

THE INTEGRATED SURVEY FOR THE RECOVERY OF THE FORMER HOSPITAL / MONASTERY OF SAN PIETRO IN LUCO DI MUGELLO

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Abstract

The article presents the results of a research on the former hospital/monastery of San Pietro in Luco di Mugello, studied from a historical point of view and analyzed by means of an integrated survey. The architectural complex, born in 1086 as a Camaldolese female monastery, was renovated in the fifteenth century, it seems by Giuliano da Sangallo, with interventions on the cloister, the loggia of the garden and the interiors. In the nineteenth century it became a hospital, a function that completely upset the structure, and then a nursing school until 1990. For years it has been in a state of decay with major collapses even in the roof, as evidenced by aerial photogrammetry with drone. The three-dimensional survey made it possible to investigate the structure in depth, creating the basis for a revaluation project of the structure but, first of all, to establish, immediately, the interventions to block its degrade and prevent its definitive collapse.

Keywords:

Three-dimensional survey, monastery, hospital, laser scanner, photogrammetry, Luco di Mugello

1. Introduction

The former hospital/monastery of San Pietro is located in the Mugello valley, 306 meters above sea level, in the province of Florence. The complex of buildings constitutes the fulcrum of the hamlet of Luco di Mugello, in the municipality of Borgo San Lorenzo, which is about five kilometers away.

In ancient times the area was inhabited by farming communities. Probably it was the Etruscans, who arrived between the VIII-I century BC, to trace a first series of routes and urban aggregates that were then developed by the Romans between the III-IV century BC. starting from the foundation of Anneianum (Borgo San Lorenzo) (Repetti, 1835).

Given the geographical position in this valley, which runs along the Apennine ridge, the main connecting roads¹ (Fig. 1) developed along which the inhabited centers characterized by a double authority arose: the administrative one within the feudal system of government of the territory and the of the Parish churches for the welcome, the stop, the shelter of pilgrims and travelers. These two authority both had both ecclesiastical and civil

duties and often interfered with each other, so much so that the Pieve often hosted assemblies to decide on community issues and, according to controversial theories, also dealt with the care and maintenance of roads (Santi, 2009).



Fig. 1: Map of the main communication routes

Beyond the function of connection, in particular with Bologna, the Mugello was not particularly important at least until 801 AD when, that is, under Charlemagne the Ubalдини family took power and together with the Counts Guidi of Casentino they found themselves opposing the

¹ The main routes to cross the Apennines were (and still are today): the via Bolognese; the via Francigena; the via Faentina; via Forlivese, more recent.

expansion of Florence, as evidenced by the castles in the area. The Ubaldini ruled the Mugello from the 7th century to 1373.

The monastery building (Fig. 2) was born in the context of the phenomenon of urbanization of the countryside that took place after the year 1000, integrating and at the same time opposing this in an area far from inhabited centers, but not excessively isolated. The Mugello valley proved to be suitable, so many monasteries and convents developed there, including that of San Pietro a

therefore, these became property of the Hermitage of Camaldoli '*pro remedio animae*'² (Fig. 3). On the other hand, the three principles of the Benedictine rule, namely common prayer, personal prayer and work, find in the Camaldolese Order an active reality with a view to retreat and hospitality. This Order, together with the Vallombrosan one, born in the 9th century, that is, in the period of the Reformation, gave birth to most of the monastic architectural complexes in Tuscany³.

The Camaldolese congregation combines the



Fig. 2: Aerial view from drone of the entire monastic complex

Luco, the subject of this research. This is the first Camaldolese female community.

The land on which it stands was donated to the Order by Count Gotitius degli Ubaldini and his wife Cunizza with the will of 1085, as daughter Matilda had no male children to whom the assets in her name could be transferred into ownership and,

community dimension and the solitary one, expressed, architecturally, by the presence of both the hermitage and the monastery. In fact, according to San Romualdo, they had to coexist since it was necessary to create a minimum relationship between the monks to avoid total isolation. The monastery is always imagined as a

²The Congregation of Camaldoli, of the Order of St. Benedict, originates between 1024 and 1025 from the conception of San Romualdo, who tried to combine the Eastern monastic tradition with the Western one in a community dimension and a hermit under the motto of " Ego Vobis, vos mihi "(from the Latin " I am for you, you are for me "); the concept is clearly expressed in the emblem depicting two doves drinking from a single common chalice. The parent company is the Hermitage of Camaldoli near Arezzo.

³ In particular in the Mugello the Benedictines had the Abbeys of Buonsollazzo, Santa Maria Bovino and San Godenzo; the Vallombrosans, the abbeys of Moscheta, Passignano and Santa Maria ad Agnano, as well as the abbeys of Santa Maria in Vigesimo, San Paolo a Razuolo and the monastery of Settimo; the Camaldolese as well as San Pietro a Luco, Santa Margherita a Tosina.

place separated from the world, far from inhabited centers and surrounded by greenery, facing inside to guarantee the peace of the monks. Furthermore the Benedictine rule provides for building in places where there are water reserves; he also inserts the *hortus conclusus* as an element linked to prayer and work. Nature is geometrically inserted in a precise limit, so the garden becomes a safe fenced space, separated from the rest of the world and difficult to access, symbolism of the celestial paradise and memory of the earthly paradise (Bertocci & Parrinello, 2012).

On the basis of these principles, in the monasteries there were precise planimetric provisions, also based on orientation, and a distinction between the living and sleeping areas, private and collective environments. The buildings were built with materials readily available locally. The church, located along the west-east axis, acted as climate protection for the buildings that were attached to it.

While in the early medieval phase the hermitage developed spontaneously through the construction of autonomous cells, in the case of the monastery of Luco the cells are part of the large and single building. Architectural extensions and embellishments followed one another over the centuries.



Fig. 3: Symbol of the Camaldolese Order, stone coat of arms in the cloister of the Luco Monastery

2. The monastery of San Pietro. Background

The historical and constructive events of the monastery of Luco began in 1085, under the Father General of the Camaldolesi Rodolfo by the Mugello's family Falcucci. Many noble families

offered protection and privileges and the first Abbess was Cunizza, widow of Gotitius, until 1105 when her daughter Matilde followed her for two years; this was succeeded by her sister Beatrice until 1132. There followed thirty-three noble rulers with the title of "Countess", who became owners of almost the entire district until they "became master and arbiter of the Luco Valley" (Chini, 1969).

The main building of the monastery, oriented in a north-south direction, was built in alignment with the facade of the church, it is about thirty meters long and rather narrow. To this, to the south, an additional body is coupled at a right angle, shorter than about ten meters and equally narrow. Everything was closed by a wall to the west, parallel to the axis of the first body, which closed the complex in a "U" shape, as was often the case in monasteries, generating the central internal courtyard. To the north of the church, along the road that descended to the Bosso stream, there were the service rooms, for the farmer's and the chaplain's. On the ground floor in the north-south body, leaning against the church, was the chapter house and next to it to the south, the kitchens. A stairwell divided the two orthogonal bodies which in the southern portion present the 'silencium' and the refectory. Going up to the first floor there were most likely the dormitories, the one of the regent abbess was probably located in the southern body together with the library. The building was still modest in size, but presented excellent opportunities for expansion and expansion, being well aligned with the guidelines of the territory. During the thirteenth century, following great political disputes that led to clashes between the Papacy and the Empire, the Guelphs and Ghibellines became increasingly strong and present on the territory, while the power of the female monastery quickly faded.

Since the abbesses returned to being rich and autonomous in the 1400s, in a few years the monastery doubled its volume, raising the quality of its architecture and its form; improving not only functionally, but above all as a symbol of the congregation and its power. The conclusion of the expansion dates back to 1476, as can be seen from the keystone on which St. Peter is depicted in half-length with the crossed keys and the inscription "MCCCCLXXVI", placed in the first of the two rooms behind the loggia at midday, where it was the *hortus conclusus*. Between the north-south body and the body of the church, a quadrangular cloister

was inserted, closed to the south by a new body that also incorporated the medieval one, thus generating a large southern front that also closed the east and west sides at an angle. Everything was marked by accurate and very controlled proportions.

The cloister, not perfectly square due to the pre-existing buildings, was however regularly structured: the short sides consisted of 5 arches on 6 columns and the long ones with 7 arches on 8 columns. In total, there were 24 piers on a low wall that served as a common pedestal and bench, divided only in the center of the elevations generating 4 ambulatories covered by 28 cross vaults. On the upper floor 24 small columns supported a wooden architrave through a mediation element, also made of wood and shaped like a water leaf, thus constituting a low balcony. It is assumed that the east front of the cloister was leaning against the already existing medieval blind wall - of the hortus conclusus - becoming the access to the monastery. This, in the northern portion near the church, perhaps had low service rooms, probably with a wooden attic, and the apse was closed with an angular body to protect the monastery. In the center of the four plastered facades of the cloister, coats of arms in pietra serena are still visible with the symbol of the parish (the keys of St. Peter) to the north and south and the Camaldolese emblem to the east, while to the west the emblem of a family. The order of both levels is Ionic, linked to the representative female figure of the monastery and each column is decorated in a different way in vast versions of plant motifs. The first medieval body, aligned with the front of the church, is now central to the plant, but the internal functions change according to a new distribution of spaces.

Currently leaning against the church is the library and, going down, the chapter house covered with a clawed pavilion with corbels in a free composite order, up to the stairwell rearranged with three cross vaults on Doric corbels. The south-east corner houses the kitchen and the refectory covered with a pavilion-shaped vaulted ceiling with 3 lunettes on the short side and 7 on the long sides and supposedly Doric. It is the largest room, measuring 12 arms by 28, and was built entirely on a single basement cellar covered with a lowered barrel. Between this and the areas further west is the Silentium, a place of recollection, equipped with a washbasin in pietra serena; this compartment housed the connection

to another flight of stairs that led to the corridor on the upper floor, at the level of the corridor of the cells. Downstairs is a similar barrel-vaulted corridor as long as the refectory. Continuing further west, the ancient medieval portion now houses two halls with a pavilion vault that become in sequence a large parlor and a small parlor and to which, towards the outside, a large loggia was attached.

This loggia one, born as a private monumental access for the use of the nuns, is divided into 6 square spans on 5 columns, with the central column Corinthian, the single one of the strictly ancient facade, while the others with capitals in modern composite and closed by two end pillars. There is a great decorative control that suggests a good reputation and competence of the architect, not known, who took care of the extension. The latter, in fact, managed to insert this decentralized loggia in the huge full elevation marked only by the sequence of the windows of the upper cells. Furthermore, the width of the loggia and the short side of the cloister to the north have the same identical length equal to 36 "braccia".

Precisely the harmony of the forms and the relationships of the entire and extremely extensive monastery lead us to wonder who was the architect. It is certainly known that in the years between 1473 and 1476 the monastic complex hosted Lucrezia Tornabuoni and Clarice Orsini, respectively mother and wife of Lorenzo the Magnificent. This coincidence would suggest that also in this case an indirect customer has been put in place, typical of Laurentian patronage and which will invest, over time, numerous other customer, since it would have been impossible to refuse the aesthetic advice of the "princeps". Furthermore, the link between the monastery and the Medici is strengthened by the similarities present in other Mugello complexes built by Giuliano da Sangallo, an architect perhaps 'recommended' also for Luco and also by the expenses for the expansion defined as 'extraordinary' by Vasari and easily associated with the Family who took care of Florence and its surroundings. However, things are much less clear if we consider that the only secular coat of arms is not Medici: it is a rampant bull with three roses, perhaps attributable to the Salvetti family, or linked to the Grulli del Borgo (bull) or Cambi-Uberti (roses). Furthermore, precisely in the years 1463-1486 there is uncertainty as to which is the reigning Abbess among the thirty-three

documented. Among other things, the diversification of the incongruent corbels on two less ornate and traditional traditional (Michelozzian) sides, would suggest a stoppage of at least twenty years in construction. It is therefore difficult to put forward a more certain hypothesis in this regard without any strong evidence and without any concrete evidence.

In 1500 the monastery underwent some interventions of a much lower thickness than the Renaissance one, mainly concerning the appurtenant goods, following which the exterior and the church were renewed. From 1599, some improvements were carried out in the monastery such as the two new vaulted ceilings in the south-west halls and the large pavilion, also in the kitchen to the east. The enclosure wall between the square in front of the public church and the oldest western courtyard also dates back to this period. In addition, the westernmost span of the southern loggia was buffered and transformed into a separate chapel forming part of the devotional path. Another series of rooms -perhaps only on the ground and service rooms- that joined the kitchen to the east with the corner rooms of the north east, incorporated the apse thus filling the void beyond the eastern perimeter wall of the cloister. From the mid-1600s there followed years of flat calm; the penultimate Countess Geltrude Poggi, reigning since 1785, promoted small and, all in all, useless jobs: such as the repair of the floors, the gilding of the furniture, the whitewashing of the walls, the renovation of the kitchen and the cells. All this did not have a sequel because the monastery was definitively suppressed in 1808⁴ (Fig. 4).

The confiscation of the property, drawn up by Napoleonic officials, saw only the 'Abbess Donna Anna Teresa Maffei' present, elected only and only to carry out the final act of the monastery. Subsequently, the rooms were divided between the Franciscans of Santa Croce and the Augustinians of Santo Spirito and used as "country rooms", as well as lent to public health during epidemics. Among these it is enough to recall the petechial typhus which, in 1815, scourged Tuscany for three years; so the monastery of San Pietro served as a hospital until 1818 (Baldacci, 2004).

The function of the lazaret anticipated, in part, what would become its new destination at the end of the century, when it would become a real

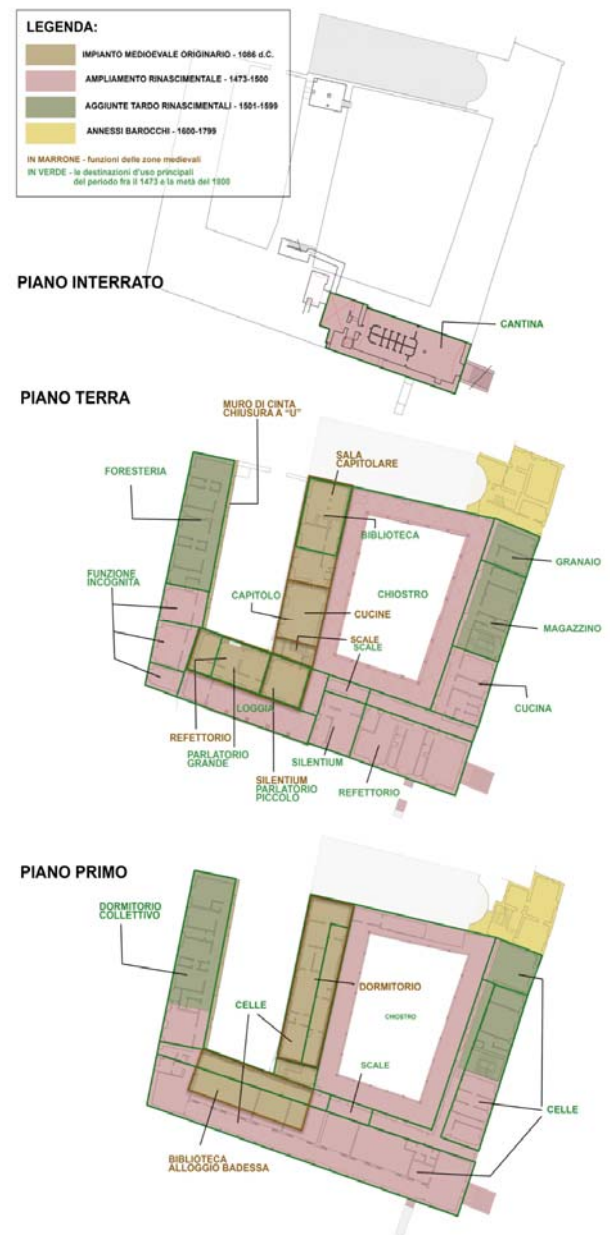


Fig. 4: Historical stratigraphy from the Foundation to the 1800s: the monastery

hospital. In fact, from 1860 there was a strong need to open a hospital that would serve the whole of Mugello, as many sick people used to die while being transported to the hospital in Florence (Fig. 5). Count Francesco Pecori Giraldi, gonfalonier of Borgo San Lorenzo, had begun to take an interest in the question and in 1867 a committee was formed to promote the initiative and raise funds,

⁴ From 1810 the suppressions of religious orders were many throughout Italy due to the need to seize goods for Napoleon's military campaigns.

both in money and in useful products or furnishing tools. It took a year to find enough and, as by law the concession was free if one of the suppressed religious places was chosen, the former monastery of Luco became attractive. As it had huge environments, healthy air, water and soil, as well as being centrally located in the practically perfect valley.

The 3,500 square meter complex allowed the insertion of all the rooms necessary for the functional change. Thus a new northern entrance was created, in the center of the ancient "U" courtyard, easily reachable from the church square; this perfectly divided the two lanes (male and female). The first, in the west wing, had about twenty beds organized on a new corridor, the second instead to the east of the southern body (Fig. 6). The two external latrines were attached to these, one per lane. The portion in the central body of the building in the first north-south system on the upper floor housed the staff quarters. A new well and the infirmary were also built. In 1907, a tunnel was built to draw water from the source and a masonry deposit for the night. In addition to the drinking water pipeline, in 1902 the hospital was equipped with a thermal power plant (centralized heater) and in 1909 with a brand new operating room thanks to the economic contribution of the Marquis Gerino Gerini⁵.

The spaces continued to increase to accommodate more and more functions: the women's ward in the south-east corner was enlarged, new kitchens were built and an isolation area was created in the north-east. The upper floor became a large ward, always divided into men and women; two new scales were added for faster and more immediate internal scrolling. Around 1930 a section of the north-east wall was demolished where low buildings were leaning against them with the functions of wash house, oven and housing for those who served the hospital, then replaced by laundry and new warehouses. The aisles of the two departments were also repaved.

In a few years the original appearance was profoundly changed and a primitive restoration was also carried out which saw the cloister entirely repainted in white and green to recall a medieval style which, however, had never existed in this context.

On the ground floor, at the intersection of the arm aligned with the church with the southern

one, a new atrium has been created open in all directions. This new south entrance allowed quick access to the emergency room for those arriving by ambulance and for those who parked in the square. The pantry was next to the kitchens and leaning against the church. On the first floor, the cells of the shelter for men and women were eliminated and replaced by rooms, which could be accessed via service corridors. In 1938 a large loggia was built on the south front for the treatment of lung diseases, built in the Neo-Renaissance style with fourteen intercolumns, to be closed with a veranda with stone columns of 'Tuscan' order. The two stairwells, previously built, were raised to connect the new lodgings for the nuns, generated by the change in height of the east arm of the factory.

Despite these adaptation works, in 1989 the hospital was closed, as the subdivision of the spaces was no longer adequate for modern needs; just think that the surgery unit and the operating room (which, however, being on the ground floor did not comply with health and hygiene standards) were located on two different floors, as well as the emergency room and radiology. The steps in front of the entrance created obvious problems for transport on a stretcher. The gatehouse was too far from the rooms which were therefore impossible to monitor.

The organization of work and assistance had become complicated, the ever-increasing demand for services was limited by the structure and its own architecture, this was one of the decisive reasons for the closure and consequent construction of the new structure into Borgo San Lorenzo.

The building became, in part, a school for professional nurses⁶, which remained active from 1989 to 1990. Following this new function, showers were built in the barrel-covered Renaissance cellar located under the refectory, while the latter was intended to canteen (Fig. 7).

Subsequently, the structure was completely abandoned and, unfortunately, it is still unused.

In 2004 the property was purchased by the Tuscany Region. The intent was to sell the property by launching sales auctions, which however went deserted.

Over the years, various proposals for change of use have been made, including a conference center, a boarding school for students, a space for

⁵ (1871-1927) politician born in Barberino di Mugello from a noble family that owned vast territories in the valley.

⁶ Founded by Don Romano Nencioli, Cosetta Giovannelli and Fabio Rossellini

local gastronomy, a facility for children and adolescents, a tourist accommodation facility. Among these there were also a more concrete idea of creating a decentralized university center for Agriculture and Livestock. The executive project of the Province included the conservative restoration and the necessary modifications for this didactic destination. However, the lack of funds has blocked this idea as well. Unfortunately, the situation of the ancient monastery is worsening day by day and the Tuscany Region, which must take care of its maintenance anyway, has requested the collaboration of the University for the survey of the current state of the monastic complex in order to start conservative and, possibly, with a view to a future restoration⁷.



Fig. 5: Photo of the cloister taken during the years of hospital activity



Fig. 6: Photo of the interior taken during the years of hospital activity

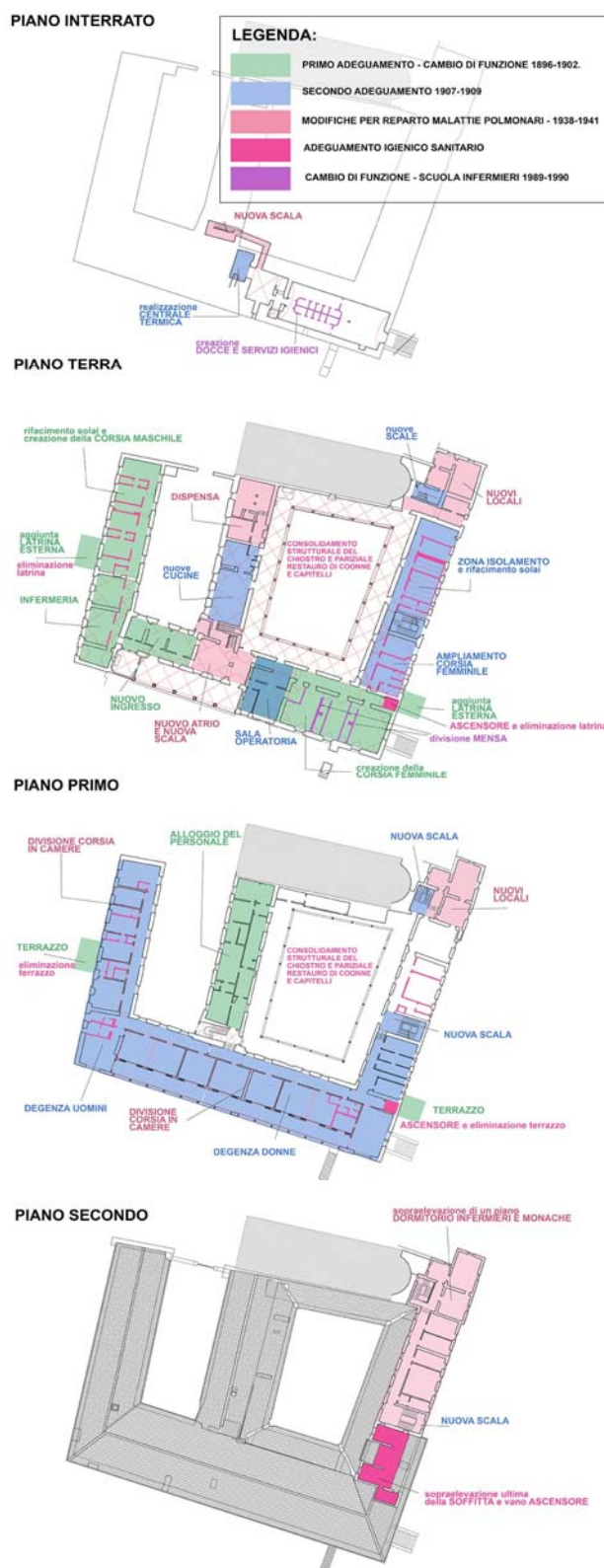


Fig. 7: Historical stratigraphy from the 1800s to today: the hospital

⁷ The first surveys were carried out in 2018 as part of the single-cycle degree thesis in Architecture by arch. Sabrina Giuricin (supervisor prof. B. Aterini).

3. The integrate survey

The survey work was necessary to read the monastic architectural complex and understand the order of interventions to be implemented in order to stop the degradation that would soon lead to irreparable collapses. The opportunity arose as part of an agreement with the Tuscany region, the current owner, which decided to intervene to stop the deterioration and use the structure for current purposes still under discussion.

The survey highlighted all the elements, ancient and recent, that make up the architecture of the former monastery of San Pietro. The work was carried out in several stages.

The existing surveys were almost useless, as many incongruent measurements emerged from the direct survey both in elevation and in plan, so it seemed appropriate to start over from the beginning and also use current technologies in order to reach reliable data.

Furthermore, the possibility of working in three dimensions has allowed navigation inside the complex, in order to elaborate more in-depth spatial reflections. A well-done and rapid survey is capable of triggering economic and cultural processes of safeguarding the asset within the complex framework in which it is inserted and it is through this that it is possible to take possession of the built architecture. The decision to integrate the two methods derives from the desire to generate a finished product of great metric and communicative value, through the ease of interpretation of photogrammetry and the high geometric precision of the 3D laser scanner. Both means of great impact, operating a sort of basic virtual direct survey for any subsequent processing (Clini, 2008).

The first operation was to prepare the chronology of the survey works, dividing them into zones depending on the measures and particularities to be highlighted. Following an initial inspection, the shape and extent of the object to be represented were established and, once the scale of representation for the proposed purposes was decided, that is a general picture of the exterior of the structure; the relevant operations have been started. The first thing to be defined exactly was the overall volume, the footprint of the building and the roofs, in order to be able to study the envelope of the factory.

Given the size of the monastery as well as the impossibility of detecting the roofs from higher

points of the same, a drone was used, the PHANTOM 3 PRO with mounted camera DJI FC300s 3.8mm f2 / 8 (Fig. 8).



Fig. 8: Drone used for aerial photogrammetry

Photogrammetry, which makes it possible to obtain a three-dimensional model through the processing of two or more photographic images of the object taken from different points of view, has also allowed the material reading of the architectural parts. Through aerial photography and photogrammetry it was possible to obtain images in raster format, i.e. generated from the original images as a result of metric transformations (photoplanes and orthophotos) and numerical-vector products, i.e. the return through the points of the object in three-dimensional reference (point cloud).

In this type of survey, the difficulty lies in correctly setting the shooting positions and then creating a flight plan for the drone, effective in capturing every portion of the object studied and in evaluating the most suitable lighting conditions (Micieli, 2019). To this end, a path grid with a nadiral camera (downwards at 90 degrees) was set to fly over the area, with a shooting overlap (therefore of the resulting images) of 85%, so that more homologous points were visible on as many photos as possible. A flight height of 40 meters was chosen to cover 1.08 hectares in 6 minutes and taking 170 photos in total (Fig. 9). To establish the positioning of the monastic complex, the GPS (Global Position System) was used for geolocation and six GCPs (Ground Control Points) positioned on the ground and characterized by opposing triangles, with the tips in the center. At this point the first acquisition of the images useful for creating an orthophoto and for having a complete picture of the roof plan of the building was.

For the realization of the 3D model, however, this flight plan was not sufficient, as there were no inclined references useful for the volume, so two

spherical reconnaissance were set: the drone made two concentric turns with the building at the fulcrum of flight and tilted camera: a lower and closer one while a higher and more distant one for a total of 129 photos.

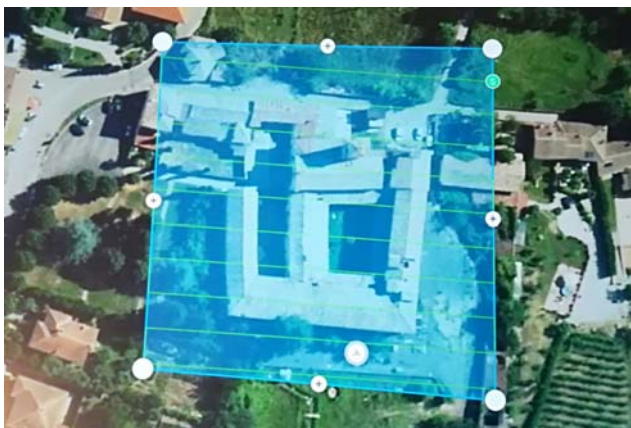


Fig. 9: Flight path of the drone

All photos, once acquired, were processed using Agisoft Photoscan software (Fig. 10).

In the first phase, which consists in aligning the camera, the program searches for homologous points among the images and calculates the position of the camera for each photo, generating a scattered point cloud. The setting provided to the program was High Accuracy alignment to use the original size image, and not partially reduced.

Subsequently, a dense point cloud was generated, based on the camera positions, once the high quality was assigned and with an aggressive filter depth (this resolves anomalies in the previously obtained values). In the third phase, the mesh is created, i.e. a 3D polygon is built on the cloud of points from the measurements taken from the surface of the photographed object. The parameter used for the orthophoto was HIGH FIELD which is used for flat surfaces for the note, while for 3d ARBITRARY which adapts to the mesh was used.

In both cases it was generated starting from the dense cloud and with a high number of polygons to compose it and have a higher quality.

Then we was move on to texturing: here to the mapping mode for orthophoto was used for the

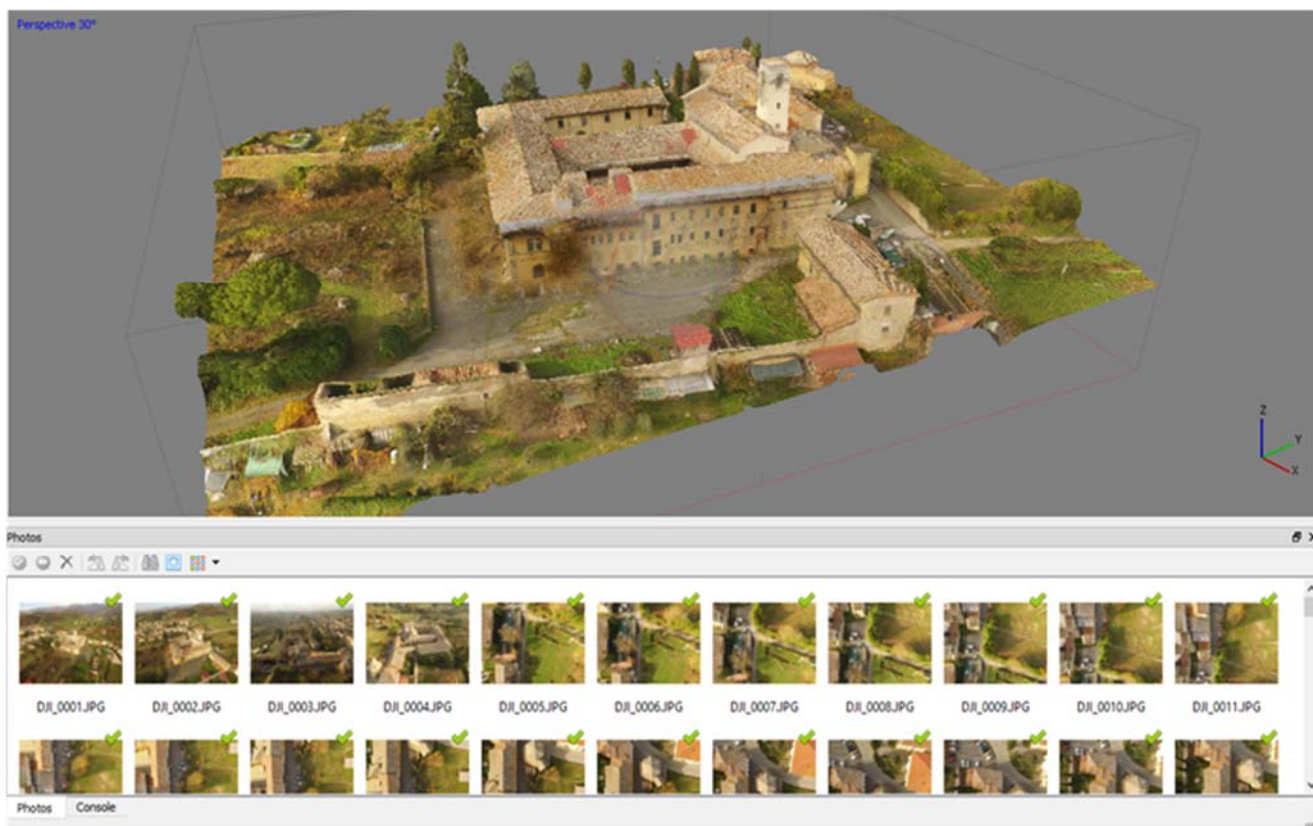


Fig. 10: Processing through Agisoft Photoscan

realization of the same based on the orthogonal projection, while the generic mode for 3D.

The blending method for both was MOSAIC which implies a two step approach: it mixes the low frequency components by overlapping images in order to avoid the problem of the seam line between two different photos, while the high frequency component, which takes care of the image data, is obtained from a single photo, the one that has a good resolution for the area of interest.

Basically it is the way in which the pixels are combined that generates the texture itself. In addition, color correction has also been enabled. Finally, after 25 hours of processing, the necessary exports were made for the purpose of the most effective representation of the building's survey.

Furthermore, it was decided to make the most of the possibilities offered by the use of the drone, that is the possibility of reaching inaccessible and unreachable areas.

A vertical grid flight was planned for each external elevation, i.e. of the east, west and south fronts, which made it possible to take photos perpendicular to each facade from three levels in height, greatly facilitating the processing of the photoplanes then processed on Photoscan as explained above.

The same thing was done with regard to the elevations facing inside the monastery, i.e. those of the two cloisters, this time accompanied by a spherical flight with dron (Fig. 11) of connection between the facades (also of help in the elaboration of a separate 3D only of these)(Fig. 12).

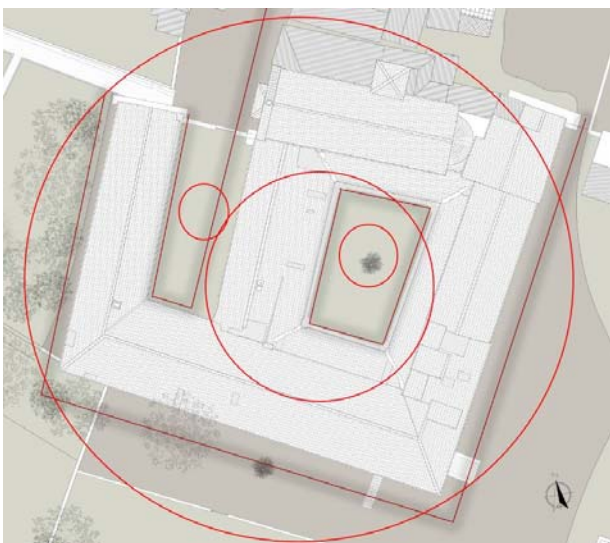


Fig. 11: Spherical flight

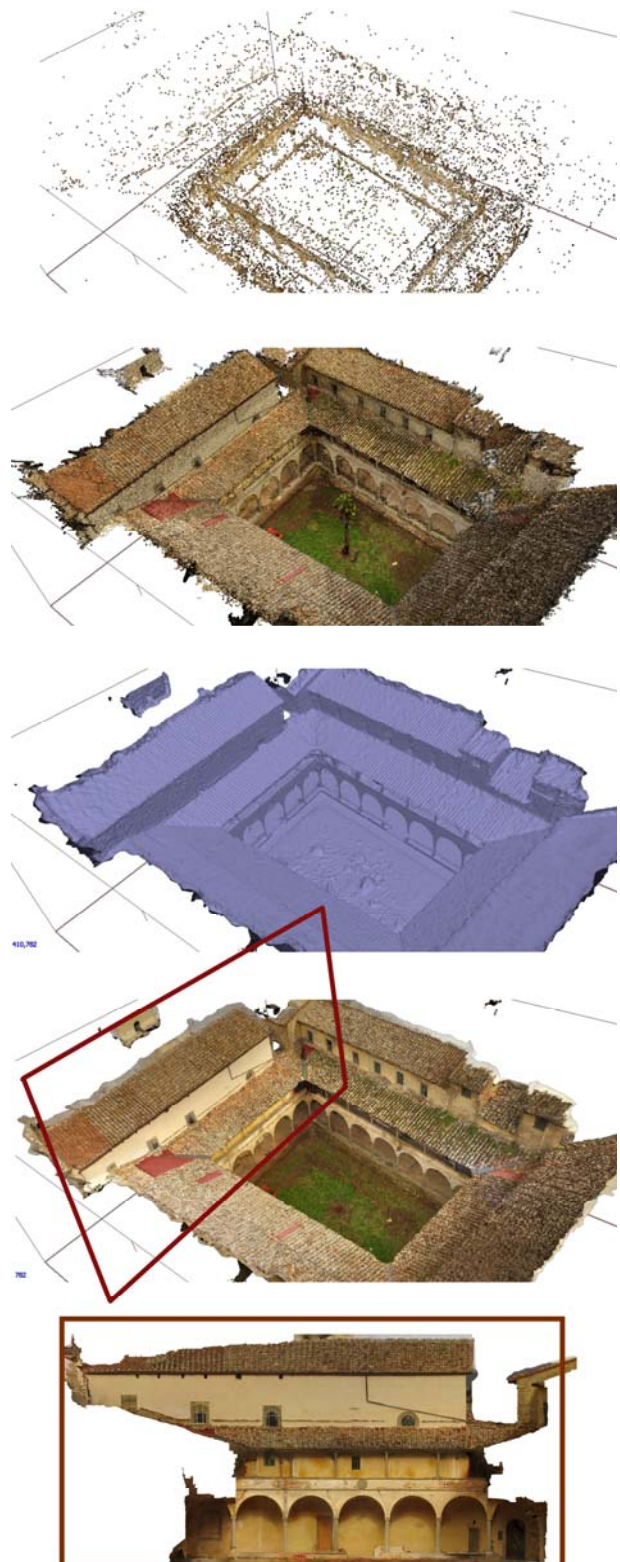


Fig. 12: Processing fourth century cloister through Photoscan

It was then decided to also use the laser scanner, to deepen and increase the information on the building, integrating this second cloud of points with that obtained by photogrammetry.

The most complex and decorated surfaces were analyzed, achieving greater definition of details. It was also possible to survey some portions of the monastery, which were not detectable by the drone to the invasion of the vegetation both on the ground and climbing the building. The instrument quickly performed a three-dimensional scan by measuring a high number of points based on the resolution chosen. Two laser models were used to speed up scanning operations: the cam2 FARO FocusM 70 and the older Z + F IMAGER 5006h⁸ (Fig. 13).



Fig. 13: Laser instrumentation used

The laser acquired three-dimensional coordinates of points distributed on the object in high density, information relating to the

reflectivity and the RGB value of the material. The lasers used are both 'phase variation', this means that the distance was calculated by comparing the phase difference between the transmitted and received electromagnetic wave. This technique requires dedicated computational algorithms to generate the coordinate information in space. These are devices that allow the digitization and modeling of objects and portions of the territory having any shape and size (Ippolito & Cigola, 2016).

The data collected consist of point clouds, which consist of a set of three-dimensional positions in a given reference system, and containing the coordinates accompanied by the intensity values. These are displayed in real time on the instrument. Given that for a complete survey of an object several scans are required and each of them has an independent reference system, it is necessary to use a software that allows the execution of the rototranslations necessary for the creation of a homogeneous 3D model for move to a single reference system for all. In the restitution work, in this case, Autodesk Recap was used to merge and index the various clouds which in this case amount to 276 (Fig. 14). The first phase of merging, that is the 'registration', saw a pre-alignment of homologous points in scans that have been partially automated by the software which recognizes them, otherwise they are entered manually.

To do this, the scans must have a sufficient degree of overlap to identify the same (at least 3) points in each one. The materialization of the quantities in question through collimation occurs through parts of clearly visible and recognizable structures (edges, characteristic points) and, in this case, also with the targets already used for



Fig. 14: Index cloud ready for the necessary elaborations on AutoCad

⁸ The field survey was performed on January 8-9-10, 2019 together with the architect operator of the University of Florence, PhD. Francesco Tioli.

photogrammetry. In the end, this processing made it possible to navigate within the indexed cloud (Fig. 15), extracting profiles and sections useful for knowledge about the artefact (Guidi, Russo, & Beraldin, 2010).

In the last phase, the point cloud was imported to Autocad for the reconstruction of the drawings necessary for the representation of the building, i.e. plans, elevations, sections etc, obtained by carefully chosen cutting plans, for a total of 3 elevations, 6 sections and plans at all levels, including that of the roofs (Fig 18-25).

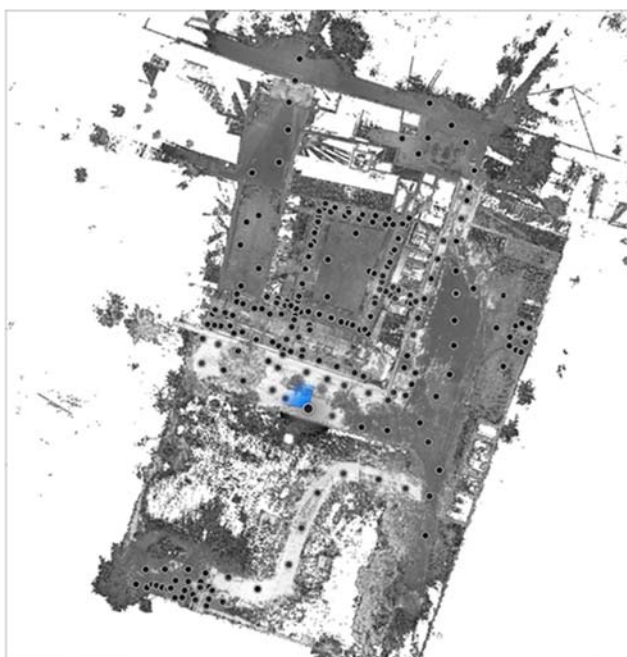


Fig. 15: Cloud indexed on Recap



Fig. 16: Scan on the south front

The direct survey of the interiors integrated these results and made it possible to reposition the walls and partitions. Particular attention was paid to survey of the vaults and to the fifteenth-century cloister. The survey confirmed a careful study by the architect who took care of the 1473-76

extension. Evaluating the facades in florentine “braccia”, we note that the southern front (Fig. 16) is equivalent to 90 “braccia” like the eastern one. The two new bodies therefore created a quadrilateral encompassing the oldest part, but generating two well-proportioned fronts. Furthermore, in redesigning the new perimeter, the southern wall was positioned 100 “braccia” from the south front.

Furthermore the loggia of this front had its central column - in axis- along the alignment of the main north-south elevation of the ancient medieval monastery, which corresponded to the trend of the church facade. The spans of this church, whose length is 36 “braccia”, are exactly equivalent to the spans of the north front of the cloister, thus offering a great compositional balance to the entire building extension. The two external chapels are also positioned following a precise reasoning: the one at noon is situated along the axis mentioned above that starts from the church and here culminates against the perimeter wall; while the chapel to the east is located along a second axis that goes from the north head of the kitchen at the eastern perimeter at a distance from the front equal to half of the southern one, that is 50 “braccia” (Fig. 17).

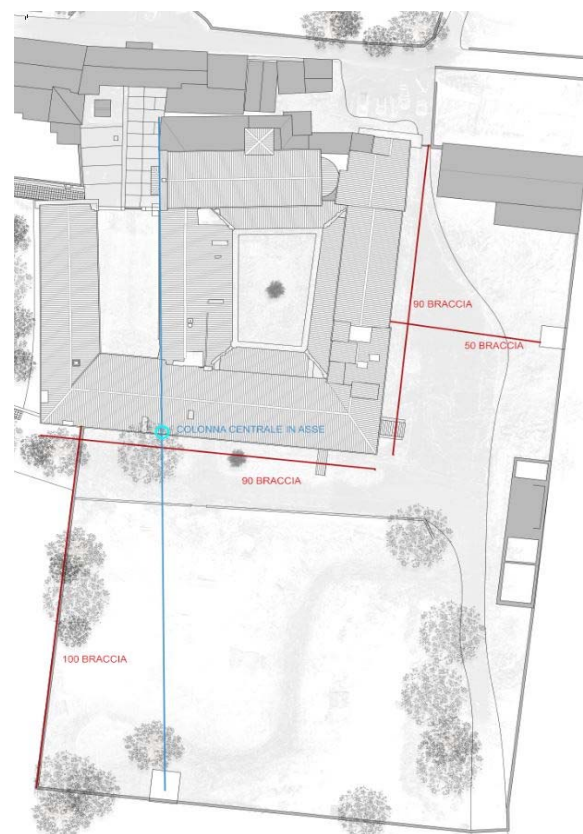


Fig. 17: Critical reading in florentine “braccia”



Fig. 18: Plan with sections



Fig 19: Section CC'



Fig. 20: South elevation



Fig. 21: East elevation



Fig. 22: West elevation



Fig. 23: Section BB'



Fig. 24: Section DD'



Fig. 25: Section FF'

4. Conclusions

Currently in the whole complex there are situations of advanced decay, generated by abandonment and lack of maintenance, which also lead to structural failure and water infiltration. The floors, almost all non-original but in stoneware, are damaged or missing; the wooden floors are deteriorated and the plasters are unsafe. The windows are torn up on 90% of the complex. The fragmentation of the vaults in some cases is so extensive that in order to find the original spatiality, numerous integrations of entire portions of it would have to be made. In others, it can be easily restored to its ancient splendor through simple cleaning and small reintegrations of the ornament. Some, especially in the cloister, show differential degradation characterized by cracks and swelling and detachment of the plaster placed on the intrados surface. But the real problems exist on the first floor where the weight

Pietro a Luco needs a first batch of urgent works to block further damage to the architectural complex and prevent its total collapse. Obviously, given the economic conditions, the attempted alienation of the property and the lack of funds, it was necessary to make a selection of priority interventions to be carried out.

Restoring the roof and the facades is certainly the first step to take, at least with regard to an improvement that could attract the attention of a potential buyer / investor.

Since it will take a long time to heal the complex, as well as a huge use of capital, it is also difficult to establish a timetable in which to ensure something definitive for the monastery and above all to set precise intervention points.

However, in this first phase of research, an analysis was carried out for the enhancement and knowledge of the building through its history and through the three-dimensional survey. In this way,



Fig. 26: Hypothesis of temporary reuse of the building

and leaks in the roof have caused the total collapse of most of the false ceilings, the detachment of the plaster, the collapse of the partitions and the complete destruction of the fixtures. In conclusion, from the analysis carried out, the monastery of San

a useful basis has been provided for those who will take on the task of stopping its decline, perhaps reviving it for new functions.

The hypotheses for the reuse of the structure also saw the idea of using the monastery as a

museum, a sort of branch of the Uffizi, where the many works that lie in the basements and will never be visible to the public could find a place. Obviously an operation of this type involves a significant use of capital and, currently, the moment does not seem propitious. So it is better, for now, to turn towards a more easily achievable use. Among the various functional proposals that have emerged over the years those that direct the asset to a private individual, for a greater possibility of monetary resources, seem more plausible. In particular, the hypothesis that seems to work best is that of a nursing home for the elderly or a recovery and rehabilitation center. This would make it possible to maintain the appearance and hospital life, in contrast with the transformation into a luxury resort or hotel, as has often happened in Mugello for many religious old settlements, which have unfortunately already

been modified in this sense. So in line with the proposed project for the nearby former monastery of Santa Caterina, the opening of the ground floor, hosting the garden and the cloister, is hoped for, for the inclusion of commercial activities in the interior (Fig. 26). Going up to the upper floors there will be rooms for cultural activities, workshops, a conference room and a wing intended for health activities, with treatment services. The monastic architectonic complex of San Pietro a Luco would thus continue to provide, in a completely new perspective, the satisfaction of the needs of its Community, that is still so closely tied to it, perhaps keeping the cloister and courtyard areas open to the public as proposed (Fig. 27). Making a sort of mix between public and private, because size allows it, could really make a difference in reviving this cultural heritage.



Fig. 27: The proposed temporary functions

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