ISSN 1828-5961

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Representing the past. Methods of Digitization of industrial archeology

Rome looks like an open-air archaeological museum; the artifacts of the past define the entire urban fabric of the city in a distinctive and unique way. When we talk about the urban archeology of the city of Rome, we are not simply referring to architectural artifacts from a distant past, but also to buildings of considerable importance that have had an impact on the urban development of the city in the last two hundred years. References are those archeologies of the nineteenth and twentieth centuries, which defined the industrial development of the city; industrial archeology. The research presented is aimed at presenting a process of digitization of these elements through relevant integrated systems. The survey methods, which allow the digitization of architectural artifacts, have been defining a new way of detecting the existing in recent decades. The research, through the analysis of two case studies, aims to highlight how these systems adapt to the survey process of industrial archeology. The photomodeling processes and laser scanner are an essential basis for analysis and knowledge of the architectural artefact. The result is the same, but the processes, methodologies and definition of the digital artefact change drastically.

Keywords:
Survey; Digitalization; Industrial Archeology; Photomodeling; Laser Scanner

DOI: https://doi.org/10.20365/disegnarecon.27.2021.9

ISSN 1828-5961

1. INTRODUCTION

When we talk about the urban archeology of the city of Rome, we are not simply referring to architectural artifacts from a distant past (Fig.1), but also to buildings of considerable importance that have had an impact on the urban development of the city in the last two hundred years. References are those archeologies of the nineteenth and twentieth centuries, which defined the industrial development of the city; industrial archeology. As the central part of the city is defined by punctual and areal elements from the Roman era, the neighborhoods of the southern part are characterized by former industries, abandoned, redeveloped or in the process of redevelopment. These industrial complexes have been abandoned and, in some cases, redeveloped to accommodate new functions. The research is aimed at presenting a process of digitization of these elements through relevant integrated systems. The survey methods, which allow the digitization of architectural artifacts, have been defining a new way of detecting the existing in recent decades. The research, through the analysis of two case studies, aims to highlight how these systems adapt to the survey process of industrial archeology. The photomodeling processes and laser scanner are an essential basis for analysis and knowledge of the architectural artefact. The result is the same, but the processes, methodologies and definition of the digital artefact change drastically. For this reason, it was decided to draw up methodological processes, compare them, and analyze which is the most suitable for defining the industrial archaeological elements. The case studies examined are two, one located in the former industrial district of Ostiense-Marconi, a pavilion of the former Mercati Generali; the other is the former Filanda located in the San Giovanni district, near the archaeological linear system of the Aurelian Walls.

Fig. 1 - Sketch of the area of the Fori Imperiali and of the historical stratifications in Rome

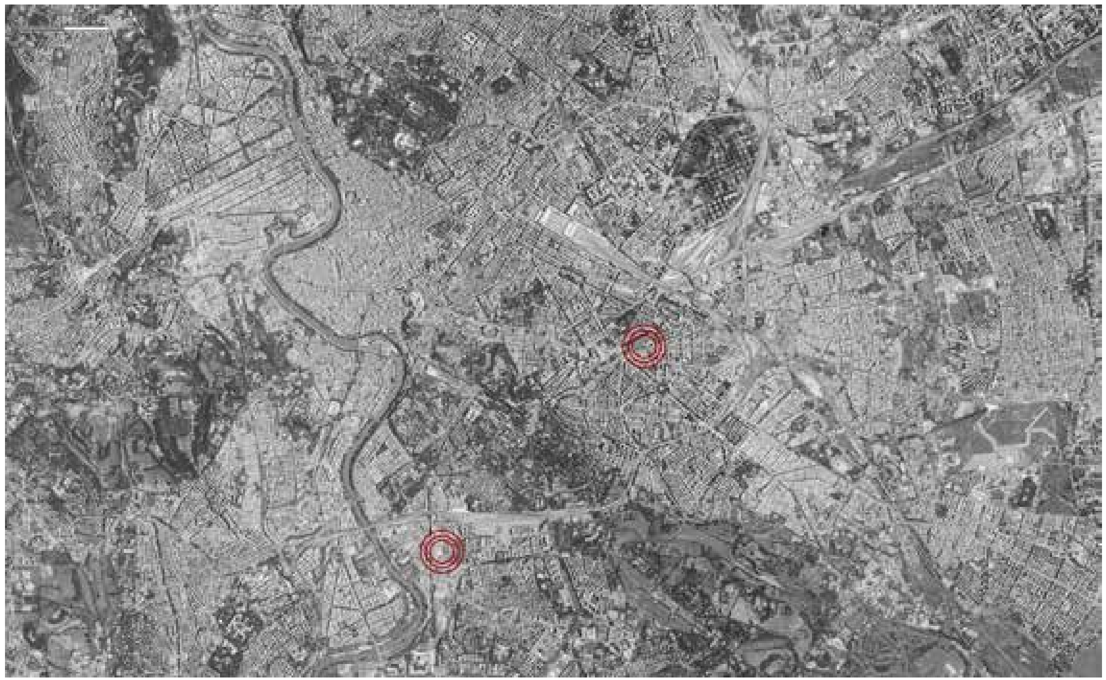

Fig. 2 - Identification of the area where the case studies are located. In the southern quadrant the Ex-Mercati Generali, in the central quadrant the Ex-Filanda.

DOI: https://doi.org/10.20365/disegnarecon.27.2021.9

Two types of digital instrumental surveys were used in the two case studies of similar dimensions, to understand what information is obtained and then how to process the data and move on to a digitalization of the architecture. (Fig.2)
These processes, with a view to managing the cultural heritage of the city, are becoming increasingly important, as they make it possible to become a basis for the preparation of a digital information database of knowledge, analysis, conservation and cataloging of architectural and archaeological emergencies of the urban fabric. This line of research is part of an ongoing research whose goal is precisely to work on the processes of digitization of the cultural heritage and historical maps of the Roman territory.

2. HISTORICAL INTRODUCTION: THE INDUSTRIAL ARCHEOLOGIES OF THE EX-FILANDA AND EX-MERCATI GENERALI

In order to prepare the digital reconstruction of the historical architectural heritage, it is always necessary to go through an accurate and in-depth historical research. Our task is to respect the history of the building, trying to restore today an image that is faithful to the current reality but aware of the transformations that have built this contemporary image over time. This is the case of the building that we know today as Ex-Filanda, in viale Castrense 51, which is in the current Appio Latino district, close to the Aurelian Walls near Porta San Giovanni and Piazzale Appio. (Fig.3)
The building in Viale Castrense, although it is known today as the "Ex-Filanda", was designed and built as a school in 1920. More precisely, it is part of the *Infantiae Salus* Pavilions, a childcare service, becoming part of the works of the Social Assistance Office of the Governorate of Rome.

Through some writings of the time, and thanks to the architectural analogy that existed between other *Infantiae Salus* pavilions, it is possible to get a rather precise idea of the building located in Viale Castrense. (Fig.4)
The three pavilions (located respectively in Trastevere, Testaccio and Appio district) were built according to a similar scheme. The general plan, created in 1920 by Engineer Romeo Cametti, shows a semi-courtyard layout, from which the largest body of the refectory protrudes. The exterior,was divided between simpler spaces treated as gardens, and areas where the vegetation was more present, cared for as a vegetable garden by the same schoolchildren. The Pavilion in Viale Castrense differs from the general project mainly in the planimetric layout, which has a linear development instead of a semi-courtyard (Fig.5).


Fig. 3 - Aerial view of the area with the Basilica of San Giovanni in Laterano, Porta Asinaria and Porta San Giovanni, Piazzale Appio and the first stretch of Via Appia Nuova. On the right of Porta San Giovanni we find the buildings in via La Spezia, behind which is the pavilion of the Ex-Filanda, lower and therefore not visible. 1950s. Source: Appiohblog


Fig. 4 - Top view of the Infantiae Salus pavilion in Trastevere, with schoolchildren engaged in outdoor games. Source: Capozzi Maria, The Infantiae Salus Pavilions, Unione Arti Grafiche Abbruzzesi, Rome, 1926

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ISSN 1828-5961

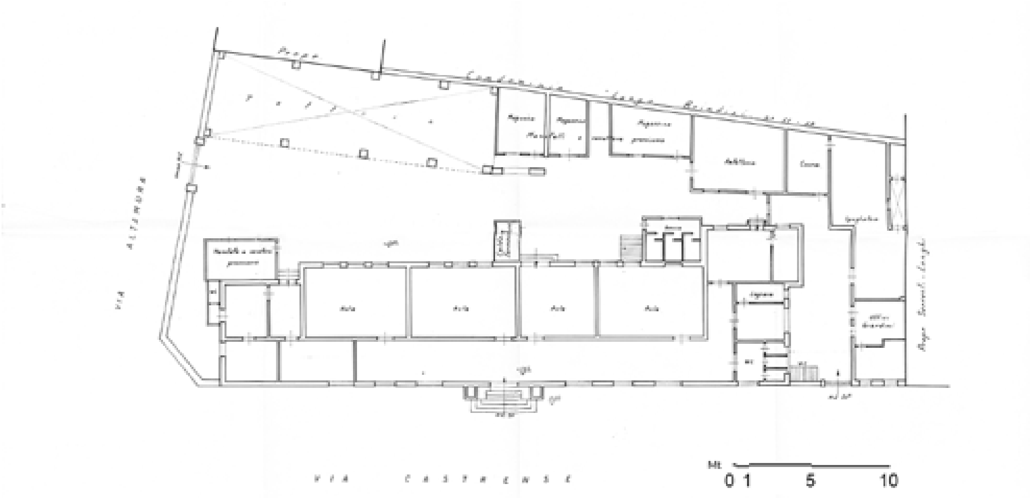

Fig. 5 - Plan of the *Infantiae Salus* Pavilion, S. Giovanni district, scale 1: 100. Comune di Roma, Ripartizione II, Revisione Inventario, 12 Novembre 1965. Source: ACPCR, POS. 763.

Fig. 6 - Aerial photo of the current situation made by drone flight.

Fig. 7 - Aerial view of the Mercati Generali in Ostiense in a period image. Source: lostitaly.it

The first specific technical drawings of the Pavilion date back to 1963, as part of a process of cataloging the buildings of the Municipality of Rome. The plan shows the building developing along Viale Castrense covering an area of 416.40 square meters. The elevation along the street, on which the main entrance is located, corresponds to a large corridor through which you have access to the different rooms. Elevations and sections show the mezzanine floor with respect to the street level on which the building develops, with the flights of stairs at the entrances. Here too, as in the pavilions of Trastevere and Testaccio, the open space of the courtyard was of fundamental importance and was, in all probability, partially organized as a vegetable garden. Two years later, a technical report with attached drawings dated 29 November 1965 by the Special Heritage Revision Office of the Municipality of Rome, shows the changes that have occurred on the lot. In addition to some internal changes aimed at accommodating some classes of the "Porta Maggiore" school, the most significant changes concerned the internal courtyard, used by the Gardens Office which built some artifacts of negligible building value. After being used as a school, the Pavilion also housed an institute of textile craftsmanship to which we owe the name of Ex-Filanda with which we know it today. (Fig.6)
The history of the Ex-Mercati Generali, located in the Ostiense district, has a parallel development to that of the Ex-Filanda: the two buildings, in fact, are built almost simultaneously, and will go into abandonment just a few years apart. The Mercati Generali were inaugurated in 1921, even if the project began more than 10 years earlier, in 1910, when the new "Project for the construction of the General Markets and foodstuffs" outside Porta S. Paolo was presented. The complex will go into disuse only in 2002, when the markets will be transferred to the new structure of the Guidonia Agri-food Center.
Characteristic piece of the Ostiense district, the Ex-Mercati Generali cover an important area between the latter and the Garbatella district, close to the Rome-Ostia railway. The complex of the Mercati Generali therefore foresees two zones: one with entrance on via Ostiense and the opposite area, with the entrance facing along the Rome-Ostia railway. (Fig.7)
The two areas are separated in the center by an area intended for the railway junction. The entire perimeter of the market is occupied by warehouses, sheds, stables, and shelters, while the basement corresponding to the sale of meat is dedicated to cold rooms. In any case, allthe pavilions are built at an elevated height with respect to the floor, for reasons of greater convenience in loading and unloading goods. At the time of the inauguration, which will only take place in 1921 due to delays due to the First World War, not all the pavilions were complete. In 1944, the bombings of the Second World War partially damaged the complex, however the activity will continue until the early 2000s.

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It is after 2002 that the history of the Ex-Mercati Generali begins a new phase that would have required a reconversion of the entire area in the "City of Youth" proposed by the mayor Veltroni. To this end, architect Rem Koolhas is entrusted with the project, never completed the reconversion work through the first excavations, had also brought to light important archaeological remains. Today, however, the area is still abandoned (Fig.8).

3. THE PROCESSES OF DIGITIZATION. INTEGRATED SURVEY METHODS

The built heritage, especially historical, has undergone over the decades, alterations, or real substantial changes, which have changed its original structure and inserting a contingent need in measuring the transformations and their stratifications.
The urban survey process has its roots in the Renaissance period, when the need to tax real estate properties and to know the amounts for the respective calculations took over. Now that the built heritage is already cataloged and projects, surveys and licenses can be traced to an architecture, the greatest need is no longer just for knowledge, but for digitization, for a transposition of the features of the building into the virtual space, easily accessible and questionable. This need is partly the result of the considerable technological developments that allow today to detect the architectural object in a short time, with increasingly precise tools and with increasingly complex and detailed digital analysis and processing. The survey today, now far from the surveying tools and the direct method, no longer measures distances and angles but directly scans the real space, through two specific tools, the laser scanner and the camera, connected to two different processes of reconstruction of the virtual space but similar in results. The process of digitization of built heritage particularly affects those key places that public administrations have included in systematic recovery and reuse programs, although the gradual extension of this process to an increasingly vast architectural landscape is also desirable. For this purpose, we have chosen two case studies that fall within this recovery plan of the municipality of Rome and in which the two virtual restitution processes described have been applied.
The first case study, the Ex-Filanda pavilion was digitized through a reconstruction process based on an instrumental laser scanner survey integrated with aerial photogrammetry with drone. The resulting point cloud, with a high degree of detail, was then used to draw up two different digital reconstructions, the first two-dimensional and the second three-dimensional. The three-dimensional reconstruction in NURBS, using dedicated software, then allows the creation of CGI views and immersive digital realities for the historical knowledge of the artefact. (Fig.9) The second case study the Ex-Mercati Generali, on the other hand, was digitized using only the photomodeling process, to understand the substantial differences and the degree of detail that is obtained with this different approach to the geometric and material knowledge of the artifact. In this case, the digitization of the artifact has focused on the material and geometric knowledge of the building, understanding how the digital model can help in the preparation of a process of material restoration of the building.

Fig. 8 - Views: areas, plans and perspectives of the current situation of the former general markets.

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Fig. 9 - View of the three-dimensional model of the exfilanda pavilion. First NURBS model made from point cloud.

Fig. 10 - Position of the shooting points of the Laser Scanner campaign. Rework extracted from Autodesk Recap software.

4. THE DIGITIZATION OF BUILT HERITAGE. THE EX-FILANDA ON VIALE CASTRENSE IN ROME

The complex of the Ex-Filanda has undergone several transformations in recent decades up to a current situation of total degradation of the main body following a fire that caused the collapse of the roofs and the progressive decay of the plaster and masonry. The lot ends with a series of annexes, built for necessity around the main building and detached from the original block, in which some municipal offices of the Giardini Service have been located.

Finally, we must remember the proximity of the former Filanda complex with the stretch of Aurelian walls that from Porta San Giovanni reach Santa Croce in Gerusalemme, that is the portion of Viale Castrense with the destination of a linear park in the near future. The relationship between the complex and the walls is essential for any design approach, it follows that the Aurelian walls themselves were surveyed.

The state of the sites constrained the design choices for the mixed technique survey campaign: instrumental survey with ground laser scanner for all accessible spaces; photogrammetric survey with drone for the roofs and internal parts of the original block whose collapses did not allow safe access for laser shooting.

The survey from the ground provided for a design of the stationing points that allowed a detail of the dense point cloud of 1mm, thanks to both the scanning quality of the FARO laser and the normal overlapping of the individual scans. (Fig.10) Due to the constant presence of traffic and parked cars, we have designed an external double polygon with stationing points on the sidewalk adjacent to the object building (Pl1) and one, further away, on the (uncultivated) lawn that runs along the Aurelian walls (Pl2). In this way, although the cloud was “soiled” by the presence of the cars on both sides of the road, we guaranteed cleanliness, overlap and the absence of shadow areas on both road fronts, for the Filanda and for the walls, ensuring the continuity of the road sections in many points except for the road surface

ISSN 1828-5961

under the parked cars. Particular attention was also paid to the scanning of some characteristic points and targets that were chosen for the georeferencing, and alignment of the point clouds obtained by laser scanners and drones. From the polygonal on the road, you entered the lot (Pl3), using internal / external connection stations that guaranteed the recognition of the point clouds and perfect overlap and adherence between them. The same dynamic was adopted to connect the office spaces (Pl4) to the external polygonal on the courtyard. The latter, moreover, had the possibility of reconnecting to the external polygonal Pl1 in two points in the accesses to the courtyard, on Viale Castrense and on Via Altamura, reducing the progressive error of overlapping the more distant clouds. For each station designed, the laser scanner generates files containing both the dense point cloud and the panoramic photographs from which the software deduces the coloring of each single point of the laser scans. The alignment process, which took place on ReCap software, is in fact much simpler, with a few operations to perform, as the survey project was accurate, paying due attention to avoiding shadow areas and properly calibrating the overlaps. The cloud of points obtained was cleaned of typical disturbances and noises, from the inevitable passage of cars and buses with strange streaks of points, from parked cars, from ghost clouds resulting from reflections on the glass. This operation was performed with the utmost accuracy, obviously trying to safeguard the correct portions of the cloud as much as possible. (Fig11)

The acquisition of data concerning the internal parts of the non-accessible block and the covers took place through the flight of a drone at an altitude not exceeding 20 meters, considering the GSD detail required. The path followed by the drone involved consecutive passages on a grid of lines parallel to the set altitude and the acquisition of high resolution images following the parallel axis method with an overlap of the shots of at least 40%. The 307 photographs taken ensured the creation of a dense point cloud (and respective mesh model) of good resolution, georeferenced with the previously reported reference points (Fig.12), to which the first laser scanner point cloud was also connected.

However, the creation of a three-dimensional model in the form of a point cloud is only a first step. First of all, it is a discrete virtual restitution, being composed of points, which, however dense, have a void between them. However, fascinating its representation may be, with particular intrinsic effects of aerial perspective, the scientific reading of virtual space must necessarily pass through two-dimensional design software and then a three-dimensional virtual reconstruction in NURBS. (Fig.13)

The redesign of the point cloud in CAD is a fundamental basis for the knowledge of the architectural artefact in every detail. In this phase the final point cloud, often decimated to allow its management in the software, is controlled through section planes, usually about 1 cm thick, which literally slice the cloud, allowing the operator to draw the section architectural by tracing the sequence of points visible on the monitor, acting with a discretization that is in fact subjective, also on the basis of the choice of the representation scale identified at the output. However, it should be noted that we tend to draw the moldings, if present, to a 1: 1 detail,

Fig. 11 - Perspective view of the point cloud. The cloud represented represents the first reworking, without considering the cleaning step of the disturbing elements.

Fig. 12 - Isometric sectional view of the point cloud. The cloud is the result of the integration between the flight with the drone and the laser scanner survey campaign.

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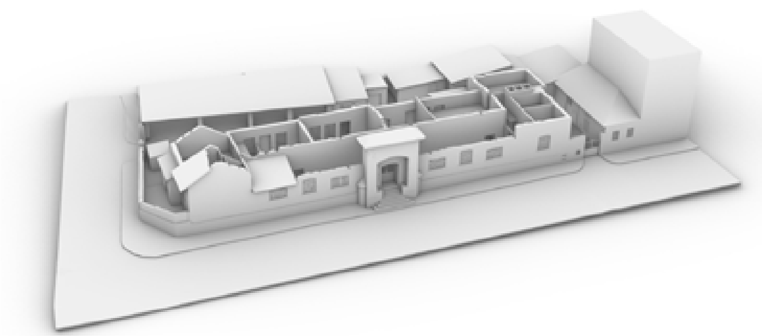

Fig. 13 - 3D model view of the Ex-Filanda. The 3d model was made using the point cloud and the 3d drawings as a source for the geometric information.

retrieving the dimensional information of the various elements directly in the digital space and, if necessary, with the help of detailed photographs.
In the tracing phase, great attention must be paid to the use of the reference UCS systems, and to the projection on the actual planes. The mechanism has its foundations on the projective systems of descriptive geometry and provides for the possibility of polishing elements found in space, obtaining their coplanar image (section and elevation) on the chosen plane. With respect to the three projective planes of the fundamental tetrahedron, we are faced with infinite possibilities of planes, with different positions, chosen, generally through four points: the center of the reference system, and the orientation of the three Cartesian axes in the new location fixed with any point along the direction of the same axis.
Often the complexity of the digital space requires that the portions of the cloud be hidden from time to time, allowing the coplanar polishing of the entire virtual space, from what is sectioned to what is in elevation, even with different levels of distance from the section plane.

With this methodology it is possible to perform elevations and sections of each part of the studio architecture, with attention to detail and faithfully reproducing the real space, which is not trivial, especially if you need to restore ruined, damaged, and decaying architectures. (Fig.14)
There is no doubt that one of the most useful fields of application in having the digital restitution of a real architecture is the possibility of being able to analyze the material aspects and deterioration calmly and more accurately for the purpose of a timely restoration project. The mapping process can be performed in two ways: either directly on the point cloud, as explained above, using the projective rules to trace not only the architectural but also cracks, stains of degradation, gaps, exfoliation ...; alternatively, a high resolution orthophotoplan can be previously generated and mapped directly on it. The use of photoplanes has now become the practice in conservative restoration projects, thanks to the ease of use, the easier management in terms of weight compared to the cloud, the more immediate communication of the aspects of degradation measurable in orthogonal projections. The fact remains that the orthophoto is a .pdf or .jpg file, therefore, in case of doubts or problems, you must always return to the original point cloud for the necessary checks.

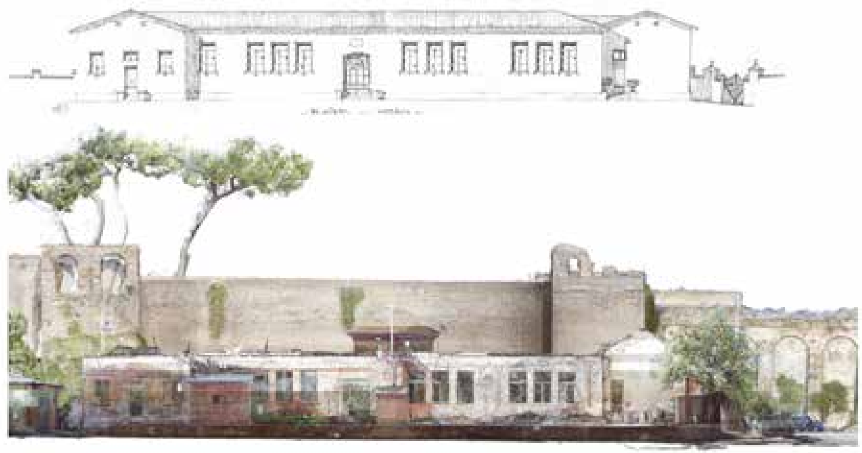

Fig. 14 - Comparison between the project design and the current situation obtained through an orthophotope of the internal courtyard. Note the addition of the accessory bodies dating back to 1965.

Elevations and CAD sections also allow you to proceed with a higher step towards parametric three-dimensional modeling. This step is a must for the digital cataloging of the built heritage, as the point cloud alone shows a rarefied space, navigable and interrogable, but discontinuous and empty. There are software that allow reverse modeling, from the point cloud to the creation of a mesh and then automatically switch to a three-dimensional model in NURBS, however this process, due to the large number of points and triangles, can be applied to small parts and not. certainly to an entire architecture and its context.

5. THE DIGITIZATION OF BUILT HERITAGE. THE PAVILION OF THE EX-MERCATI GENERALI IN ROME

The complex of the Ex-Mercati Generali in Rome, the subject of a recovery and reuse plan by the Municipality, today falls into a state of complete abandonment. The current state of deteriora-

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tion of the complex derives from the decentralization of industry from within the urban fabric in the peripheral part of the city. The pavilion under consideration is part of a system of architectural artefacts that are largely the same in size, materiality and architectural style. Located inside the courtyard of the former markets, it has no elements that prevent a direct survey campaign integrated with an instrumental survey campaign. Unlike the case of the Ex-Filanda, where the first digitization process was implemented using a laser scanner, in the case of the Ex-Mercati Generali it was decided to use photomodeling. Photomodeling, a survey technique that has now become the standard, through Structure from Motion (SfM) techniques, with which it is possible to reconstruct the 3D geometries through the association of two or more photos in which homologous points are recognized, i.e. easily recognizable points in pairs of frames. The photomodeling process uses the homologous points of the photographs to first build a sparse cloud and then a dense cloud of points. Points are associated based on color values and the location where photographs are taken. The processing programs used to implement this survey technique use all the metadata of the photographs for the association of homologous points. In the case of the photomodeling process, the digital model obtained through photographs does not result in 1: 1 scale as it is based on dimensionless frames. This made it necessary to integrate the photographic survey campaign with a direct survey campaign to verify and scale the model obtained. The digital model obtained from photomodeling, based on the homologous points of the photographs, moreover, if applied to architecture can create conflicting results. For this reason, it was necessary to create multiple internal models and one external model. The greater number of dimensionless models, then inserted in a single digital environment, would not have been possible without using the direct survey carried out simultaneously with the photographic campaign as a reference element (Fig.15).

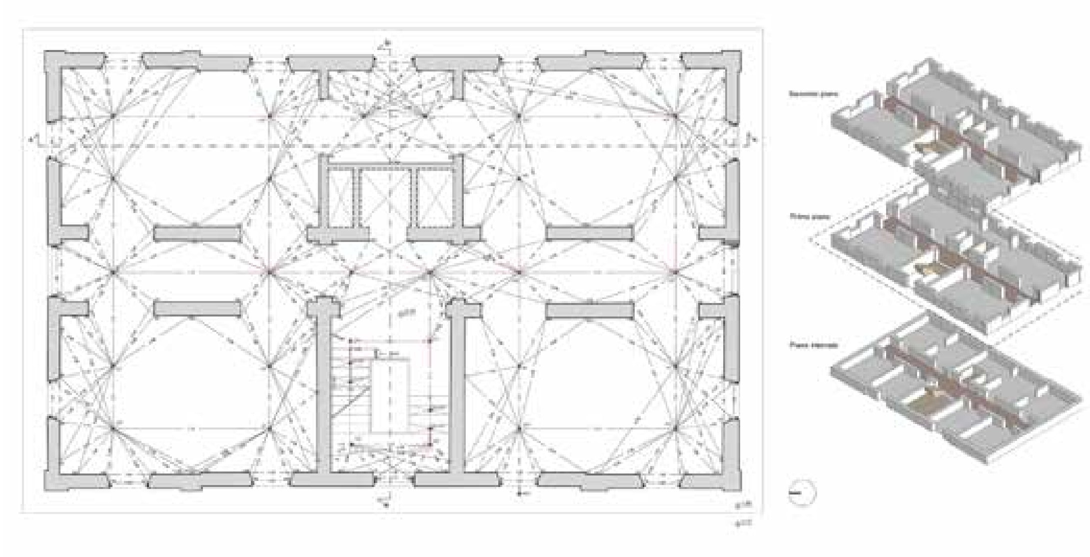

Fig. 15 - Cleaning up of the direct survey campaign. On the left the plan with trilateration of the first floor of the pavilion, on the right an exploded 3D three-dimensional reference.

The association of homologous points, which is based on chromatic elements and GPS position of the photographs, increases the degree of imprecision of the digital model, in some cases creating artifacts within the model, whose reading is not easy to understand. This is in stark contrast to the model made by laser scanner, where the laser detects any architectural element that the light beam manages to reach, reproducing it in full scale (Fig.16).
The geometric imprecision of the architectural model obtained through photomodeling led to the creation of a different modeling process than that implemented on the Ex-Filanda building. Where in the first case, the modeling could only be implemented using the point cloud and specific software that create triangulations between the points and therefore a usable and usable Mesh model; in the case of the Ex-Filanda, the two-dimensional drawing must be the starting point. The process implemented was as follows: cleaning of the direct survey campaign, photomodeling of the various environments, integration of the direct survey with the point cloud models, two-dimensional editing of the elements (two-dimensional drawings and orthophotoplanes), three-dimensional digital model created for historical analogy and vector drawings. The orthophotoplanes obtained from the photomodel allow us to draw up a precise and detailed material analysis of the building, outlining a solid foundation for the restoration project (Fig. 17).

6. THE MODELING PROCESS: THE 3D DIGITAL MODEL

One of the fundamental aspects for the dissemination of cultural heritage by public administrations is the easy reading of the files that must be provided to the user. To allow an effective and non-discretized communication of the detected space, it is important to create, starting from the point clouds, a solid 3d model, in mesh, or even better in nurbs. The rarefied model made up of points only must

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Fig. 16 - Orthophotoplan, and CAD drawing of one of the pavilions of the former Mercati Generali. The three-dimensional model of the point cloud was obtained through a photographic survey campaign and a photomodeling process.

go through a process of constructing the surfaces between the points themselves, a reverse modeling, or a two-dimensional redesign of the new ones to recreate the orthogonal projections useful for the realization of the Nurbs model. Virtual reconstructions, in this regard, can have a double value. Firstly, an ideal reconstruction that restores an image of the artifact in a given period, restoring an image that was lost or never existed. Secondly, it is possible instead to recreate the appearance of the building in its current state, at the time of the survey. Obviously the two types are the consequence of different communicative purposes. On the one hand the purely cultural-informative aspect, on the other the more technical aspect in view of conservative rehabilitation projects that require knowledge of the state of the places at the initial stage of the design phase. This second type of Nurbs three-dimensional modeling clashes with the relative difficulties in reading the individual parts from the point cloud, requiring the necessary identification of criticalities, as well as the choice of the most streamlined and truthful reconstructive solutions. The problem of virtual reconstructions in contexts of evident architectural degradation is the strong irregularity of the walls in plans and elevation due to natural processes of decay, collapse or static collapse. This operation requires a more accurate two-dimensional reconstruction of the building, with the redesign, even partial, of sections and elevations for each wall partition. The problem on the walls also extends to the supports of the roofs, floors and the remaining portions. The same collapses within the site impose discretization choices of the nurbs model: reconstruct only the architectural components still in place, excluding the rubble of the collapses from the modeling. The reconstruction excludes from the three-dimensional modeling everything that would necessarily be removed in a phase of clearing and cleaning the site, this delivers a cleaner image compared to the one during the survey. The solutions that are adopted to simplify the digital reconstruction are linked to the real need to find a middle ground between a mesh model, in a certain way more detailed formally deriving directly from the point cloud, and a nurbs model, which instead guarantees a greater simplicity of management, communication, and interrogation by external users. These solutions have been agreed from time to time with the administration, which has expressly requested a nurbs model to be provided to the design studios, as a starting point and help for the design phase and can be integrated more easily with the final projects. There is no doubt that the work behind such a virtual reconstruction is in a certain sense greater than the two-dimensional redesign alone, which focuses on typical plans and elevations and some characteristic sections. Virtually reconstructing the detected three-dimensional space instead requires a deep knowledge of all the architectural components of the building, recognizing and extrapolating information on each individual architectural and construction component directly from the point cloud. However, the real need of public administrations to have these types of reconstructions today clashes with an absence of codified rules and delegating to subjective choices on how and what to model in three-dimensional virtual space. A lack that practice and time should resolve in a more scientific and generalized way.

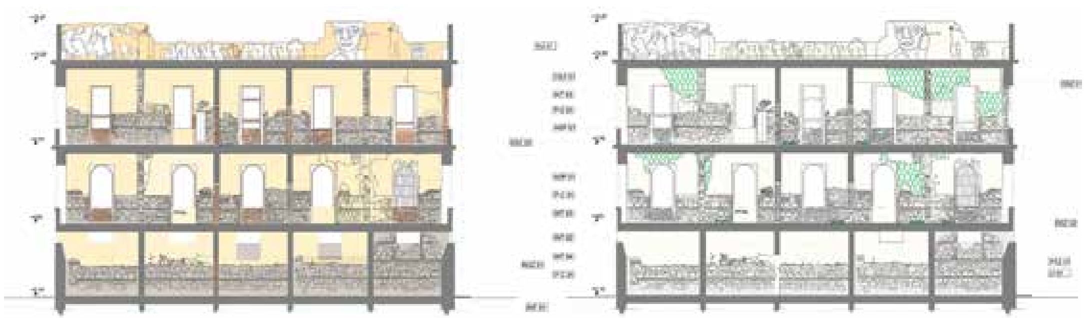

Fig. 17 - Material mapping on the left and mapping of the degrade on the right of the pavilion case study of the former general markets. The drawings were made by integrating the point cloud model, direct survey and orthophotoplanes.

 DOI: https://doi.org/10.20365/disegnarecon.27.2021.9

ISSN 1828-5961

7. CONCLUSIONS

The research presented focuses on the digitization processes of archaeological structures grafted within the urban fabric of the city of Rome. We focus on how different integrated survey processes lead to similar but specific results for each need. The survey, as described, is only the first of the processes that allows to obtain a digital model of reality in 1: 1 scale. The examples presented are only a small part of the broader departmental research that sees as its goal the digital reconstruction of the archeology and the historic urban fabrics of the city of Rome. A concrete help, not only for the planning and understanding of the city, but also an instrument of historical memory that without adequate resources is likely to be lost. (Fig.18) The knowledge of an architectural artefact in recent years is not based only on two-dimensional drawings, but through modeling and rendering software, which allow it to be enjoyed at 360 degrees. The article presents two distinct approaches, the first aimed at a survey process, where the goal is not only to obtain a model aimed at the material knowledge of the building but also at an immersive three-dimensional knowledge of the building. The digital model, through external instruments, allows to create virtual environments through which it is possible to experience the space, and in the case of a reuse project, to maintain a digital memory of the original conformation of the architectural element. The second approach, on the other hand, sees the integrated survey and digitization of the building as a tool aimed not only at the geometric knowledge of the building, but at a detailed analysis of materials and decay that has indelibly marked the building over the years. A mainly two-dimensional digital model that allows a careful and detailed restoration project.

Fig. 18 - Orthophotoplan of the Ex-Filanda obtained from a point cloud. The point cloud was created through an integrated instrumental survey, using laser scanner technologies and drone shooting.

DOI: https://doi.org/10.20365/disegnarecon.27.2021.9

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