase through UAV (A) and photogrammetric processing using Metashape (B) and RealityCapture (C).

Geosystems Cyclone, through which the main steps of filtering, registration, certification and processing of the global point cloud were performed, a methodological workflow widely adopted by the research team (Lumini, 2021). This first activity made it possible to ensure a reliable metric-morphological basis that will be crucial for all subsequent ones dedicated to the virtual reconstruction of the church (Fig. 5C).

2.2. Acquisition and processing of SfM photogrammetric survey data

In parallel with the acquisitions by TLS, a series of SfM photogrammetric survey campaigns were also carried out through the use of various photographic devices and optics. For the close-range photographic captures, approximately 4,000, an Olympus OM-D EM-1 Mark II mirrorless camera was used, through which the exterior and interior faces of the church, as well as its entire floor, were surveyed. These detailed ground acquisitions were complemented by an extensive aero-photogrammetric survey of the entire Parish Church complex carried out with a DJI Mavic Air UAV device, through which about 700 photos were taken in manual mode and at different elevations (Fig. 6A). The acquired data were subsequently processed within two different photo-modeling software. In order to compare the outputs experimentally, the drone data were imported within Agisoft Metashape Pro, while the others within RealityCapture (Fig. 6B-C).

In both cases, through specific Structure from Motion (SfM) and Image-Matching (IM) processes, it was possible to obtain two types of assets: a set of textured 3D models useful for extracting orthophotoplans or for virtualization purposes, and a set of metrically descriptive point clouds of all those upper parts of the complex (such as roofs, windows, or steeple) whose data had not been acquired by the TLS (Ferdani, 2020).

2.3. Integration processes between methodologies

As noted above, the adopted acquisition methodologies provided different digital outputs. However, the data processing according to the individual methodologies revealed some issues, either related to missing data acquired from the laser-scanner or related to the metric-morphological reliability of the photogrammetric data developed from the close-range and drone photography campaigns. In order to overcome these critical issues, the data developed by the two digital survey methodologies were integrated with each other, specifically operating on the point cloud assets (Arrighetti et al, 2022).

The first step in these integration processes involved referencing the point cloud developed from the drone data with the more metrically reliable one processed by TLS. First, a series of clearly recognizable control-points were identified on the latter, whose coordinates

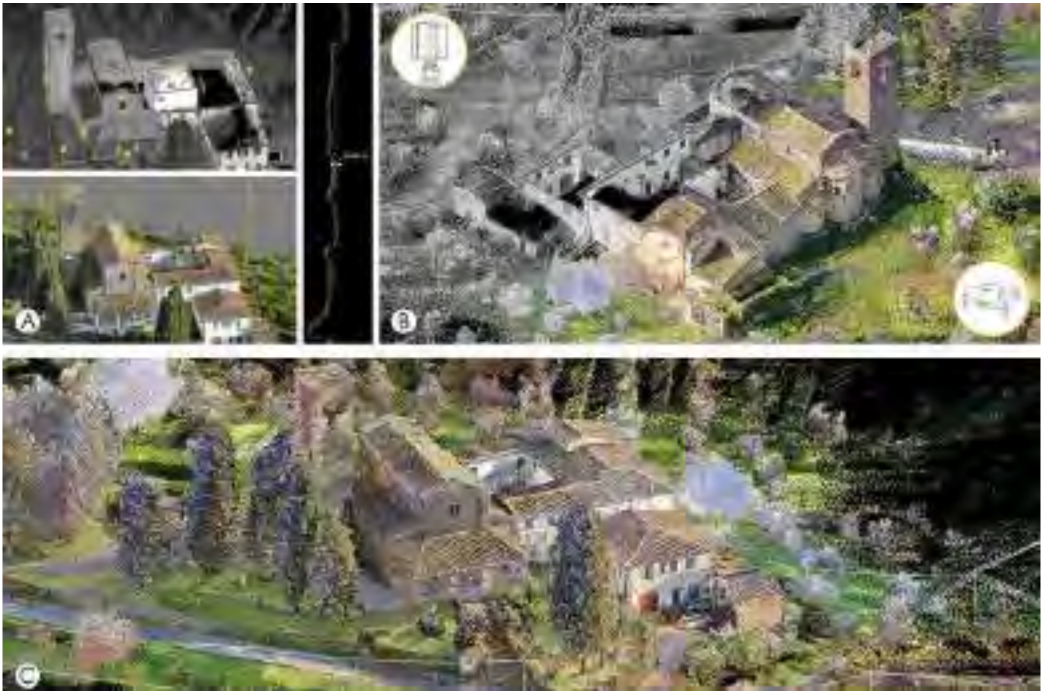

Fig. 7
Referencing between clouds (TLS/SfM) by homologous points (A-B) and integrated global point cloud (C).

were then extracted and associated with homologous points on the aero-photogrammetric point cloud (Fig. 7A). The latter, now calibrated and referenced according to the coordinate system of the one developed by TLS, was exported and inserted within Leica Geosystems Cyclone software, where it was aligned with the other ones already registered (Fig. 7B). After a check for any misalignment errors, it was possible to ensure a metrically reliable 3D asset, complete in every part and exploitable for multiple applications (Fig. 7C).

3. Application perspectives for documentation and virtualization

opposite page
Fig. 8
Potentialities of developing 2D graphical outputs intended for documentation and analysis purposes.

The results of the operative processes carried out during the research and integrated digital survey phases have provided an extensive database containing many types of information assets: historical-documental researches, 360° panoramic photos, technical graphic drawings, orthophotoplans, colored point clouds and 3D photogrammetric models.
Based on these elaborations, it is possible to identify as many digital application perspectives, which can be basically divided according to two purposes: documentation/analysis and virtualization/valorization.

As for the first line of research, graphical outputs such as 2D graphical drawings (Fig. 08A) allow in fact to identify and record on them the results of both diagnostic investigations, such as those related to the materials of the various elements or the surfaces decays present (Fig. 8C-D), but also the different evolutionary-constructive phases that the Parish Church and its masonries have undergone over the centuries.
On the other hand, 3D assets, such as colored point clouds, allow not only the creation of graphical diagrams (such as axonometric or exploded views) to document and make comprehensible the relationships and functions of the various spaces in the complex, but also the extraction of specific graphical visualizations, the so-called elevation maps, which describe the state of axiality of a wall compared to a vertical plane, through which the deformation state and structural instabilities can be analyzed (Fig. 8B).
Regarding purposes of valorization and virtual dissemination of the architectural site, digital assets such as panoramic photos or 3D photogrammetric models allow instead to increase knowledge and remote visit possibilities through specific virtual fruition solutions. Within this research project, two solutions were experimented. The first involved, following graphical optimization, uploading the textured 3D model developed from drone data within a specific online virtual visualization and navigation platform, thus making it accessible and measurable by anyone directly on the Web.

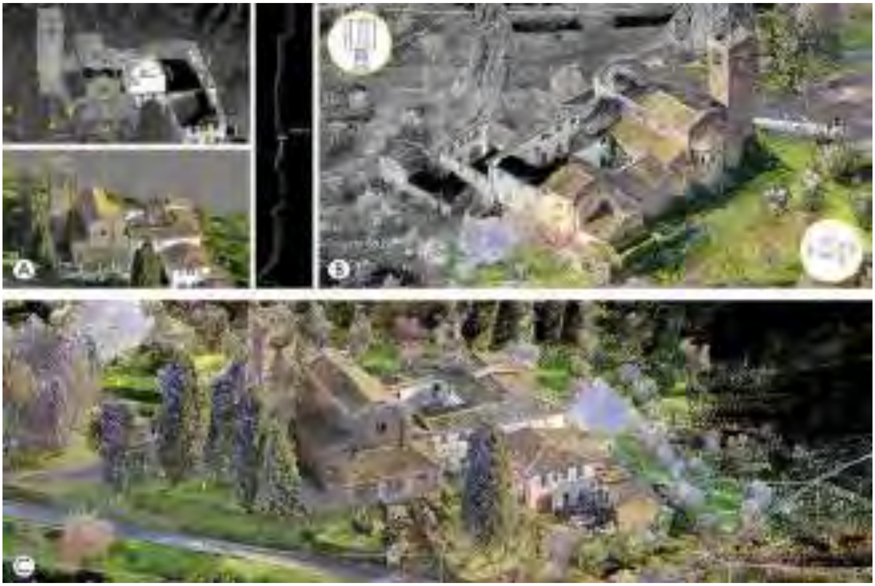

Fig.9
Potentialities of developing digital assets for valorization and virtual dissemination purposes.

Fig.10
Application perspectives schema for documentation and virtualization of the Parish Church of San Leonardo.

The second, instead, exploited some HD panoramic photos taken by the laser-scanner, which were uploaded within an additional online platform dedicated to the development of Virtual Tour 360. Within Theasys, the photos were connected to each other creating a sort of visit path, which was also enriched with information and multimedia assets dedicated to the storytelling of the Parish Church of San Leonardo. Finally, in order to make these digital assets effectively usable by anyone, links from the various web platforms have been associated with specific shareable QR-codes (Fig. 9).

4. Conclusions

The Parish Church of San Leonardo represents for Artimino and the surrounding areas a Heritage of valuable architectural and cultural quality; however, it appears evident both its lack of attractiveness and digital dissemination and the tourism potential it could offer if well valorized. The integrated digital survey conducted within this research project was intended to test a series of tools that on the one hand support actions to analyze, document and increase knowledge of the architectural site, and on the other promote the development of assets and virtual fruition systems to increase its visibility and attractiveness. The digitalization of the spaces and the artworks they contain is, therefore, not only a way of documenting and preserving the cultural and scientific heritage, but also a solution for the dissemination of the historical and architectural contents of the Parish Church, making them virtually accessible to a wider audience. The large amount of digital assets created, together with the application perspectives identified within this paper, allow the possibility of directing further future research aimed, for instance, at the development of App-mobile, Digital Museums and virtual fruition tools for the valorization of places that are poorly frequented or far from the main visiting routes, in order to promote an idea of widespread and more sustainable tourism (Fig. 10).

Acknowledges

The graphical elaborations present within this paper, as well as the operations conducted and the results obtained, were developed within a master thesis in 'Survey and Representation of Architecture and Environment' titled 'Integrated digital survey of the Parish Church of San Leonardo in Artimino. Methodological processes and application perspectives of the developed database' discussed by graduating student G. Limberti in July 2022 at the Department of Architecture (DIDA) of the University of Florence, with supervisor Prof. Arch. S. Bertocci and co-supervisor Arch. A. Lumini, who coordinated and guided the research and activities carried out.

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DIGITAL DOCUMENTATION FOR THE COMMUNICATION AND ACCESSIBILITY OF CULTURAL HERITAGE

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Abstract

This paper focuses on the possibilities offered by digital documentation to create tools for the dissemination and accessibility of the Franciscan Observance heritage. The two case studies have been selected for their particular characteristics, linked to the historical context of the Observance, the landscape-territorial context and their current use. The idea examined for the first case study is to allow individuals with reduced mobility to access virtually all the conventual spaces that are physically not accessible, solving the issue in a non-invasive way, exploiting the potential offered by the use of digitally acquired data to create a virtual tour. In the second case, the problem of the inability to access a site classified as a Portuguese National Monument was addressed. Thus, a temporary modular exhibition pavilion was designed to contain installations that provide information on the history and architectural development of the convent and fortress and can also be used by blind and visually impaired people.

Keywords: Franciscan Observance, Cultural Heritage, remote accessibility, virtual tour, tactile map

opposite page
Fig. 1
Aerial view of the Eremo. (Photo credits: Federico Ferrari, Marco Medici).

1. Introduction

This contribution deals with the results obtained in the final phase of the Project, focused on the analysis of the data collected during the study of the case studies and the project opportunities offered by them. The research methodology exploits historical and archival sources and integrated digital survey techniques to document and study the network of Observant convents and the routes that connect them for their conservation, protection, and enhancement. This paper illustrates two hypotheses for communicating conventual complexes — one in Assisi, Italy, the other in Caminha, Portugal — and making them accessible to users.

2. Research goals

Many of the complexes analysed by the F-ATLAS project have access problems: some are located outside the main tourist or communication routes, others are located in sites challenging to reach on foot or using transport, others have a spatial distribution rich in height differences and narrow passages, some are in a state of neglect or ruin, or are closed. Therefore, one of the project's aims is to identify guidelines for managing and processing digital data collected during survey campaigns, to produce digital elaborations that allow users to access places of interest virtually. Thanks to the potential offered by the datasheet census and georeferencing in the GIS database, it is also possible to correlate the case studies to create thematic networks of points of interest at the territorial level.

3. Historical framework and architectural features

The two case studies were selected for their particular relevance to the themes dealt with in the F-ATLAS Project and for their intrinsic architectural and landscape characteristics. The historical context in which both convents developed is closely linked to the events of the Franciscan Observance. Therefore, the two sites were considered valid case studies for formulating design hypotheses that would fit into the research of Heritage communication.

3.1. Eremo delle Carceri, Assisi, Italy

The Eremo delle Carceri is a sacred site located on Mount Subasio, near Assisi, Italy. It was established in the 13th century around a pre-existing chapel dedicated to the Holy Mary. The caves where St. Francis and his companions lived in seclusion can still be seen

within the sacred oak forest. The convent underwent architectural expansions by the Observant community, specially blessed Trinci and St. Bernardino of Siena, between the 14th and 15th centuries. The church of St. Bernardino, the refectory, and the dormitory were added during this period (Di Giampaolo, 2013; Mercurelli Salari, 2013). In 1602, the Eremo came under the Reformed friars' custody until the various Franciscan movements were unified in 1897 (Canonici, 1991). The Reformed friars worked to consolidate the architectural structures in the 17th to 19th centuries.

The Eremo has been recognised as a UNESCO World Heritage site since 2000 (https://whc.unesco.org/en/ list/990, accessed on 30 March 2023). The Eremo is part of the Umbrian romitorial complexes, along with other sites like S. Francesco a Tuoro, S. Maria della Spineta, SS.ma Pietà del Farneto, S. Bartolomeo di Cibottola, Scarzuola, Buonriposo, S. Michele a Baschi, Speco di Narni, and Romita di Cesi (Canonici, 1991). These complexes are strategically located near main cities and municipalities, emphasising widespread diffusion at the territorial level (Pellegrini, 1984). This choice of location served the religious communities' apostolic and meditative activities (Pellegrini, Paciocco, 2001;

Fig. 2
Aerial view of the fortress and convent of Santa Maria da Ínsua. Photo credits: Pietro Becherini.

Amonaci, 1997; Canonici, 1991).

3.2. Santa Maria da Ínsua convent, Caminha, Portugal

The Santa Maria da Ínsua convent in Caminha, Portugal, is one of the earliest Observance convents built in the country, along with three others in the Norte region. Founded in 1392 on a small island south of the river Minho mouth by Franciscan Observants from Spanish Galicia, it originated from an oratory built on the site of a pagan temple (Teixeira, 2010; Rodrigues et al., 2020). In the 17th century, the convent expanded and was surrounded by a fortress. However, in 1834, the Franciscans were forced to leave due to the dissolution of religious orders in Portugal. The Ministry of War managed the complex, followed by the Navy Ministry. In 1910, the fortress and convent were classified as National Monuments, but they are currently abandoned and inaccessible to the public. In 2016, a plan was made to lease the property for a lodging establishment, with construction adaptation scheduled for 2022-2023 (Becherini et al., 2022). The complex can be accessed by boat, with a ravelin protecting the main entrance of the fortress and four bastions and a wedge along the outer perimeter. Inside the fortress are military quarters and a powder magazine. The convent's buildings are arranged around a central cloister, with the church, chapter room, kitchen, refectory, vegetable garden, and sacristy distributed along its sides. The friars' cells are on the first floor. A digital survey in September 2021 revealed that the fortress buildings were well-preserved, except the military quarters that lacked roofs. The convent buildings were in poor condition, with the first floor inaccessible due to gaps in the wooden floors. There were signs of restoration using incongruent materials, and degradation on the walls due to water movement from ocean tides entering the structures.

4. Data collection

Integrated digital survey campaigns were carried out for both convents, with LIDAR and aerial and close-range photographic instrumentation. The purpose was to acquire reliable morphological and dimensional data of the internal and external spaces of the two convents and the surrounding context in compliance with the project's primary goals. Simultaneously, bibliographical and archival research was carried out to gather historical information about the evolution of the conventual complexes over the centuries and their relationship with the events concerning the movement of the Franciscan Observance (Cottini et al., 2023; Rodrigues et al. 2020). The methodologies employed were consistent with those used for the documentation of the other case studies of the F-ATLAS project and consolidated within the research team (Cioli, Cottini, u.p.; Cottini, Becherini, 2023; Soler et al., 2023; Volzone et al., 2023; Becherini et al. 2022; Cioli, Lumini, 2021; Bordini et al., 2021; Bertocci et al., 2020; Pancani, 2017). The raw data acquired were eventually processed in line with the project's specific objectives to obtain heterogeneous data: 3D point clouds, three-dimensional mesh models, and cataloguing data sheets – that can be used to investigate the collected material. The data is then correlated within a GIS database, which also provides geospatial information on the network of convents between Italy, Portugal and Spain.

4.1. Accessibility issues

The digital survey of the Eremo delle Carceri highlighted some critical access, mainly due to the volumetric increases made over time and the architecture's adaptation to the place's topography. Steep gradients characterise the distribution of the convent rooms. The paths that lead inside the refectory, to the cells of the friars on the upper floor, to the cave of St. Francis, and to the caves of the hermits within the sacred wood are connected by paths with strong gradients, irregular steps or passages reduced in height and width (Cottini, 2022a). The criticalities of access to the convent of Santa Maria da Ínsua appear evident considering its particular location: the transport service through small boats is managed by local companies and is available only at certain times of the day, depending on the tides, and on the island there are no paths dedicated to people with disabilities, nor refreshments and toilets. Access to the fortress's interior is managed exclusively by the association Diver (https://diverminho.

Fig. 3
Accessibility issues inside the Eremo delle Carceri complex. Credits: Carlotta Assirelli.

pt) and is only possible through defined routes to avoid unsafe structures. Considering that the entire complex will be converted into luxury accommodation in the coming years, it has been established that a remote-use system is the best solution to continue ensuring access to this protected heritage (Volzone et al., 2023).

5. The projects

The research focused on the possibility of using data obtained from integrated surveying techniques and historical documentation to create valuable products for the dissemination and accessibility of the two conventual complexes.

5.1. A virtual tour for the Eremo delle Carceri

The proposal for the Eremo delle Carceri includes the design of an interactive portal accessible both remotely via the web and on-site through touch-screen totems. The portal collects various data, including a virtual tour of the conventual spaces, historical and geographical information, multimedia materials, and details on how to reach the location. The data synthesises *in situ* and archive research activities, presented user-friendly for a non-specialised audience. The design model follows Garrett's experience design approach, prioritising the user's expectations and choices throughout the product development (Tosi, 2018; Garrett, 2011). Historical information is summarised and presented along a timeline, focusing on significant events in the Eremo's history, accompanied by images. The evolution of the convent is showcased through three-dimensional models, illustrating its progressive growth and changes over time.

opposite page
Fig. 4
Virtual Tour of the internal and external spaces of the Eremo delle Carceri. Credits: Carlotta Assirelli.

Accessibility information is presented on interactive maps, including access methods and cycling-pedestrian paths in Subasio Park and the Sacred Wood of the Eremo. The virtual tour employs spherical photographs connected along a defined path, providing a 360° view of the external and internal environments of the Eremo. Interactive info boxes offer additional information about the decorative elements and historical context of the settings. The virtual tour is especially important for enabling individuals with reduced mobility to virtually access spaces that may not be physically reachable (Cottini, 2022a; D'Acunto, Friso, 2022).

5.2. A pavilion for the convent and the fortress of Santa Maria da Ínsua

The pavilion design for the convent and fortress of Santa Maria da Ínsua aims to preserve the memory of this heritage, which is currently in a state of decay and will soon undergo significant changes, making it inaccessible. The pavilion consists of four identical modules. It creates a path that narrates the history of Santa Maria da Ínsua and provides information about thematic routes connecting it to other regional and national points of interest. The modules are made of mobile panels, allowing flexibility in appearance to suit specific needs and maintaining a connection with the surrounding area. The project focused on designing a tactile product for blind and visually impaired individuals to explore the spaces of the convent and fortress, understand their layouts, and learn about the original uses of the rooms. A tactile map was created using laser-cut plexiglass layers. The ground floor plan of the architectural complex was simplified and schematised to enable blind individuals to form a mental image of the represented architecture. The fortress and convent are visually contrasted through red and white plexiglass plates, respectively, with a distinguishable touch pattern applied to the fortress.

Fig. 5
The pavilion inserted in the context of the beach of Moledo (credits: Luigi Perrotta).

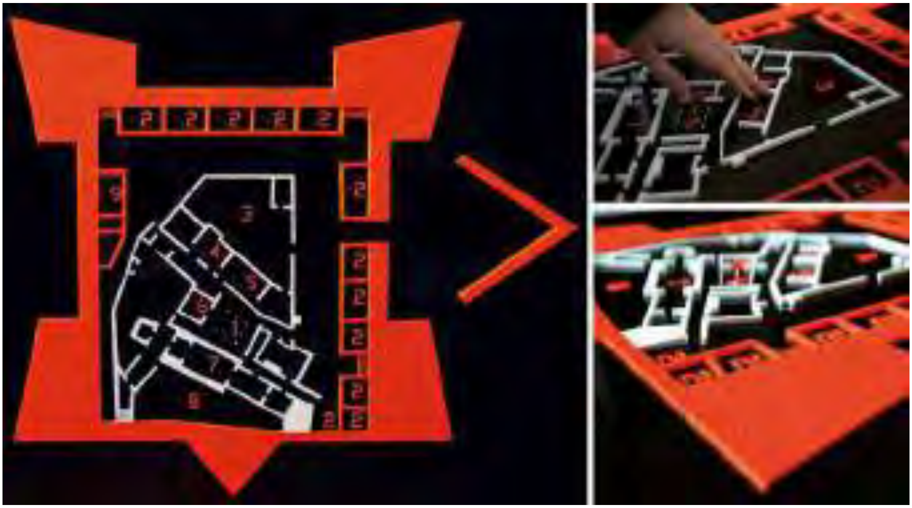
Arabic numerals and Braille labels identify the different functions of the fortified and conventual spaces, helping blind and visually impaired visitors comprehend the various architectural areas. The design of the tactile map considered ergonomic aspects, including the threshold for tactile sensation, which influenced the data synthesis and product dimensions (Cottini, 2022b). This approach ensures the map is user-friendly and enhances the experience for individuals with visual impairments (Gussoni et al., 2008; Riavis, Cochelli, 2018).

6. Conclusions

The collected material from survey campaigns plays a crucial role in improving the communication and accessibility of Heritage sites. For the Eremo delle Carceri, a well-designed virtual tour is advantageous for on-site and remote use. The virtual tour allows visitors to explore inaccessible areas to those with physical impediments while disseminating information about the complex to a broader audience. The design hypothesis focuses on a non-invasive solution to maintain the site's nature while enhancing accessibility. Similarly, for Santa Maria da Ínsua, digital data collection enables the availability of Heritage elements to the public, even remotely. The data can be processed to create products for people with disabilities, such as tactile maps for the visually impaired and blind (Cottini, 2022b; Sdegno, Riavis, 2020).

Virtual digital tools aim to complement real experiences, not replace them. Heritage virtualisation involves scientific digitisation, designing access to digital content, studying User Experience, and training specialised personnel for managing digital Heritage. Geolocation and GIS technologies can integrate isolated architectural complexes into local tourist routes, further enriching the overall experience for visitors (Cottini, 2022a; Cottini, 2022b).

opposite page
Fig. 6
On the left, the tactile map of the convent and fortress of Santa Maria da Insua. On the right, some map details show the different tactile patterns used (credits: Luigi Perrotta).



Combining these operations widens the means of knowledge dissemination, preserving the essence of Heritage while embracing digital advancements (D'Acunto, Friso, 2022; Clini et al., 2022).

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REVERSE MODELING PROCEDURES FROM DIGITAL SURVEY TO 3D PRINTING. THE CASE STUDY OF THE NATIVITY CHURCH IN BETHLEHEM

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Abstract

This paper shows the main stages of the procedural process of solid modeling and prototyping techniques developed from 3D descriptive databases of historical-architectural heritage. In particular, some research outcomes undertaken within the documentation project of the Nativity Church in Bethlehem, a UNESCO site since 2012, are examined. The experimentation was conducted in the DAda-LAB Laboratory of the Department of Civil Engineering and Architecture of the University of Pavia, where the research was promoted within the framework of a collaboration agreement with the Piacenti Spa company in charge of the restoration of the entire complex. Documentation activities for producing a three-dimensional database, obtained from the integration of point clouds produced by image-based and range-based instrumentation, promote and to investigate monumental architecture. Through reverse modeling methodologies, 3D databases and point clouds produced by digital surveys are converted into a 3D model that, optimized, segmented, and decomposed into portions, can be 3D printed. The printed models become useful for tactile and visual enjoyment of the heritage, promoting understanding of the formal components and articulations that govern the space. The printed model is thus the result of a critical process of analysis and synthesis of acquired and subsequently processed information.

Keywords: Reverse modeling, 3D printing, Nativity Church in Bethlehem, UNESCO.

1. Introduction

In the digitization age, the development of new documentation and communication methodologies has led to a transition of the 'real' into the 'virtual'. Indeed, new technologies have made it possible to transform parts of the physical world into three-dimensional virtual models. Today, a further stage of advancement makes it possible to close the 'real-virtual-real' loop in the documentation process. The return to the real form of the physical world is expressed through the transformation of databases into tangible models, solid reproductions of the object under investigation, appropriately scaled with respect to the original (Brusaporci, 2017). Consequently, the more complex the object, the more its reproduction will be guided by a specific design drawing, linked to the scale of representation and the level of detail to be obtained. The management of heterogeneous databases for the reverse modelling process will be even more complex. The use of multiple digital instruments (laser scanners and/or photogrammetric instruments), different point densities, missing data and the necessary interpretation of missing surfaces, all contribute to the 3D modelling process for Cultural Heritage (CH) aimed at printing at an architectural scale. The research, which deals with the articulated case study of the architectural complex of the Nativity in Bethlehem, aims to structure a reverse modelling methodology, replicable on other similar contexts, to obtain highly descriptive 3D printed models. These models must be capable of narrating the cultural heritage under investigation from a new perspective. These printed products offer an easy, direct and inclusive communication of the documentation and narrative of the heritage and allow potential visitors a diverse type of interaction with the asset. (Aleardi, 2016). The blind or visually impaired can benefit from a tactile experience thanks to the type of material used for 3D printing and the high level of definition of the material surfaces. From a cognitive point of view, 3D printing allows simultaneous understanding of the relationship between all spaces through physical immersion within the model.
At the same time, the possibility of dividing the prototyped object into various parts allows for a playful-educational use.

2. The model and the 3D printed model

The three-dimensional model, as a physical reproduction in scale of an artifact, is configured as a study tool for architectural design. It was once used as a useful and effective communication tool, capable of conveying the designer's ideas and facilitating the understanding of construction details, both to the client and the workers, during the execution of the work. One example is the wooden model from St. Peter's Basilica, designed by Antonio da Sangallo and executed by workers under the direction of architect Antonio Labacco (Docci, 2009). The model, on a scale of 1:30 with a total height of 4.68 meters and a base of 6.02 x 7.36 meters, could be opened at a central longitudinal section, so as to facilitate the understanding of the interior spaces and structural composition. From the model, it is still possible today to understand the architect's design choices and gain insight into the Basilica's interior and exterior decorative apparatus (Cadei, 1999; Benedetti, 2009).

The communicative efficiency of the wooden model provided Michelangelo, who succeeded Sangallo at the head of the site, to harshly criticize project, both for the lack of light provided by the prepared lighting systems and for the poor management of the interior spaces. Both Michelangelo and Brunelleschi used to make models to represent their design choices and focus attention only on certain aspects, useful for understanding the design idea. Brunelleschi realized models with careful detail, for almost all of his projects, focusing attention only on the aspects he deemed useful to communicate: the structure, decorations, or choice of materials. (Corazzi, 2021; Ricci, 2010) In this sense, the physical model was not considered a tool accessible to everyone since its realisation required time, craftsmanship, personnel and specific technical skills, which also implied high costs. Today, through digital technologies, it is possible to make an essential contribution to research, diagnosis, restoration, conservation, protection, communication and the dissemination and enjoyment of Cultural Heritage. The use of these technologies has increased exponentially, creating new scenarios and possibilities in the field of CH. The evolution of tools, methods, technologies, and software is reflected in the actions of surveying, production, and management of 3D databases, which have given rise to the latest 3D printing processes. Rapid prototyping given by three-dimensional printing is a technique that allows direct, mass production of material copies of objects characterized by even complex shapes and geometries. All this is made possible from a digital model obtained by reverse modelling processes. Printing the digital model takes place within an easily calculable timeframe and at a relatively low cost, if commercial printers are used. In recent years (Zastrow, 2020; Scopigno, 2017), this technique has received a considerable impulse due to the large market diffusion of desktop 3D printers, which are low-cost and compact in size. These use additive technology of the Fused Deposition Modelling (FDM) type, which enables the generation of real three-dimensional volumes through the superposition of material layers.

The process of realising the 3D reality-based and high-reliability print model assumes, as a starting point, the digital survey carried out according to established procedures (Parrinello et al. 2021).

Fig. 1 The Nativity Church.

The survey is followed by a post-production phase of the Scan-to-Mesh type, during which optimisation operations are carried out on the digital copy to obtain a 3D printable 'Manifold' model.

3. Case study

In order to optimize three-dimensional printing processes to propose a methodological protocol to be replicated on architectural heritage, the study was applied to the Basilica of the Nativity in Bethlehem: the complexity of the building combined with an intricate articulation of volumes and structures allowed for testing the processes leading from digital model to physical model. The Basilica is a major pilgrimage destination in the Holy Land and has been on the UNESCO World Heritage List since June 2012. This nomination in 2014 promoted the beginning of restoration work, carried out by Piacenti S.p.A., aimed at consolidation and cleaning operations of the surfaces. To support the conservation actions with drawings that represented the actual state of the Basilica, researchers from the DAda-LAB Laboratory of the University of Pavia and from the joint LS3D Laboratory (University of Florence) supported the company with a series of documentation actions preparatory to the restoration works. The surveys covered both the architecture of the Nativity and the mosaic floor and wall details (Parrinello, 2015; La Placa, 2019; Doria, 2020).

opposite page **Fig. 2** The documentation activities of the historic center of Bethlehem.

Due to the dimensions of the Basilica and the articulation of the spaces, the documentation activities were organised in different survey campaigns and with the use of different types of instruments, among them: Terrestrial Laser Scanner (TLS – Faro Cam2); Mobile Laser Scanner LiDAR (MLS – BLK2GO) and systems for photogrammetric acquisition (Unmanned Aerial Systems – UAS – DJI Phantom 4 Pro). The many phases of the survey have converged in a database characterized by high

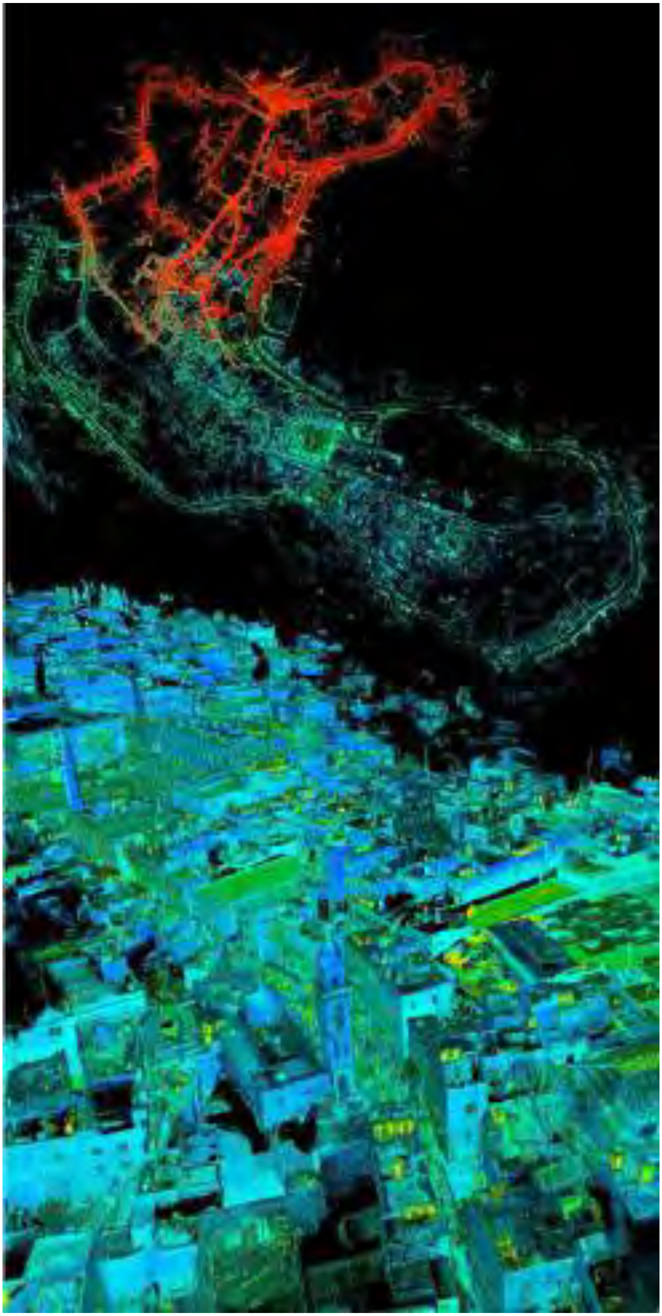

Fig.3
The result of the point cloud database of the historic center of Bethlehem.

opposite page
Fig. 4
For the organization of the printing activity, it was necessary to subdivide and break down the structure of the church into blocks.

metric and colorimetric reliability, from which two-dimensional technical drawings have been elaborated, useful for planning restoration works.
In 2022, once the documentation activities for the restoration were completed, Piacenti S.p.A entrusted the research laboratory DAda-LAB with the production of a 1:50 scale 3D printed model of the entire Nativity complex. The production of the model is intended for museum displays on the occasion of the travelling exhibition 'Bethlehem Reborn' organised to promote Cultural Heritage and tourism in Palestine and to advertise the restoration work.
The research project involved managing the pre-existing survey database to develop the digital model for three-dimensional printing. The process developed is that by reverse modeling: starting from the discretized digital data of the state of affairs (represented by the laser and/or photogrammetric point cloud), it was possible to generate an initial continuous digital model (mesh) through the application of semiautomatic processes. Subsequently, the model was optimized through manual processing, such as closing the holes automatically generated in the modeling phase, removing nonexistent artifacts generated by the automatic procedures, and subsequent 'stitching' of adjacent surfaces. Depending on the type of the source data, the post-production phase of the mesh model may require

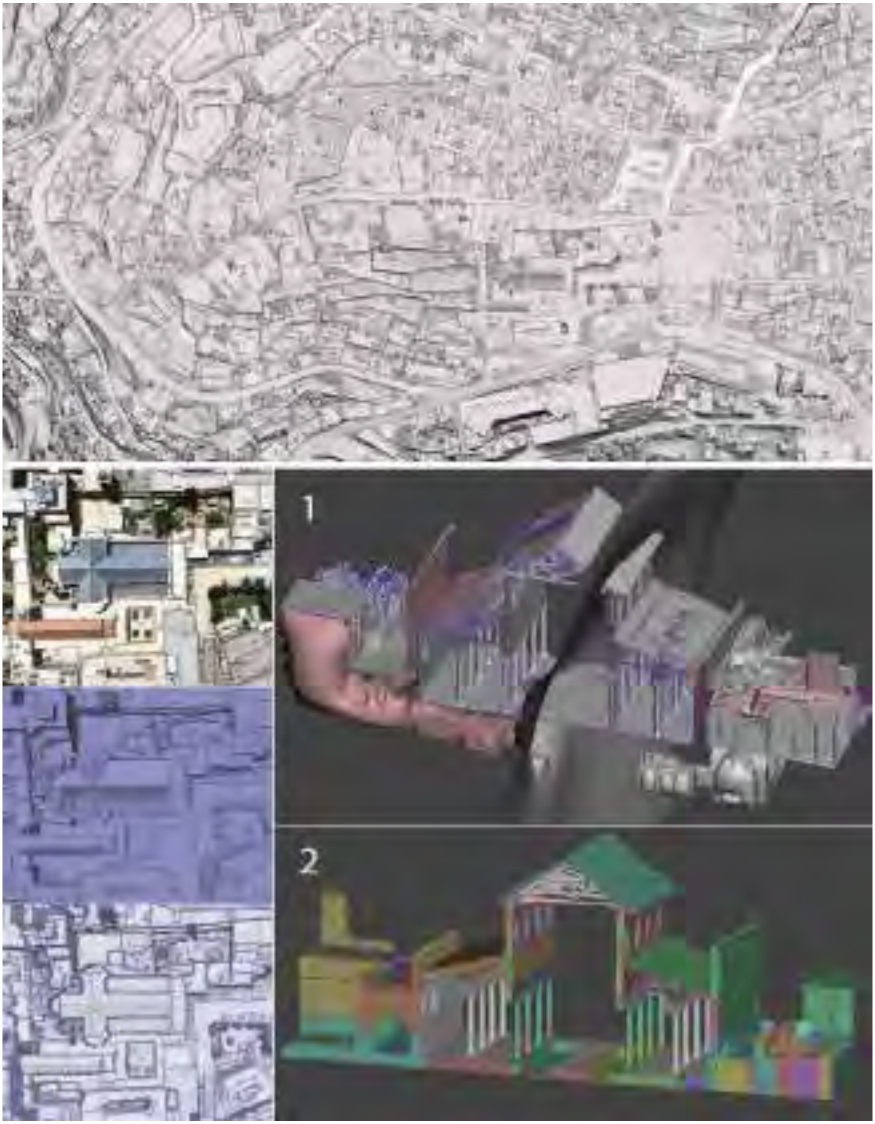

Fig. 5
The first phase involved the elaboration of the model mesh surfaces, according to two different scales of detail from the urban scale for reading the texture of the historic center to the detail scale for reading the individual architectural components of the case study of the church of the Nativity.

particularly different timelines; the process from a photogrammetric base includes the generation of an optimized but less morphologically accurate mesh, so it is more likely to produce nonexistent or erroneous features/objects; the survey obtained from the application of terrestrial laser scanners turns out to be more reliable and is the optimal basis for a better result from the geometry point of view, despite the fact that the data is more complex to handle. The optimal result is an extremely accurate, both in morphological and volumetric terms, capable of representing even the smallest detail elements of the artifact. The point cloud produced at the end of the survey campaigns was configured as a database with a total weight of 465GB, which was therefore complex to manage in its entirety. Therefore, it was divided into several portions, first into homogeneous areas: the underground caves, the roof and the central body. The central body was in turn divided into 6 strips each consisting of 4 blocks. The point cloud, recorded with Leica Geosystem's Cyclone Software, was portioned taking care to preserve an overlapping strip between adjacent blocks, an essential expedient for the subsequent alignment steps. The first cut was followed by post-production processes of the Scan-to-Mesh type: each individual block is transformed into a polygonal mesh through a process involving the use of different software (3DReshaper, MeshLab and MeshMixer), the main steps of which are listed below:

- Decimation of the point cloud
- Point cloud cleaning
- Generation of raw mesh models
- Integration of missing parts
- Mesh model optimization and defect removal.

The 'point cloud cleaning' phase required particularly extended timelines (about 2 months) due to construction scaffolding inside the church during the survey. These generated noises in the cloud, which were later converted into imperfections in the raw mesh model, also prolonging the optimization and defect removal phases beyond measure. When we talk about 'integration', we mean the replacement of parts or surfaces that were modified in the intervening period between the different moments of the survey, among which are: the excavations carried out to unearth the mosaics, the rebuilding of the vault, and the removal of scaffolding. In particular, for the integration of the roof, data from drone photogrammetry were used, through which it was possible to reconstruct the extrados of the roof aligned later with the model of the building. The generated outputs consist of a series of solid Mesh patterns, with a good degree of overlap (about 20% of the total volume) between adjacent pieces, then trimmed with a clean cut to create a fine joint, with sub-millimeter error (+/- 0.1 mm). For locations that are not accessible with TLS or

opposite page
Fig. 6
General and detail photographs of the model during the finishing phase after printing.

MLS such as the roof, the exterior surface of the rear façade, and other unreachable areas, photogrammetric drone (UAV) surveys were planned.

The processing of this type of data is faster than that of a laser point cloud, as the photogrammetric pipeline (in the Agisosft Metashape environment) already provides for generating a mesh model at the end of the process. The level of detail of this mesh is significantly less than that of one produced by TLS cloud triangulation but still acceptable for the scale of representation chosen.

The overall digital model of the entire Basilica was discretized into the sub-parts previously listed, thus subdivided to facilitate the reading and fruition of the final physical model. The different cuts were planned by first creating a vertical longitudinal section through a cut along the nave that, separating the Basilica in two, highlights the interior spaces of the naves. A second horizontal cut was made at a height of 3/8 of the column shaft starting from the base, thus allowing the upper part of the Basilica to be raised and show its floor plan and ceiling in detail, visible from the bottom up. Finally, a diagonal (diamond-shaped) cut was provided for the visualization of the floor plan of the caves. They are developed on different levels, and it was not impossible to choose a single plane of horizontal section to encompass all the rooms. For this purpose, a composition of inclined and horizontal cutting planes was designed, such that both the caves and the connecting stairs to the ground floor were sectioned.

The final result is a model with a base of 148 x 101 cm and 52 cm high, divided into six macro-blocks that can be divided into each other to facilitate the reading of the interior spaces. For the physical reproduction of the model, the printers present in the DAda-Lab and PLAY laboratories of the University of Pavia were used; these are 10 3D printers (Creality ender-5 Plus model) equipped with a 35 x 35 cm printing plate, counted among the largest desktop FDM-type 3D printers on the market. The size of the print platter sets the limit for the maximum size of each portion, making it necessary to divide any model into blocks with the base less than 35 cm per side. Each macro-block, in addition to general cuts designed to make the model 'accessible', has therefore been further subdivided at overhanging elements or complex areas to be printed. This makes it possible to reduce the material consumption for the temporary supports needed during the printing phase of the projecting elements and to optimize the quality of the final product. The overall model was divided into 132 pieces exported in OBJ format and converted to G-code printing format using Ultimaker's Cura Slicer software. The ability to have ten printers made it possible to reduce the actual printing time by running them in parallel.

The entire process lasted 7 months, starting from mesh modeling to 3D prototyping for which about 82 kg of PLA filament were used,(13) for a total of 9375 hours of printing and 2 months dedicated to the assembly and finishing stages of the model.

4. Conclusion

On the occasion of the itinerant exhibition Bethlehem Reborn, which has been exhibited both at the UNESCO headquarters in Paris and in a number of Italian cities since 2022, a installation has been planned in the halls of the Broletto building in Pavia, with a series of illustrative panels describing the digitization project of the monument and with the 1:50 3D printed model of the Nativity. The presentation of the model was designed following the exhibition logic of the Sangallo model: open along the central longitudinal section to allow visitors to simultaneously understand the complexity of the interior and exterior environments and understand their mutual relationships. Similarly, the elevation levels were separated, raising the floor level of the Basilica relative to that of the caves, so as to make the underground system visible. The prototyping process achieves, also thanks to this exhibition, one of the expected goals of the documentation project: to become a physical and tangible narrative of such an important historical and Cultural Heritage for humanity. The research results experimented on the Basilica of the Nativity complex partly confirmed the possibility of producing a physical model from a 3D database in a relatively short time and with sufficiently low costs. In fact, although the process of reverse modelling combined with rapid prototyping technology represents a new possibility for heritage knowledge and fruition, limitations and margins for process improve-

Fig. 7 Bethlehem Reborn exhibition display, from Paris location (left) to Pavia location (right) with poster (center).

ment must be considered. On the one hand, these concern the modelling process: the complexity and richness of decorative details and small architectural elements and components requires a careful analysis of the modelling steps and the choice of the print scale. On the other hand, 3D printing techniques and the tools dedicated to them are still relatively new and under development: for example, the limited size of the printing plate of commercial printers implies a forced division of a large and medium-sized model into several blocks. This procedure implies a joint between the assembled parts remains visible, which makes the model perceptually 'imperfect'. This can be overcome by using large industrial printers, which consequently increases production costs. However, it is perhaps appropriate to meditate on the meaning of that imperfection (Parrinello, 2012), that aspect linked to the specific action of the technician-craftsman that we find and appreciate so much in the wooden models of the 16^{th} century, and that allows us to re-appropriate the value of the draftsman's manual skill, a value we would never want to lose.

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THE USE OF HBIM AS A TOOL FOR DETECTING THE HABITABILITY OF THE FRANCISCAN HERITAGE BUILDINGS. THE CASE OF MONASTERY OF SANTA CLARA DE LA COLUMNA (BELALCAZAR, SPAIN)

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Abstract

The different technical and legal tools for heritage protection have made it possible for us, today, to enjoy important monumental complexes. The divergence lies in the artistic contexts in which, due to the genesis of their programmatic typology, they require habitation, as in the case of monasteries. This article collects the results of a long investigation, on which we have been working, and whose main objective has been to find a tool that allows us to continuously measure different indicators in which both the protection of the elements, and the capacity for habitation, are guaranteed. For this we have contextualized the research at the Monastery of Santa Clara de la Columna in Belalcázar (Córdoba), a monastery with the highest heritage protection in Spain, and which, in turn, accommodates a religious community. The results have allowed us to design habitability parameters, within protected heritage contexts.

Keywords: Monastery, heritage, convent.

Fig. 1
Aerial view of the monastery of Santa Clara de la Columna in Belalcázar (Córdoba), object of the study.

1. Introduction

The new graphic tools for the conservation of heritage have become fundamental instruments and increased in recent years with the appearance of both hardware and software patents; these tools are dedicated to meticulous data collection with exceptional detail. These technologies have allowed the documentation, analysis, detection and diagnosis of pathologies in heritage with a degree of accuracy never before seen. Parallel to graphic development, important database engines have made it possible to converge architectural systems and heritage realities with parametric structures, thereby supporting the accumulation and processing of objective data for the complex heritage reality.

These technological developments have had an important impact on the delimitation of heritage contexts as well as on determinations of degrees of conservation and deterioration. This objectification, accompanied by important graphic processes, has omitted essential elements such as habitability within protected areas. Being aware of the need to insert habitable contexts into the conservation of heritage and document, in parallel, the evolution of the conservation of these spaces, new and innovative incorporations are needed. That is the objective of the research synthesized in this communication, i.e., to establish a graphical and parametric tool that allows, at all times, the study of the evolution of inhabited heritage contexts. For this, we study the Convent of Santa Clara de la Columna in Belalcázar (Córdoba), which in addition to being an Asset of Cultural Interest, has a community of Poor Clare nuns who must inhabit the protected spaces.

2. BIM representation systems in heritage

In 2000, according to the Rilievo Charter, surveys were declared fundamental. The knowledge gained from and digitization of survey are approached from the heritage protection perspective through graphic expression, where the drawings reflect a process that should not only be valued for the result but also as a tool and method for recording thoughts that are developed in the transversality of architectural facts through the intentionality of models, the selection of information and the diverse and new dimension collected from the elements (González Pérez, 2018). Murphy et al. (2009) defined HBIM as a new historical structure modelling system that creates complete 2D and 3D models capable of including relative information beyond construction methods and material composition. The addition of technical, qualitative and quantitative information and the relationships established inside and outside through links to external documents characterize the potential of its use (Logothethis, 2015). Despite the rapid evolution of BIM, challenging research opportunities have arisen with regard to adapting to the requirements of existing buildings (Volk et al., 2014). Recent research has focused on HBIM methodology beyond the result, including research management, conservation activities and information dissemination. The understanding of the complex heritage reality of spaces such as Cartuja de Jerez (Castellano Román, 2017) regarding landscape and historical and constructive identification has allowed not only the contemporary registration of this property but also generated new distinctive information with transversal contributions. Consequently, it is essential to reflect on how, in relation to an HBIM survey, the development of a library of interactive parameters is illustrated, subject to the variability of objects and spaces based on the historical dimension, their behaviour and the need for master plans to describe and protect them, as is the case of the Archaeological Ensemble of Itálica, whose research objective (Pinto Puerto et al., 2012) was justified in the need to create an exhaustive and flexible document that would codify the heritage reality and in turn allow the addition of properties included in the trace of the cartographic base. The needs of the interested parties are manifested beyond the professionals of the AEC industry, as HBIM studies have focused on the graphic point of view, containing the fluid participation of other professionals (Garagnani, 2013). The implementation of HBIM still requires

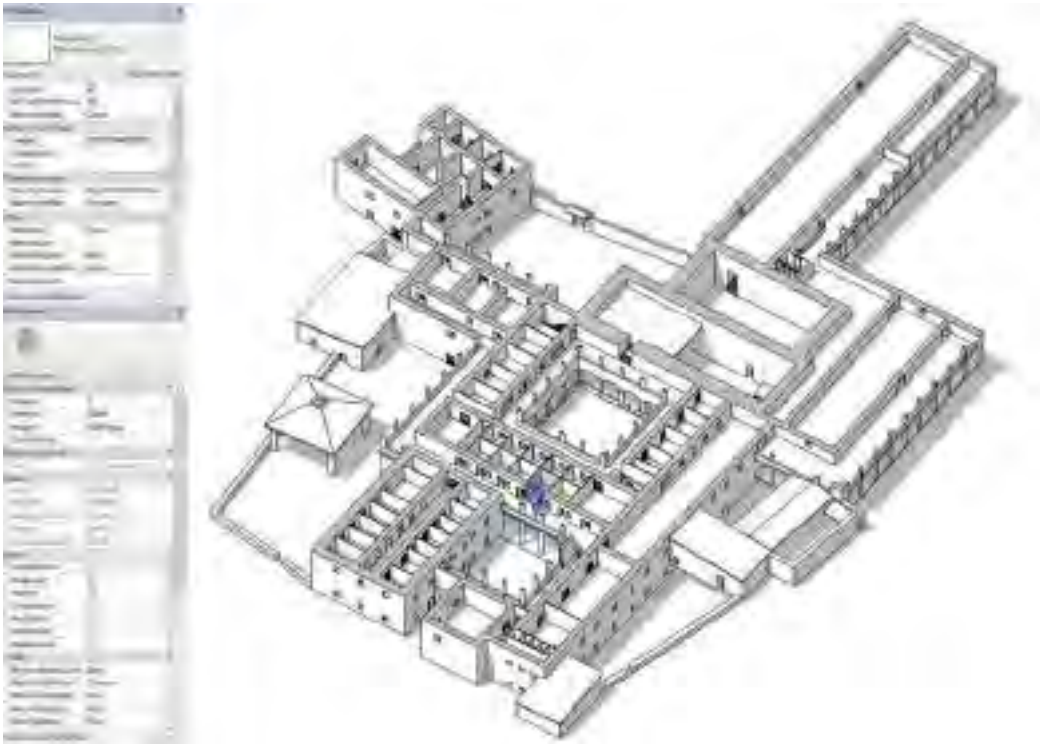


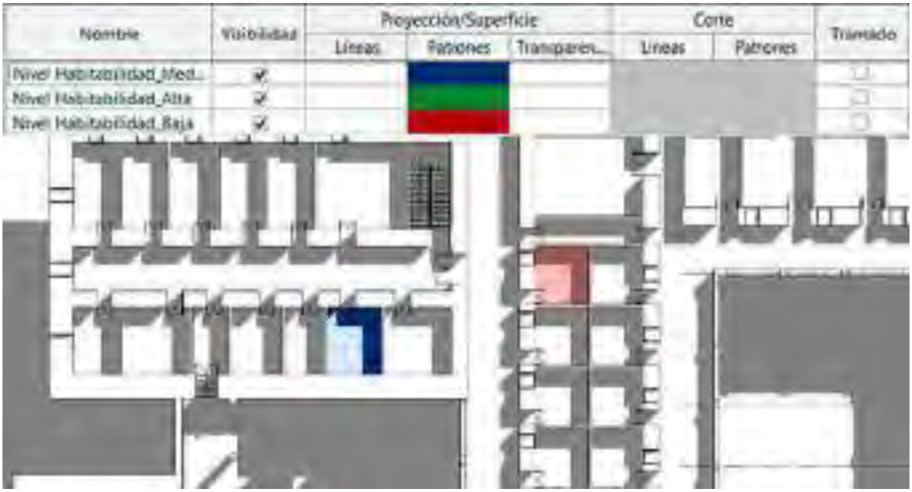
Fig. 2
Image of the process of digitization of habitability parameters in the heritage context of the Convent of Santa Clara de la Columna in Belalcázar (Córdoba).

opposite page
Fig. 3
Comparison through the visualization of the habitat level parameter in a monastery cell.

a methodological debate and practical experimentation to apply this type of documentation in a broader process of heritage conservation and maintenance (López et al., 2017).

3. Graphic support as an analysis tool

Therefore, the question that arises in this research is not the achievement of high-precision three-dimensional BIM modelling but the exploration of the possibilities of the tool in the field of architectural survey and representation as a way of knowing a heritage property in relation to its contemporaneity. In this way, it focuses on developing and implementing those parameters that allow managing patrimonial and habitability information. When modelling a new building, BIM-based systems provide parametric objects of generic shapes, ordered by type of family, which are easily adaptable to each specific case. In relation to heritage buildings, current object libraries are very limited and therefore make it difficult to achieve a satisfactory representation of architecture (Alcinia Zita, 2021).



To correctly analyse all the aspects related to the reality of the monastery, a constructive analysis is necessary given the traces and historical growth, the constructive solutions adopted and the behaviour associated with the forms of life in the space.

In relation to the method used, there are two aspects. First, several HBIM surveys were documented to carry out a critical analysis of the process used and the assignment of information, and then, we conducted our own survey. To erect the convent, the case made by Manuel Castellano Román (2017) has mainly been followed. Similar to the characterization of spaces by levels (urgency, conservation, vulnerability and visitability) being derived from a previous definition of the construction elements, this research proposes in parallel to carry out a characterization that allows evaluating the level of habitability of a space within a heritage context. The dimensional and constructive definition and the heritage characterization through the creation and assignment of parameters related to pathologies, state of conservation, interventions, etc., allowed an objective reflection on aspects related to the comfort, safety and accessibility of living spaces. These parameters are defined from the technical code that governs the requirements of living spaces and housing conditions that the WHO contemplates in its environmental consideration of the person.

4. Graphic parameters of coexistence between heritage and habitat

The parameterization of elements and spaces of the model has allowed the objectification of the technical characteristics to proceed to the parameterization of spaces. This succession allows a filtering and deep understanding of a reflection on the space of architecture and its

Fig. 4 Phase and parameters associated with a cell (room).

behaviour through graphic representation. The parameterization of the patrimonial and housing levels of the convent have made it possible to demonstrate the already indisputable reality of guardianship and the domesticity and practicality of a space whose maintenance is not only based on its protection but also on its use derived from the complicity of the community that inhabits it.

As a consequence of this scalar definition of the material volume to the empty space that it encloses, deficiencies have been detected in the habitability of certain spaces directly related to factors such as the type of protection, the demand for environmental conservation of their finishes, the presence of elements that prevent accessibility and, in contrast, others that, despite being in the same patrimonial register, manage to converge in the common operation.

5. Conclusions

The representation and visualization of heritage beyond a traditional survey by means of parameterization as a method of the objectification of architectural realities and as a tool for identifying, cataloguing, measuring, visualizing and comparing aspects has allowed observations of the relationship between the construction and the interior behaviour of the complex 'city' that has governed its evolution.Through the development of new research vectors applied to heritage in parallel to habitable space, we have determined patterns of behaviour that have allowed us to make spaces for daily life compatible with maximum heritage protection. The graph of all these spaces, together with the deep development of new parameters, has been the main objective from which we have been able to analyse all the results obtained.

Credits

This publication is part of the I+D+I project US.22.04, financed by the Junta de Andalucía, through the Secretaría General de Vivienda de la Consejería de Fomento, Articulación del Territorio y Vivienda ; and PID 2020-115786 GB-100 research project, funded by MCIN/AEI/10.13039/501100011033.

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ROMANESQUE CLOISTERS. ECOSYSTEMS OF DATA AT THE ROOTS OF EUROPEAN CULTURE

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Abstract

144 small columns punctuate the cloister of Sant Cugat (12^{th}-13^{th} century, Barcelona, Spain). As many are the capitals, redundant with ornamental motifs alternating with zoomorphic and phytomorphic ones. The considerations that lead to the sculptures being anything but a succession of bizarre whims are recalled via a remotely accessible information system or search engine. Within a spherical panorama, clicking on the predefined spots, it is possible to visit the virtual gallery in 3D and thus the metadata linked to them. This article discusses the opportunity to organise an ecosystem of information that can be consulted from within a dynamic environment in which the user can interact with 3D digital models and obtain thematic answers.

Keywords: Common Data Environment (CDE), Benedictione Cloisters, Sant Cugat del Vallès

1. Introduction

At a ratio of 18 per side, the cloister of the Sant Cugat del Vallès abbey (12th-13th century) is punctuated by 72 posts of twin column. Twice as many are the capitals redundant with zoomorphic and phytomorphic decorative motifs. Improbable at first glance to discern a logical connection between what appeared to be a kind of extravagant bestiary. However, there are several considerations that lead to question the reason for such decorative fantasy in a mystical place configured in the image of the Heavenly Jerusalem (Gen. I) dedicated to prayer and reflection (Pistilli, 1993). Indeed, by the time Councillor Guillem de Claramunt allocated the sum needed to complete the work on the cloistered enclosure (Rius i Serra, 1945, vol. II, doc. no. 456; vol. III, doc. no. 118 p. 319), Bernard had been gone for a good thirty-seven years and with him the rigour imposed by the Reformed Rule (as in a letter sent to his cousin Robert of Châtillon in 1124). Whether one wishes to sustain the subjective taste of the stonemasons or to consider them functional to the Christian catechism, it is necessary to broaden one's reflection to understand the reasons for the characters that make the cloister of Sant Cugat engaging and mysterious.

2. Theory

'Modern man', writes Marius Schneider (1903-1982), an expert in music, archaeology, art history and natural philosophies, "barely perceives the great inscrutability of the acoustic world, the polychromy, polyrhythm and linear force of sound from which the ancient cosmological legends made the visible and tangible world proceed" (Schneider, 1976 p.13).

Trained in the school of Julius Schlosser (1866-1938), Schneider offers an unprecedented interpretation. In fact, he researches and argues that, starting from the central garden opening located in the east gallery of the cloister of San Cugat, the actions carved on the capitals demand different but mystically related ideological lines. The mimic language and the pitch of the vocalisation of certain species of mythological animals recall the symbolic characters perfectly superimposable on the same sculptures.

By drawing the traces of an idiom, in terms of its mathematical structure and psychological nuances, "more perfect than Greek, richer than Latin and more exquisitely refined than both" (Dandekar, 1987-2005, pp. 9555 and following), Schneider brings the musical attributes of the mythological sculptures and an archaic philosophy to the attention of contemporaries. In this perspective, the iconographic succession not only materialises the score of the Iste Confessor (the Gregorian chant articulated in the version dedicated to the patron saint found in the abbey) but a perpetual calendar within which narrative fragments can be decoded at different levels of metaphor, profane and religious (Rossi, 2014). Clear are the premises, precise the sources, testable the procedures adopted by Schneider verified in Catalonia in two other coeval cloisters (Schneider, 1976, p. 13).

3. Thesis

Not at all willing to enter the merits of controversies aimed at proving the musical nature of the capitals or their metaphorical meaning, the topics discussed move from disciplinary curiosities. First, they aspire to make figures and sounds experiential to follow the reasoning entrusted exclusively to written texts, and then to transport the semantic richness assumed by the scholar within a space of man-machine collaboration. By shortening the distance between past and present, the visitor-user inspects and understands the supposed direction, put in place with the means of the time, to evolve, with today's systems, towards an understanding of the identity of the 'place within a place'. Imagining an information space will allow the dissemination of an inherited good, a premise for any project of safeguard and protection, while the related telecommunication services will support the comparison with the coeval cloisters of Girona and Ripoll – with the aim of evoking the extraordinary fecundity of the relationships developed along the Pilgrims' Ways. A cultural vision of the period will make it possible to conserve for 'future memory' the (im)material characters stratified on the cloisters while at the same time enhancing the heritage that, in the space and time in which it was achieved, contributed to forging the identity of Europe (Lopez, 1966).

4. State of the Art

The evolution of hardware and software linked to the services offered by the shared network (internet) has led to a revision of the communication paradigm. In the new millennium, it is telecommunication and teleportation services that are at the centre of considerations (de Luca, 2019; 2020). The accessibility and thematic sharing of data, in space and time, benefits learning by promoting actions that the media, including those dedicated to the service of heritage, do not fail to multiply. Consequently, the focus of Representation has shifted from describing the physical characteristics of the studied object to the context in which it is embedded to design digital environments in which knowledge can be 'capitalised'. Within human-machine collaboration spaces (CDE, Common Data Environment), the user learns and understands the background to explore its functionality with the help of multimedia interfaces (visual, auditory, tactile) and/or linear or map indices. Emphasising the connections, the user follows interests, aspirations and desires by superimposing real and artificial with a different degree of truth (Banfi et al., 2023).

Fig. 1
Virtual Museum interface with a view of the cloister panorama.

To this end, prodromal is the survey of the dimensional, functional and figurative characteristics of the abbey cloister, then the photogrammetric survey and digital reconstruction of the capitals. Tools and methodologies tested in the error coefficient offered the opportunity to generate photorealistic models. The digital 'copies' (digital twin) were used for a museum tour: a virtual gallery of textured 3D models can be accessed from a computer or mobile device (Fig.1).

The interactive and immersive use of the 'voiced' capitals refers to a hypertext structure of documents and metadata (Cabezo and Rossi, 2017). Despite the excellent functionality of the freely used platform (https://sketchfab.com/), where the link does not exist, there is no specific information or additional knowledge. Hence, the opportunity to improve interactivity and information sharing.

5. Results

In step with the times and in line with the most recent guidelines for the Safeguarding of Heritage (Unesco, 2003 et seq.), the representation of the (im)material characteristics of the cloister of San Cugat is conducive to reflecting and experimenting with supportive, comprehensive and integrated modes of communication. Involving the participation of an extended community is an imperative in our time. The success of pedagogical, social and economic programmes depends on it (Cerquetti, 2015, pp.247-269; Adachi et al., 2022; Marks, 2022). For this purpose, a traditional web is not sufficient, but instead a 'dynamic' web spectrum of applications with alternative paths, whether simple or complex.

These, unlike the previous applications, require a geography of data that can be adapted to the needs. Data 'ontologies' are managed by algorithms designed to improve machine behaviour: different modes of preferences, from the possible virtuous outcome of connections, are conveyed to self-enriched information carriers (De Luca, 2020b). Machine Learning sift through the 'traces' left by users, transforming their requests into goods or activities of an intangible nature to be supplied and sold.
Therefore, in systems capable of interacting with the users, we see the possibility of making individual research dialogue with data sciences. Raising the interest of an enlarged audience is the prerequisite for proper digital operation (ICOM-UNESCO).
In our case there are two characteristics that attest to the emblematic validity of the case study: the copiousness of ideological lines taken into consideration by the Alsatian scholar and the active participation of the monk who, invested with participatory responsibility, is transformed into a 'user' of the cloistered space. With guided synesthesia, he transposes, elaborates, chooses, undertakes paths that, although oriented towards the success of a predetermined end (salvation history), imply – in their becoming – a sort of flowing energy.
This informing criterion brings the experience of the contemporary user closer to that of its predecessor. The semantic richness of the cosmogonic, doctrinal, narrative, mathematical musical themes is revealed by the conventional codes that correct programming assisted by intelligent machines can render and transform into 'intellectual levers'. Orienting intersections, additions and subtractions, is the culture of the Middle Ages at that time based on the same scientific foundations: artists and men of letters, influenced by natural forces, in particular the planets (Abelson, 1965), linked theology and philosophy to the mathematical sphere in the Ars Musicae (Casiodorus, 5th century). Scientific and narrative themes are related by articulating the '*quadrivium*', i.e., the science of arithmetic, astronomy, geometry and music, with the '*trivium*', grammar, dialectic and rhetoric (Boethius, Prologue to the Institutio arithmetica, Book I, 1.1). Gestures and zoomorphic vocalisations are thus the signs of a system of shared correspondences in the culture of International Gothic. Moving from the description of events to philosophical conceptualisations, the sculpted actions articulate, in a simple and complex manner, a conventional language that is nourished and enriched by personal experience. Making use of the aids offered by programming in Visual Basic, an event-driven language, object-lists are managed by a single toolbar so that a sequence of notes that can be sung by vocal emission alone (Gregorian chant), reproduce musical phrases in the version dedicated to the patron saint (Rossi, 2014). The notes recalled by means of their wavelength are correlated with the colours and the succession of actions carved in succession (Fig. 2).
The conclusions were transcribed into a graphical-visual interpretation useful for the

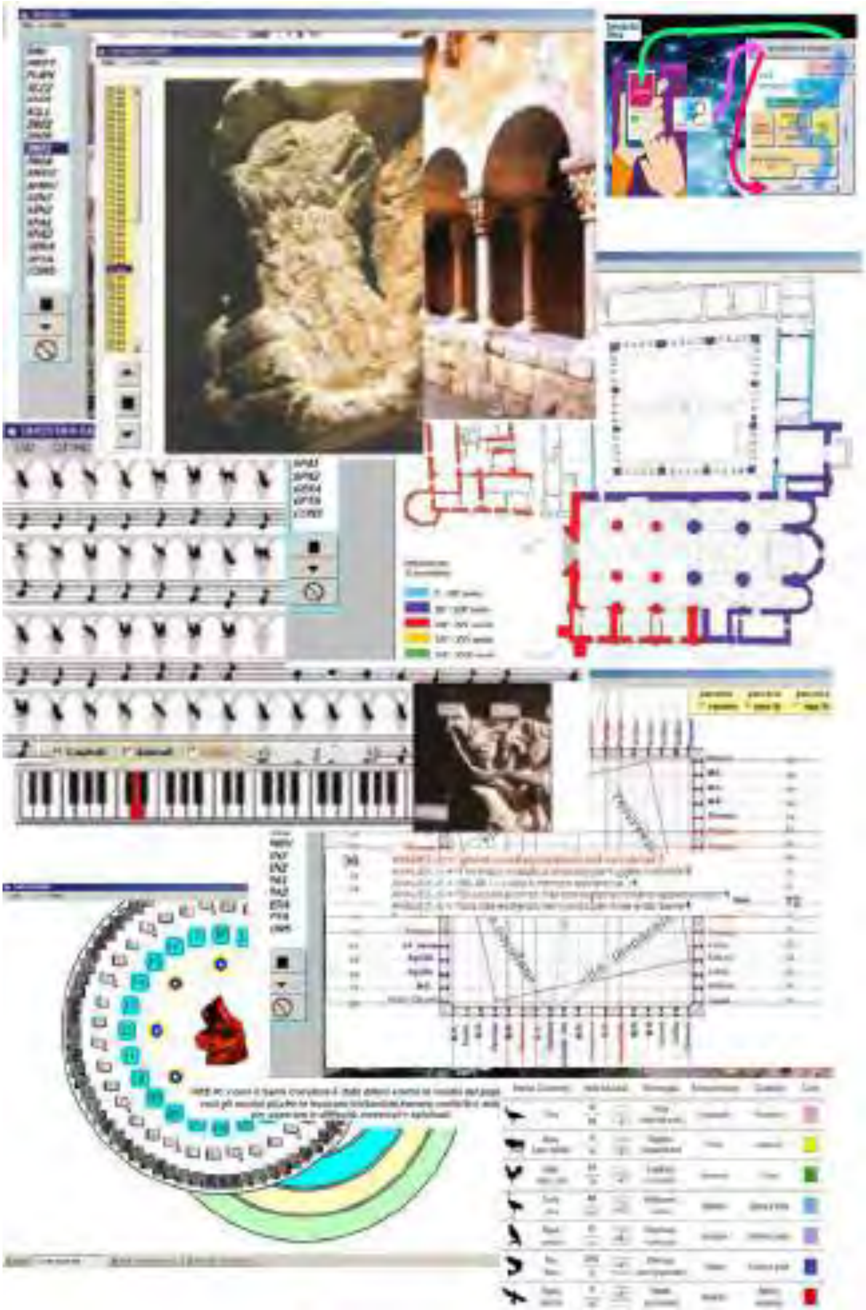

Fig. 2
Visual Basic window. Intersections of information with sinoptic.

computerised representation of the capitals, revealed in the light of the thematic analysis as 'nodes' of exchange between transparent and ethereally superimposed contents. As dated as it is, the system allows for the verification of the correspondence between the sculptures and the decoding of the basic vocabulary. The visitor's neural network is entrusted with complex correlations that an intelligent system could simulate. In this case, the programmers assume strategies from which the machine extrapolates basic rules that it applies, when stimulated, to choose the correct output.

Of computer competence is the ability to organise 'intelligent' paths and trajectories, while, of relevance to Representation remains the opportunity to extract-abstract qualities to designate visually composable semantic elements within an appropriate computer space (Marks, 2022). For this purpose, a traditional web is not sufficient, but instead a 'dynamic' web spectrum of applications with alternative paths, whether simple or complex. These, unlike the previous applications, require a geography of data that can be adapted to the needs.

Data 'ontologies' are managed by algorithms designed to improve machine behaviour: different modes of preferences, from the possible virtuous outcome of connections, are conveyed to self-enriched information carriers (de Luca, 2020b). Machine Learning sift through the 'traces' left by users, transforming their requests into goods or activities of an intangible nature to be supplied and sold. Therefore, in systems capable of interacting with the users, we see the possibility of making individual research dialogue with data sciences. Raising the interest of an enlarged audience is the prerequisite for proper digital operation (ICOM-UNESCO). In our case there are two characteristics that attest to the emblematic validity of the case study: the copiousness of ideological lines taken into consideration by the Alsatian scholar and the active participation of the monk who, invested with participatory responsibility, is transformed into a 'user' of the cloistered space. With guided synesthesia, he transposes, elaborates, chooses, undertakes paths that, although oriented towards the success of a predetermined end (salvation history), imply – in their becoming – a sort of flowing energy. This informing criterion brings the experience of the contemporary user closer to that of its predecessor. The semantic richness of the cosmogonic, doctrinal, narrative, mathematical musical themes is revealed by the conventional codes that correct programming assisted by intelligent machines can render and transform into 'intellectual levers'.

Orienting intersections, additions and subtractions, is the culture of the Middle Ages at that time based on the same scientific foundations: artists and men of letters, influenced by natural forces, in particular the planets (Abelson, 1965), linked theology and

philosophy to the mathematical sphere in the *Ars Musicae* (Casiodorus, 5^{th} century). Scientific and narrative themes are related by articulating the '*quadrivium*', i.e., the science of arithmetic, astronomy, geometry and music, with the '*trivium*', grammar, dialectic and rhetoric (Boethius, Prologue to the Institutio arithmetica, Book I, 1.1). Gestures and zoomorphic vocalisations are thus the signs of a system of shared correspondences in the culture of International Gothic. Moving from the description of events to philosophical conceptualisations, the sculpted actions articulate, in a simple and complex manner, a conventional language that is nourished and enriched by personal experience.
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6. Discussion

In trying to look at the material characteristics of the cloister to see the intangible contents to be re-presented, reflections emerge that creep in between the folds of the arguments, 'understood' rather than 'defended' in their reciprocal deep motivations. The Alsatian scholar interweaves knowledge in a way that cannot be replicated in current times given the specificities of the disciplines involved. Of interest is the guiding criterion used to involve emotional and ethical aspects and thus promote, beyond reason, spiritual enrichment. In the psycho-physical unity, *quantum* mathematics has recently found in its explanations a return to an overall dimension that is not merely logical deductive but inclusive of cognitive experience. In this way, a vision of the history and philosophy of science is renewed, launching the challenge for a new alliance between man and nature. In drawing all the consequences from the Studies on the Rhythm of Three Catalan Romanesque Cloisters, one realises that the everyday cultural world, history and its values falter (Zolla, 1992, p. 372). A modality that finds a hypothetical unity in the man-machine interaction, a platform designed to collect and order model-documents to schedule the phases of a path that provides consequential and concrete outputs, inductively verifiable.
A few strings of rules if managed by a computer and used in a multimedia, multi-channel, multi-modal manner, offer almost inexhaustible potential for the human brain. The ability to restore parts of the truth and interact and reconstruct with interrelationships,

finds in Artificial Intelligence unforeseen solutions that are difficult to foresee for those who are caught up in the habit. They are also enlightening for those who are called upon to give birth, figuratively or literally, to something that does not exist but is potentially present in physical reality, analysed, remediated and thus re-presented in order to share and make interoperable the outcomes and potentialities in itinere.

7. Future work

The study appears mature for an interdisciplinary strategy that by leveraging a shared and interoperable strategy promotes cultural, social and economic renewal. The theoretical-methodological reflections on the 'Digital Heritage' and its implications urge to 'Re-mediate' (Cameron and Kenderdine, 2007) aspects to make the present dialogue with the histories and memories of the past. This is a challenge for the current research that looks at the healthy complexity envisaged by Schneider as a stimulus to master the problem of 'vision' (Eismann, 1992, p.1), i.e., to combine personal research with data science, to "imaging heritage" rather than to observe passively 'a heritage of images' (Brusaporci 2023).

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THE ORIGINS OF CHRISTIANITY.
MONASTERE DE SAINT CLAIRE, NAZARETH

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Abstract

In the cradle of early Christianity, Nazareth, an important historical site that resisted the last century's urban aggression, houses in a setting of extraordinary modernity a Monastery of the Poor Clares. The work of Pierre Vago on the Colle del Tremore, perfectly centered in its being an example of modern architecture declined within a particular functional context of religious type, shows today the limits of the passage of time. The cognitive and documentary investigation of the artifact allows highlighting not only an almost unknown work of the French author but also consolidating a thought concerning the relationship between the solid type of the claustral system and modern architecture as a vector of reinterpretation of design practices inherent in modernity.

Keywords: Nazareth, Monastery, Clares.

Fig. 1
Pen-and-ink drawing of the previous convent in 1898, unknown author.

opposite page
Fig. 2
Current status (photos by Michelangelo Pivetta).

The complex of the Order of Saint Clare in Nazareth, in the heart of the historic region of Galilee, among many similar ones distributed throughout the world, is particularly interesting not only for its geographical location but for the relationship it defines with modern architecture dedicated to religious places. The convent is positioned on the top of the so-called Tremor Hill, a relief located south of the depression at the bottom of which the road axis of Paulus ah-Shishi Street extends, exactly facing the mass of the Basilica of the Annunciation by Giovanni Muzio and the hills that determine the theatrical backdrop towards the north.
The term 'tremor' with which this hill is called comes from a tradition, probably early medieval, for which here, Mary, witness to the episode of the life of Jesus reported in the Gospel of Luke (Lk 4, 28-30), anguished for the fate of his son condemned to death, he felt a sort of sob from the suffering and apprehension that made the earth tremble.
The site demonstrates, even today, how it has always been manned and inhabited precisely due to the peculiar presence of caves and natural ravines. In the building tradition of the peoples who inhabited Palestine, the practice of building their homes by exploiting

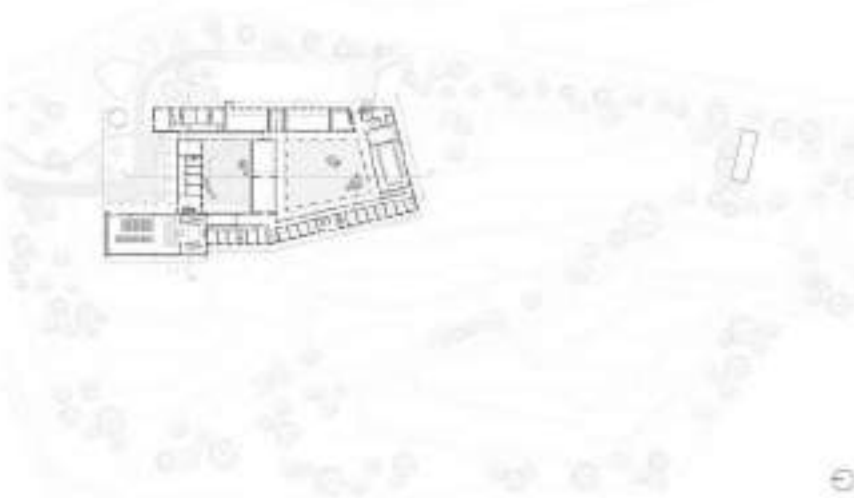
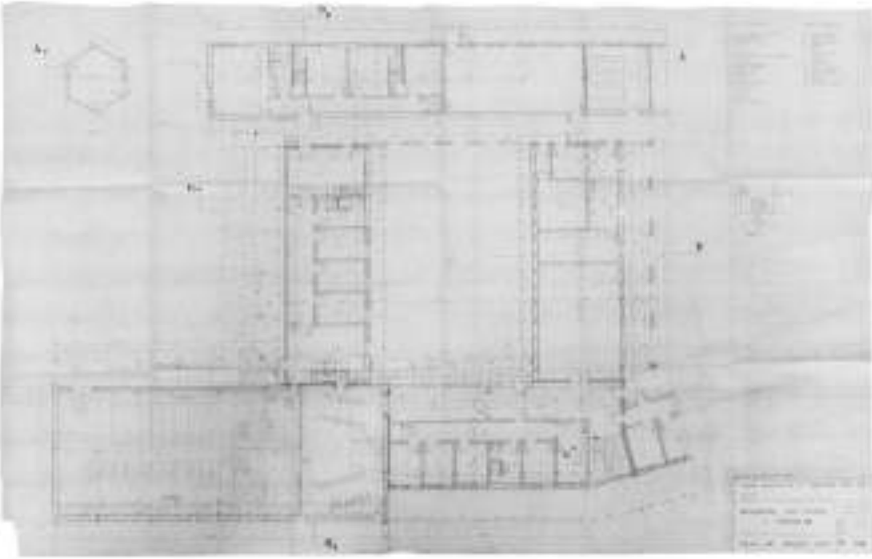
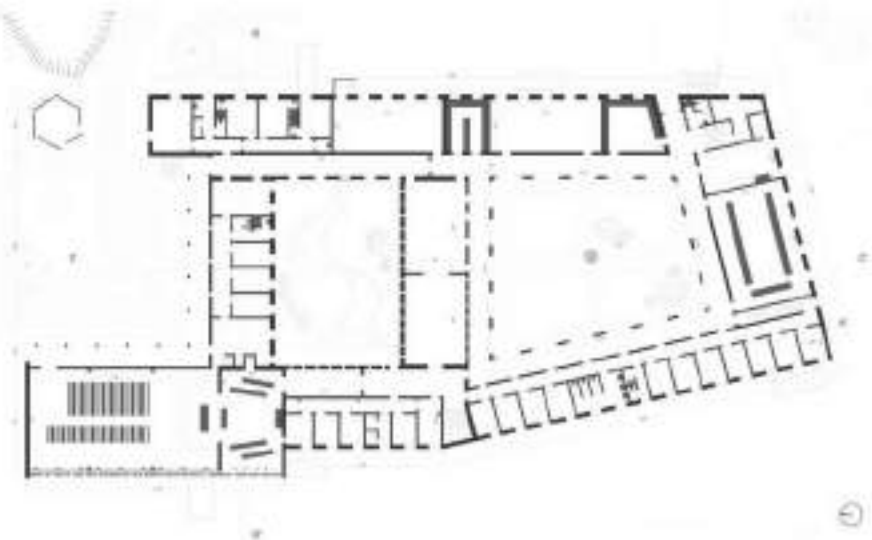


Fig. 3
(above) General plan. Original drawing by Pierre Vago Atelier.
(below) Ground floor and site context.

opposite page
Fig. 4
(above) Ground floor. Original drawing by Pierre Vago Atelier.
(below) Ground floor, current status survey.

geological formations is known and confirmed by all the archaeological findings and by the same testimonies that make up the oldest part of the nearby sanctuaries of Nazareth. The Tremor Hill is shaped regularly in the four directions of the cardinal points. From the lowest relative altitude and identifiable with that of Paulus ah-Shishi Street, the top of the hill rises for approximately 130 metres. The hill seems to be separated into three parts: the first faces north in the direction of the Basilica of the Annunciation, the second faces east and is occupied by a religious building and slowly slopes down from the top, the third to the south descends even more slowly and here in fact there is a magnificent orange grove. Always along the southern slope, the most effective from a topographic and landscape point of view, since the Pierre Vagos' original project an orographic arrangement was envisaged with low walls and agricultural preparations and, towards the extreme edge of the border, a small cemetery.





The existing building complex was built at the beginning of the 1960s and can be attributed, due to its architectural and technical characteristics, to so-called modernity. It is undeniable that the complex designed by Pierre Vago is of excellent compositional quality, in perfect alignment with the refined intellectual and theoretical characteristics of the author. Both the planimetric layout and the conception of spatiality and the relationship between the interior and exterior underline a profound knowledge of the dynamics that manage the living in similar places. It seems that Vago has concentrated proudly on the comparison with a thousand-year history made up of experiences, often experimental, of buildings designed and built based on the need to respect 'rules' and dynamics specific to ecclesiastical orders and their way of interpreting community and relational life.

The project takes up the genesis and meaning of cloistered architecture which, from its origin in the Benedictine environment around the 6th century, is nothing other than the repositioning of Roman building typologies in a community and religious context, subject to a regulatory system well defined and in which the composition of the individual parts underlies and develops the practice of the 'rule' itself.

Peristilium, *impluvium*, *cubicula* and *vestibules* of the Roman *domus*, as well as the sequential distribution logic and the dynamic but precisely regulated relationship between serving spaces and served spaces, becomes the cloistered system of the monasteries and convents that we know today.

To this system is obviously added, often as an integrated body, but other times through a more violent graft, the volume of the church, which at this point emerges as perhaps the only true novelty from a compositional point of view compared to the ancient tradition.

In the case of the monastery of Nazareth it is evident how the reading, or rather re-reading, of these peculiar historical-architectural paradigms informs the work of Pierre Vago who sagaciously proposes in the plan an exact spatial consecutio functionally organized around two cloisters of different sizes and with equally diversified destinies.

Added to this is the cruelty, in some ways already largely brutalist, of a process of despoliation of architecture according to the dictates of post-war modernity, when in theoretical and practical form what can be identified as 'ornament' is interpreted as fragile or sterile technical and formal uselessness. The almost 'Doric' harshness of the architectural apparatus of the complex fits exactly into this scenography of modernity, to the extreme in the implementation of some prefabrication solutions or the refined smallness of the vertical elements such as the pilotis consecrated by his friend Le Corbusier.

Thinking better about the entire compositional-artistic apparatus of the complex, it appears evident that there was, by Vago, a powerful choice in wanting to implement

an asynchrony between a thick and powerful horizontality of the planimetric system and a vibrant fragility, through subtlety, of all the vertical systems, such as the pillars which become very thin pilotis and the unbalanced openings in a completely unusual vertical proportion.
The complex of the Monastère De Saint Claire, although present in the general catalog of the archive of the author's works at the '*Institut français d'architecture – Center d'archives d'architecture du XXe siècle*', in the opinion of the writer, is not sufficiently investigated within a critical architectural literature, as a work of central interest in the historical and typological context of which it is part.

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Exhibition Catalogue
F-ATLAS – Digital Documentation of Franciscan Landscapes in Italy, Portugal and Spain


SUPPORTI
5x SCHERMI 65"
60 x 120 cm
a colori
• 12 " Italia
• 4 " Portogallo
• 4 " Spagna

DIGITAL DOCUMENTATION OF FRANCISCAN LANDSCAPES IN ITALY, PORTUGAL AND SPAIN

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F-ATLAS Conference featured an Exhibition, illustrating the culmination of the Project's research. Complementing the scholarly discussions and presentations, the Exhibition provided a tangible experience, allowing conference participants to delve into the project's findings in a visually captivating manner, through a series of graphic panels, immersive videos and 3D-printed models.
The exhibition dedicated to the final results of the European project F-ATLAS, titled Digital Documentation of Franciscan Landscapes in Italy, Portugal, and Spain was presented for the first time during the F-ATLAS Conference — Franciscan Observance Landscapes, which took place within the premises of the Domus Pacis of Santa Maria degli Angeli, Assisi (PG). Specifically, the exhibition was displayed in the Perfetta Letizia room of the conference center and was designed to be easily transported and set up in different environments. In the forthcoming months the exhibition will travel to Portugal, coinciding with the 4th International Conference on Architectures of the Soul, and subsequently to Spain, to be displayed in the University of Barcelona — in the Faculty of Geography and History.

Fig. 1
Project of the exhibition panels.

Exhibited materials

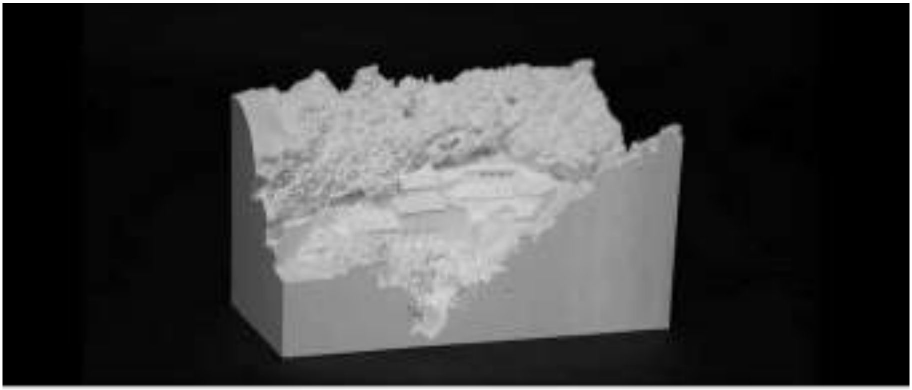
The exhibition encompasses a collection of twenty-four colour-printed canvases, eight detailed scale models, and several interactive digital products.

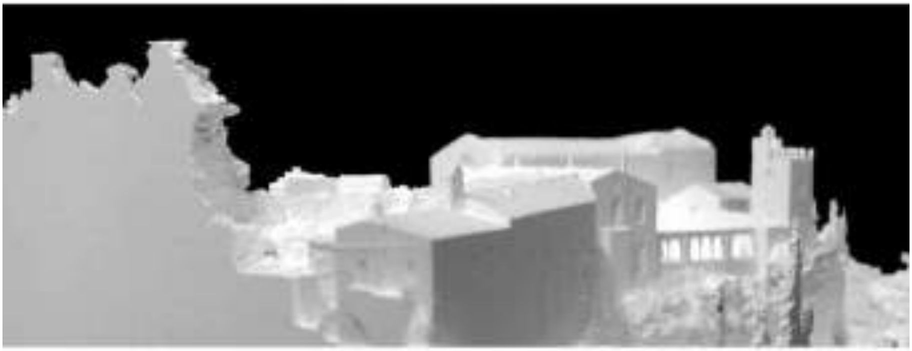
The canvases are divided into various thematic groups, with pairs and trios strategically positioned to offer a coherent visual narrative. Starting from the two couples of introductory panels, the tour continues with twelve panels dedicated to several Italian landmarks: Porziuncola of Santa Maria degli Angeli, Romita di Cesi, Eremo delle Carceri, Speco di Narni, San Bartolomeo convent, San Vivaldo convent. They are followed by two couples of canvas about São Francisco do Monte and Santa Maria da Ínsua, two emblematic Portuguese conventual complexes. The last four panels concern two peculiar Spanish convents, Convento de Los Franciscanos of Chelva and Sant Miquel d'Escornalbou.

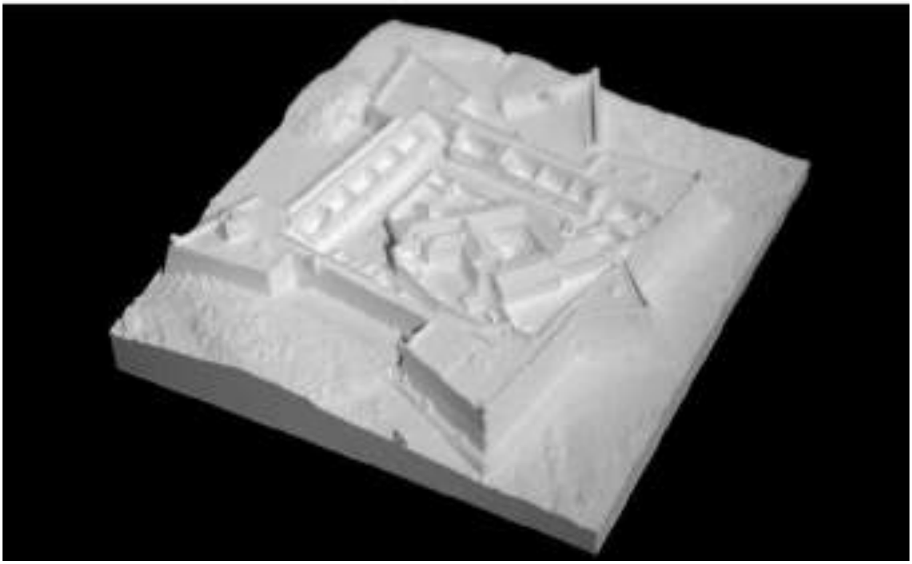
opposite page
Fig. 2
Photos of the 3D models, from above: Eremo delle Carceri, Monestir de Sant Miquel d'Escornalbou, Santa Maria da Ínsua (photo credits: Andrea Pasquali).

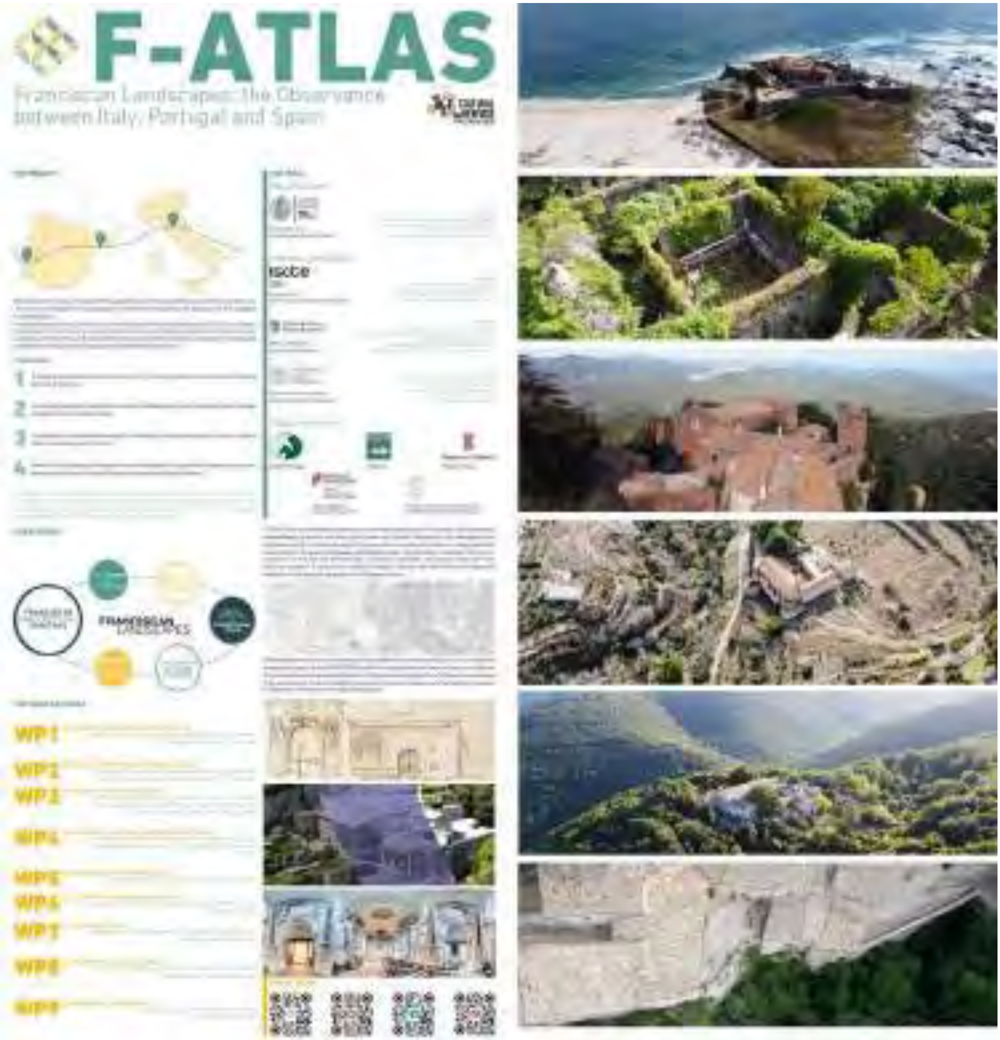
Furthermore, the exhibition includes scale models crafted with white PLA filament. These models provide viewers with a tangible connection to the architectural complexes depicted, allowing for a closer examination of their details and scale, and their relationship with the surrounding contexts.

The digital dimension of the exhibition adds a dynamic layer to the experience. Three captivating videos, one for each of the participating countries, offer an immersive journey into the essence of these sacred spaces. Additionally, a dedicated website page equipped with a Geographic Information System (GIS) of the case studies allows visitors to explore the exhibition's context in depth. Finally, a virtual tour of the Eremo delle Carceri in Assisi offers an interactive exploration of this remarkable site.









EXHIBITION CREDITS

Panels layout: A. Cottini

Panels credits:
Eremo delle Carceri: C. Assirelli
Romita di Cesi: A. Cottini
San Bartolomeo: M. Cabiddu, A. Saletti
Speco di Narni: A. Loponte
Porziuncola: C. Cerbai
San Vivaldo: G. Pancani, A. Pampana-Biancheri, M. Pastore, S. Pedagna, F. Staderini, Y. Stella Tang, A. Vanzi, B. Vongher, A. Zanarini
São Francisco do Monte: G. Mugnaini
Sant Miquel de Escornalbou: J. Dallapozza, G. Amaducci, S. Alinari
Convento de los Franciscanos: A. Cottini

3D Models

Coordination in the preparation of models: F. Brandão
Print of the models: J.P. Sousa
Collaborator: J. Jacinto

Credits

Laser Scanner Survey: M. Bercigli, F. Cioli
Close-Range Photogrammetric Survey: A. Cottini
Drone Photogrammetric Survey: F. Ferrari, M. Medici

Thesis title: **Progetto di una piattaforma digitale per la valorizzazione e la fruibilità dell'Eremo delle Carceri ad Assisi**

Student: C. Assirelli
Tutor: S. Bertocci
Co-Tutor: A. Cottini

Credits

Laser Scanner Survey: P. Becherini, A. Cottini
Close-Range Photogrammetric Survey: A. Cottini
Drone Photogrammetric Survey: P. Becherini

Technical Drawings: G. Batnini, G. Battaglieri,
A. Bellagamba, E. Bertelli, M. Bonechi, L. Carosi

Credits

Laser Scanner Survey: P. Becherini, A. Cottini, F. Cioli, F. Ferrari, M. Medici
Close-Range Photogrammetric Survey: R. Ferretti
Drone Photogrammetric Survey: M. Medici

Thesis title: **Un programma di documentazione e valorizzazione per la chiesa del Convento di san Bartolomeo a Foligno**

Student: A. Saletti
Tutor: S. Bertocci
Co-Tutor: F. Cioli

Thesis title: **Il Convento di san Bartolomeo a Foligno: rilievo e documentazione per la conservazione del complesso**

Student: M. Cabiddu
Tutor: S. Bertocci
Co-Tutor: G. Minutoli, F. Cioli

Credits

Laser Scanner Survey: F. Cioli, A. Lumini
Close-Range Photogrammetric Survey: E. Bordini
Drone Photogrammetric Survey: A. Lumini

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Student: A. Loponte
Tutor: S. Bertocci
Co-Tutor: A. Cottini

Credits

Laser Scanner Survey: F. Cioli, R. Ferretti
Close-Range Photogrammetric Survey: A. Cottini, F. Cioli, F. Ferrari
Drone Photogrammetric Survey: P. Becherini

Thesis title: **Rilievo per l'interpretazione della Basilica di santa Maria degli Angeli. Dalla Porziuncola di san Francesco alla basilica-reliquiario di Galeazzo Alessi**

Student: C. Cerbai
Tutor: S. Bertocci
Co-Tutor: R. Ferretti

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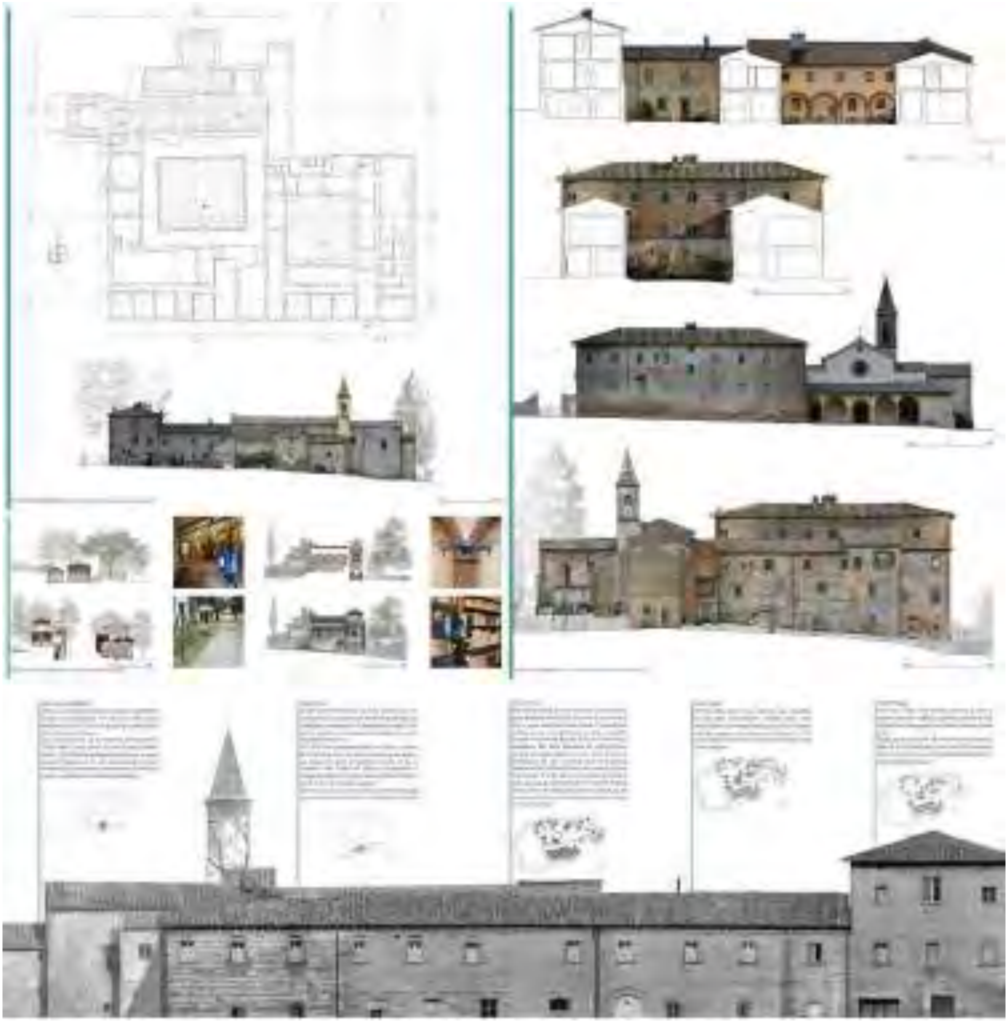
Technical Drawings: A. Pampana-Biancheri, M. Pastore, S. Pedagna, F. Staderini, Y. Stella Tang, A. Vanzi, B. Vongher, A. Zanarini



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Laser Scanner Survey: P. Becherini, A. Cottini
Close-Range Photogrammetric Survey: A. Cottini
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Student: L Perrotta
Tutor: S. Bertocci
Co-Tutor: A. Cottini

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Student: G. Mugnaini
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Tutor: S. Bertocci
Co-Tutor: F. Cioli, S. Brizzi

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Carta
da fonti gestite in
maniera responsabile
FSC® C124462

Finito di stampare da
Rubbettino print | Soveria Mannelli (CZ)
per conto di **dida**press
Dipartimento di Architettura
Università degli Studi di Firenze
2024

The volumes present contributions from the International F-ATLAS Conference, promoted within the European project “F-ATLAS – Franciscan Landscapes: The Observance between Italy, Portugal and Spain”, funded in 2020 by the JPICH 2019 Conservation, Protection and Use Call. The Conference brought together experts from various disciplines, including history, architecture, geography, digital humanities, and computer science, creating a rich and comprehensive interdisciplinary dialogue. Participants from renowned international universities offered unique insights into the Franciscan Observance and its impact on European Cultural Heritage. The contributions examined the past and sparked discussions on the future of documenting and safeguarding religious heritage.
Integrating historical research with technological progress opens exciting possibilities to create comprehensive digital archives, virtual reconstructions, and immersive experiences that can bridge the gap between the past and the present.

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ISBN 978-88-3338-222-7