

# Historical-constructive investigations and digital modelling for knowledge and requalification of the architecture of the second half of the twentieth century. The case of the University of Calabria in Cosenza (1972-1986)

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## ABSTRACT

The analysis of the heritage of the second half of the twentieth century offers useful lines of study to understand the evolution of building industrialization in Italy, both in the more advanced areas of Northern Italy, and in the Central and Southern regions, where the spread of these practices was more challenging. This paper presents the first results of the analysis conducted on a portion of the University of Calabria campus, located in Arcavacata, near Cosenza, and designed by a group guided by Vittorio Gregotti. This study is part of a research project concerning the requalification of buildings of the second half of the twentieth century, built with prefabricated components, also in combination with structures cast on site. The case study presented in this paper belongs to the first phase of the realization of the campus. The ongoing research aims to associate the historical investigation with the survey of the actual building to build a digital model subsequently of the complex in which to summarize the results of the archival analysis with the data concerning the state of conservation and any technological criticalities observed. The archival analysis carried out to date has highlighted some features of the case study useful to relate the local experience to the national Italian construction context. The transfer from the national framework to the Calabrian case of industrialization faced difficulties and delays. The presence and possible effects of these contextual inertias (logistic, technological) will be verified, in the subsequent phases of the ongoing research, through other Calabrian realizations of the period such as, for example, the Martensson student residences, the new railway station and the Gescal public housing district of Vaglio Lise in Cosenza.

## KEYWORDS

*Construction History, Light prefabrication, Requalification of building heritage, University of Calabria, 1970-80s*

## 1. INTRODUCTION

The analysis of late 20th century heritage, and particularly that relating to the 1960s-1980s repertoire, offers useful lines of study to understand the evolution of building industrialization in Italy. It also facilitates the enrichment of knowledge of construction practices, both in the outposts of experimentation located in the North of the country, and in the regions of Central and Southern Italy, where the diffusion of these practices proved to be slower and more difficult. This paper presents the first analyses conducted on a portion of the University of Calabria campus – located in Arcavacata, near Cosenza – as part of a research project aimed at the study and enhancement of buildings of the latter half of the twentieth century, made with prefabricated components, also combined with structures realized on-site. The research, which is currently being conducted, seeks to examine the diffusion of building industrialization in Southern Italy, verifying the presence of national influences, and the development of an analysis methodology. It is based on the combination of archival investigations and procedures for digitalizing historical data, which are useful for the redevelopment of architectural heritage.

## 2. THE METHODOLOGY

The common use of archival documents as sources for the knowledge of twentieth-century heritage has both highlighted the value of graphic, photographic and construction site materials produced by clients, designers, and companies, as well as emphasised, in some cases, the limits of an exclusively documentary approach. With the exception of large works or corpora of realizations that have been properly documented due to the presence of archives with significant collections, the incomplete documentation, and the poor state of document conservation sometimes make the investigation complex and imperfect. Moreover, archival documentation is not always able to provide a representation of the as built version, given the experimental nature of many works, and the consequent adaptations and/or changes that occurred on site and

which, therefore, have not been documented in the projects, if not partially. Given these premises, the combination of archival surveys and direct investigation of the building, with reference to its geometric-dimensional, technological-construction characteristics and to its deterioration framework, are today strongly facilitated by the availability of non-invasive techniques and tools that are useful for the implementation of digital models of the buildings (i.e. architectural, plant-energy, structural models).

In this framework, the ongoing research aims to combine the historical-archival investigation with building survey, using traditional techniques and more advanced tools. The result is a digital model – intended as a synthesis of the knowledge process – in which the information framework deriving from the archival analysis and the knowledge of the actual state of the building (state of conservation, levels of technological criticality) are summarized.

To date, the survey has been conducted starting from the literature concerning the first and second-degree competition of the University of Calabria campus project won by the group guided by the Italian architect Vittorio Gregotti and considering the archival documentation preserved at the *Direzione Tecnica e Patrimonio Immobiliare* (technical office) of the university. These are the documents of the early phase of development of the masterplan. Other drawings concern the structural design, produced by the contractor of the works, the *Impresa Idrotermica Italiana 3i S.p.A.* Once the research for available materials was completed, the selection of key documents started, resulting in the collection of records useful for the definition of the design and construction events. This documentation is being digitalised to build the historical background on the base of which to verify the actual state of the building and to implement the digital model (BIM) of a sample portion of the built complex. The survey of the current state is ongoing, and is being conducted, starting from archival materials, according to two methods. A first, more essential method which is intended to verify the simplest geometries, is based on the control, using traditional survey techniques, of key-points and measures. A second method concerns the examination of the spaces of the Department of Chemistry and Chemical Technologies (the volume of cube 15C) and of one of the large classrooms, conducted by means of laser scanners (Fig. 1). For these parts, in fact, considering the dimensions, the functional and geometric complexity of the interior spaces and the adjustments that have taken place over the years, it has been decided that the use of an analytical procedure oriented towards the digital modelling of the volumes, according to the 'scan to BIM' methodology, is consistent with the objectives of the research project. The first results of the examination of the archival sources are presented below, starting from the general project of the campus and the first phase of realization of the masterplan. Subsequently, the survey campaign, currently underway, was launched. The acquisition phase is conducted with 3D scanners which, due to the complexity of spaces, required 315 'station points' and will be implemented with data from digital photogrammetry, and from drones for the survey of the roofs. The obtained 'point cloud model' offers a morphometric base of the building parts and a way to read and highlight the architectural, construction and structural characters of the complex (Fig. 2).

### 3. THE GREGOTTI PROJECT FOR THE UNIVERSITY OF CALABRIA

On 20 July 1972, the international competition for the design of the campus of the University of Calabria was launched [1]. The object was “*the design of the buildings relating to the first phase of development and the formulation of proposals for a general masterplan for the university complex (12000 students)*”. The winner of the selection was entrusted with the project of the first phase of development of the campus. This was the first call for tenders launched in Italy for the construction of a department-based university. An experience that was part of “*that euphoric cultural climate that [...] celebrates in university architecture the most significant archetype of our time*” [2]. The competition was contemporary, in fact, with other projects of the 1960s-1970s, among which it is worth mentioning those for the Universities of Cagliari, Salerno, and Florence, as well as the new departments of Sciences of the University of Palermo [3]. The commission, called upon to evaluate the proposals received for the new university to be built in Arcavacata, selected six projects admitted to a further evaluation phase, aimed at identifying the three projects to be awarded. At the end of the work, the group led by Vittorio Gregotti along with Emilio Battisti, Hiromachi Matsui, Pierluigi Nicolini, Franco Purini and Bruno Viganò were granted the first prize of the second-degree. The commission appreciated the high formal level, the vigour of the architectural message, the character of a meeting place attributed to the three-level path system. The *Tekne* company supported the architects for the technological and structural design. The winning project was a landmark work in the national debate on the subject – in which Gregotti also participated with the project for the new departments of Science at the University of Palermo (1971-82) and with that for the Florence university (1971) – and a key achievement in the Calabrian construction framework. In the region, at that juncture, the infrastructure development of the Crati valley was underway, marked by the construction of the new railway station in Cosenza (1971-72) by the Nervi and Bartoli-Sara Rossi group. At the same time, the construction site of the Calabrian portion of the Salerno-Reggio Calabria motorway was taking place, with viaducts of Silvano Zorzi and Riccardo Morandi. These facts, together with the University of Calabria project, related the regional situation with the national cultural and construction framework. In the Calabrian context, on the one hand, we observe the presence of some of the masters of Italian structural engineering, and on the other hand, through the project of the campus and railway station, we note the experimentation oriented towards the use of industrialized building



Fig. 1. Graphic processing showing the portion of the university complex surveyed by laser scanner. The 3D model provides a basis for reading the layout and construction solutions.

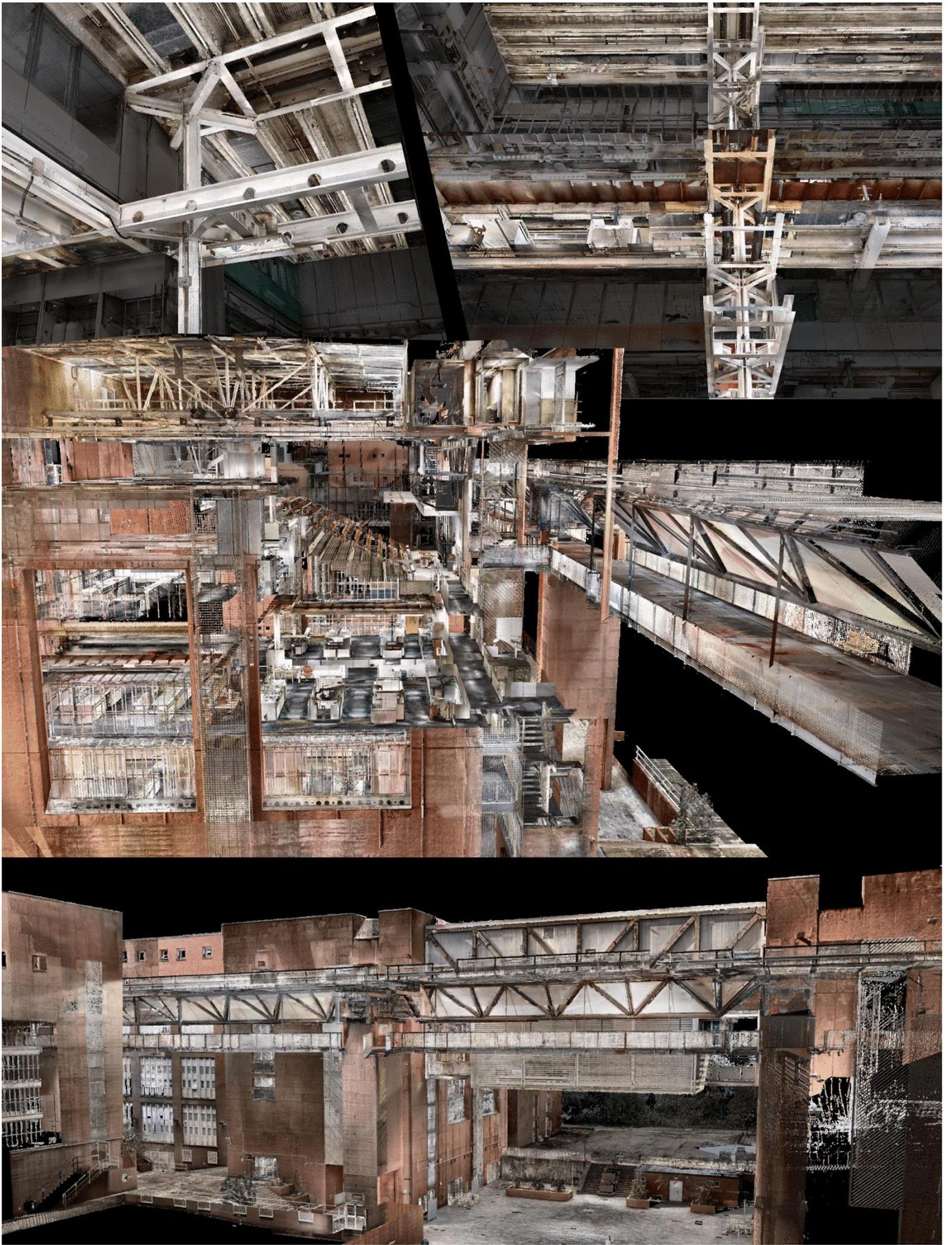


Fig. 2. Drawings deduced from point clouds. The breakdown of the 3D model into some parts can enrich the examination of the spatial and construction logics.

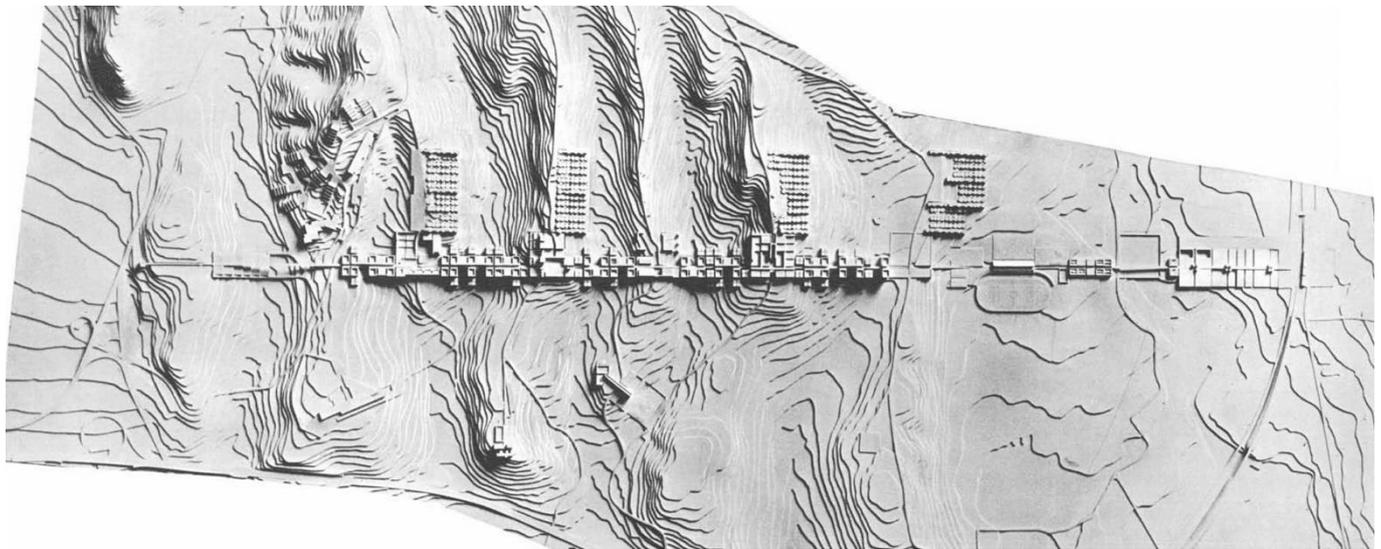


Fig. 3. Model of the project (phase 12,000 students): on the left (south) the relationship with the routes of the Salerno-Reggio Calabria motorway and the state road 107 Silana-Crotonese, on the right (north) the relationship with the Paola-Cosenza-Sibari railway line. Source: Rykwert J. *La nuova università della Calabria*. Domus 540: 16, 1974.

processes, unusual in the regional practice of that time. The first development of the competition project, concerning the Department of Chemistry (now the Department of Chemistry and Chemical Technologies), was representative of the characteristics of the Arcavacata campus. Construction began in 1977, before Gregotti and his team left the construction site, because of the difficult relationship between designers and clients [4]. On 14 January 1977, the Board of Directors of the University of Calabria entrusted the direction of the works of the Department of Chemistry to Carlo Rusconi Clerici, who had already been involved in the project with the company *Tekne* [5]. On 6 July 1977, the *Impresa Idrotermica Italiana 3i S.p.A.* of Rome signed the contract for the realization of the complex [6]. During the summer of 1977, under the technical direction of Rusconi Clerici and the artistic supervision of Vittorio Gregotti, the works started [7]. Interactions between clients, designers and companies advanced with difficulty. In the first months of 1981 Rusconi Clerici and Gregotti were relieved of the supervision of the works. The construction continued under the direction of Eng. Ettore Loizzo, to conclude in the January of 1986, while other executive phases of the campus project were already in progress, following the approval, in 1981-82, of the plans for the departments of Structures, Earth Sciences, and Mechanics. The execution difficulties did not obscure the brilliant design concept, the “*result of a neo-utopic thought*” and aimed at “*configuring new design horizons, full of a transformed collective dimension*” [8], which it is useful to recall in its fundamental contents.

The Gregotti group's first-degree project, with a high density and linear layout, immediately stood out for its excellent relationship between buildings and landscape [9]. The system affirmed first what the architects defined in the competition report as “*a principle of settlement*” that proposed – through the correct relationship between the spaces for research, teaching, services and the site – a “*model of new settlement*” that survives today, fifty years after its establishment, after the successive expansion of the campus, testifying “*the principle of settlement as an act of evidence of that place by means of the architecture*” [10] and confirming “*that the project possesses its own consistent adaptability to the changing circumstances that it has encountered and will continue to encounter*” [8]. Two morphological and functional systems interacted over a vast area of the Crati valley, near Cosenza. The first consisted of the succession, along a linear layout, of the square-plan buildings of the departments (25.20x25.20 m), cubic architectural-functional units placed on the sides of the ‘bridge’ (the path equipped for pedestrian and vehicular traffic and the passage of the plants of the campus). The buildings started from a constant height (227 m a.s.l.), and attached to the ground following the natural orography, thus obtaining blocks of different heights. The second system, following the longitudinal course of the hillsides, consisted of low houses intended for the residences of teachers and students. The common services of the university were located at the intersection between the bridge and the existing roads, defining squares whose urban profile suggested the relationship of the campus facilities with the context. The settlement scheme prefigured by the Gregotti group, was marked by the vast scale of an axis with a total length of 3.2 km, “*Ariadne's thread suspended in the void*” of which Manfredo Tafuri wrote [11]. At its southern end is where the Salerno-Reggio Calabria motorway and the state road 107 Silana-Crotonese approach, there is a large parking area (Fig. 3). At the northern end, there is the pre-existing railway line that runs towards the Tyrrhenian coast and the town of Paola, is placed a new railway.

#### 4. FIRST PHASE OF DEVELOPMENT OF THE GREGOTTI PROJECT: THE DEPARTMENT OF CHEMISTRY (1977-1985)

The realization of the first portion of Gregotti masterplan included the fundamental elements of the general project: the bridge (the path equipped for the pedestrian and vehicular traffic and the passage of plant ducts), the typical architectural and functional unities reserved for the research and teaching activities of the departments (the cubes), and the 250-seat classroom, an example of the large common teaching spaces (Fig. 4). This first phase of the construction offered, potentially, a test to verify the standardization of the construction procedure, the consequent saving of resources and times, and an exam to prove the level of spatial flexibility that the construction system allowed. In reality, the project's outlook faced a complex execution process. The solution adopted for the cubes of the Department of Chemistry highlights a recurring application in the Italian construction background, based on the combination of elements made on site and prefabricated parts produced off-site (Fig. 5). In this case, cast on site reinforced concrete load-bearing walls, associated with prefabricated floors and steel pillars and beams, and internal walls based on industrialized components, are present. The chosen scheme aimed to summarize the structural behaviour of concrete walls, employed as bracing elements, with the versatility of steel components, suitable for covering larger spans and allowing a flexible arrangement of the various floors. Gregotti chosen the concrete-steel combination in the project for the new University of Florence (1971). In Florence University, the standard section of the buildings highlights, on the perimeter, the presence of two concrete walls containing service spaces, stairs and systems ducts; inside this massive envelope, there is an organization of a light steel structure, useful to ensure different layouts according to the needs of the departments. The archival examination of the Arcavacata project has so far highlighted the combination of the spatial flexibility studied by Gregotti with the construction system resulting from the collaboration with *Tekne*, the Milanese engineering company headed by Carlo Rusconi Clerici, who had long been engaged in the expansion of methods and techniques for industrialization of construction processes. The complicity between the two project topics is evident from the preliminary drawings, in which we can see, for example, the grid of construction components necessary to define the spatial and functional system of the building, organized on an essential morphological and construction alphabet, which became part of the evocative repertoire of sketches and graphic investigations of the design process [12]. In the same way, the preliminary sections of the higher cubic architectural-functional units reveal, beyond the apparent simplicity and compactness of the stereometric volumes of the departments, the versatility of the layouts, whose articulations indicate the physical and visual relationships between the various levels, and the arrangement of large glazing walls.

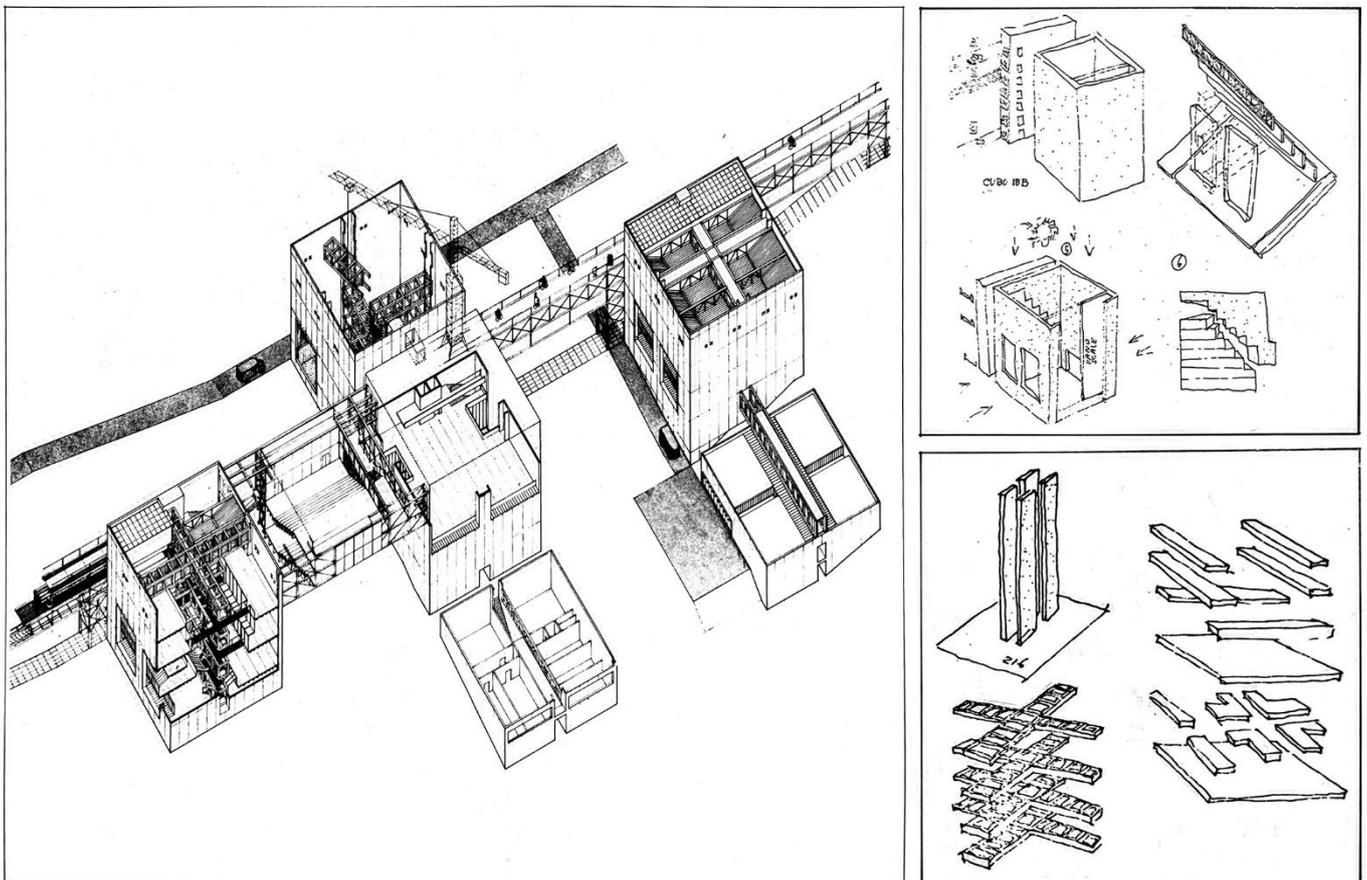


Fig. 4. Department of Chemistry: construction and functional schemes of the competition phase. Source: Rota I. Il progetto per l'Università delle Calabrie e altre architetture di Vittorio Gregotti. Electa, Milano, 1979, 21-23.

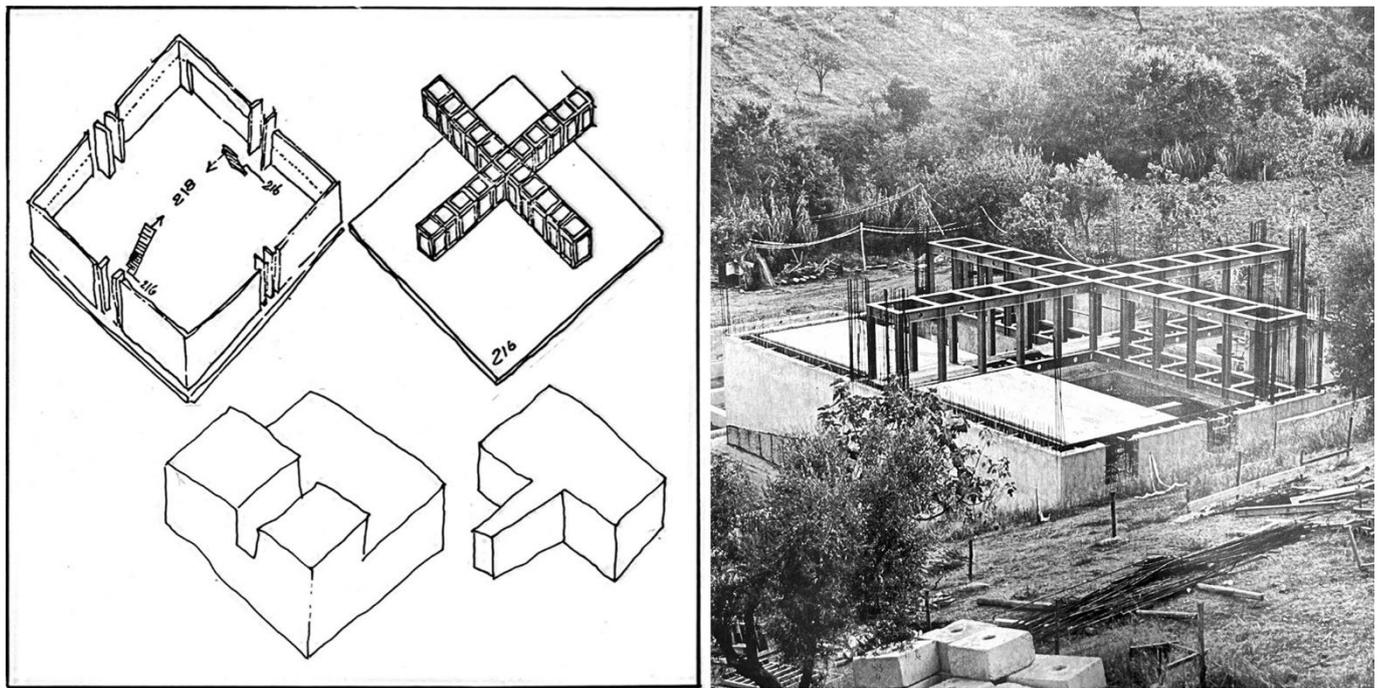


Fig. 5. One of the two low cubes of the Department of Chemistry: construction and functional scheme, photograph of the construction site. Fonte: Rota I. Il progetto per l'Università delle Calabrie e altre architetture di Vittorio Gregotti. Electa, Milano, 1979, 21,35.

Finally, they evaluate the location of the walkways and of the windows, and the roof structures [13]. The comparison of these intuitions with the drawings of the executive project refers to few adjustments of the early scheme and, those introduced, were suggested by the results of the geotechnological tests that determined the use of piled foundations (and the simultaneous elimination of one of the two basement floors), and by the adaptation of the prefabricated large tiles used for the floors, recommended by structural design evolution. On the other hand, the essential rules were unchanged, even in the presence of dimensional purposes recommended by the functional needs of the Chemistry department.

In the executive project of cubes 15C and 17C, the designers defined the geometry of the typical departmental building (the cube), proposed in the competition phase, on a rectangular plan (26.40x21.30), articulated on nine floors. The layout of each consisted of a primary functional and construction sub-system with a square plan (21.30x21.30 m), which was flanked – as in the aforementioned Florentine project – by a service sub-system, 4.80 meters large, which contained the stairs, the elevator and the main plant ducts, according to a concept that divided, in the planimetric-construction layout, the parts adaptable to the different teaching and research needs of the departments from the invariant ones (stairs, service spaces, systems). The geometric-functional sub-systems were formed, according to one of the two configurations studied in the competition process, considering the views and the relationship of the buildings with the bridge. In the first case, the one adopted for cubes 15 C and 17C, the service block (4.80 meters large) was placed on the East front, with the long side parallel to the axis of the bridge, determining the opening of the windows on the square below the hall (the 250-seat classroom). In the second option, which can be found, for example, in the Department of Structures, built a few years later, the service block was placed on the North side, with the long side perpendicular to the axis of the bridge, thus allowing the arrangement of the windows towards the bridge, and on the hills of Arcavacata.

According to the 1970s project, the two tall buildings (cubes 15C and 17C) of the Department of Chemistry had a load-bearing structure composed of 30 cm thick cast-on-site reinforced concrete walls strengthened by ribs. Inside, two steel columns with a cruciform cross-section, whose shaft culminated in the capital with four bracket to support the beams of the floors, were (Fig. 6). The walls absorbed the vertical loads transmitted by the floors, the roof, and the beams of the suspended hall (located between buildings 15C and 17C) supported by the walls themselves. In addition, they functioned as bracing elements that absorbed horizontal forces. There were two floor types in the tall buildings. In the part of the services, with a smaller span, they consisted of an 18 cm thick reinforced concrete slab, while in the remaining areas, intended for offices, laboratories and classrooms, prefabricated prestressed reinforced concrete large tiles were, arranged in spans of 8.90 m [14]. The components were placed on one side on a C-beam positioned on brackets, with a double-T section, embedded in the casting of the concrete walls and, on the other, on perforated core beams, arranged on four supports (the perimeter walls and the brackets welded at the head of the two steel pillars). Welding metal plates, attached to the prefabricated components and connected to the C-beams with NP profiles and plates arranged in the section of the elements, connected the large tiles to each other. Initially, the designers selected large precast reinforced concrete tiles, but, finally, they used prefabricated prestressed components, 36 cm high and 90–102.5 cm wide, and with ribs

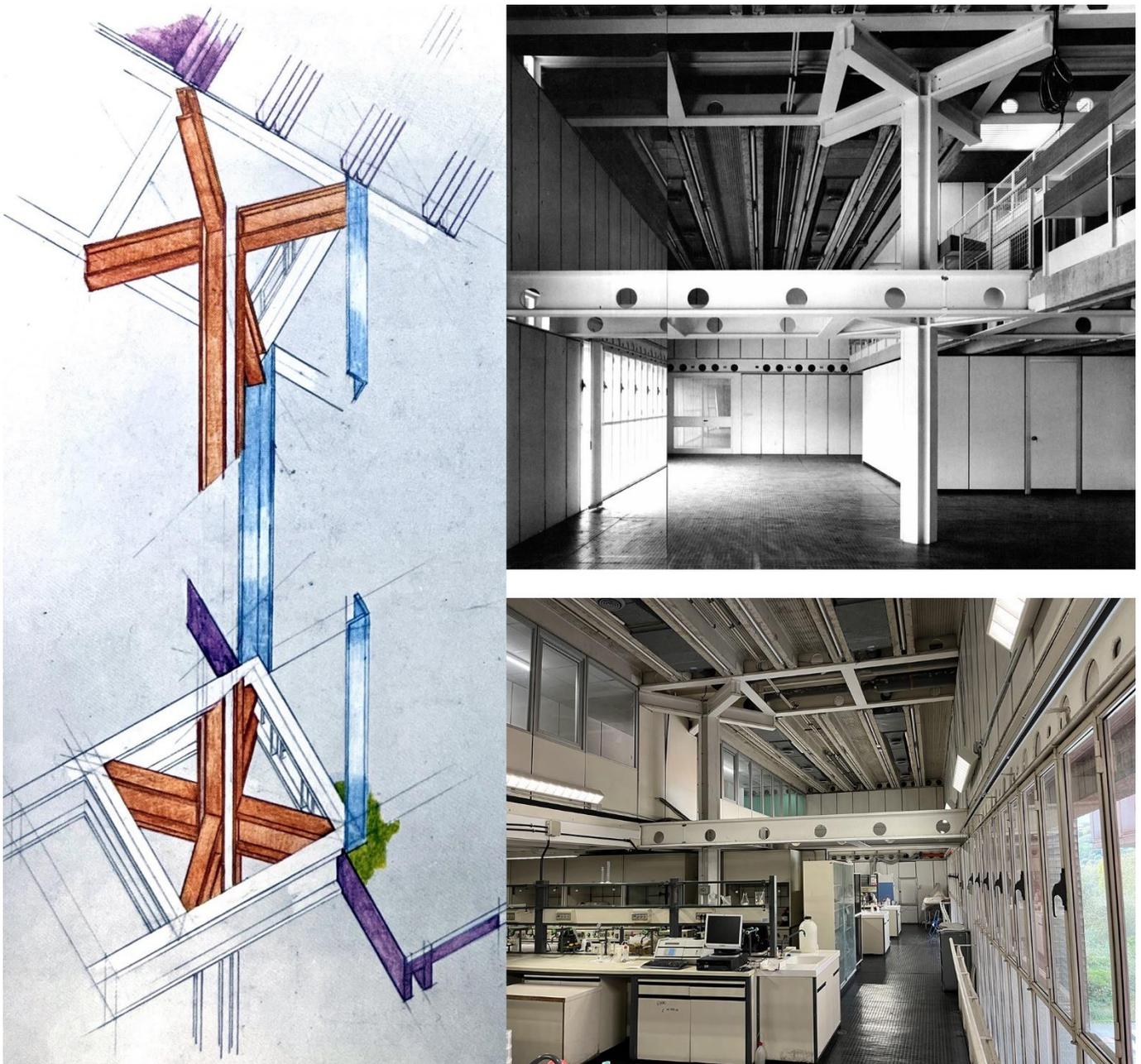


Fig. 6. Detail of the steel column with a cruciform cross-section, whose shaft culminated in the capital on which four brackets were placed to support the floor beams. Left: Drawing of the competition project (Source: Rota I. Il progetto per l'Università delle Calabrie e altre architetture di Vittorio Gregotti. Electa, Milano, 1979, 17). Right, top: a laboratory of the Department of Chemistry in 1980s (Source: Gregotti V. Cronaca esemplare. Domus 673: 34-35, 1981). Right, bottom: current photo of a laboratory of the Department of Chemistry and Chemical Technologies (photo by the authors).

increased to 9.5-10.5 cm instead of the 7.5 cm established in the early phase of the project. The exposed intrados of the floor marked the interiors with an industrial character, similar to that of the Science Departments of Palermo, where, however, “*the precision of a technology reduced to the essential nature of its structural mechanics*” [2] corresponded to the generalised use of prestressed prefabricated elements, which in Arcavacata instead was integrated into a mixed structural scheme. Exposed connections between the large tiles and between the floor and the supports confirmed the industrial language of the laboratory spaces, as well as the exposed ducts of the systems. Metal trusses, and tempered glass skylights (U-Glass) and fiberglass-reinforced polyester sunshades formed the roof [15]. A characteristic element of the façades of cubes 15C and 17C, not used in the following evolution of the campus, were the terraced curtain walls that occupied a large part of the elevations, overlooking the square protected by the zig-zagged profile of the hall (Fig. 7). It was a 630 cm wide field, divided into glazed modules 90 cm wide and 267 cm high. These curtain walls testified, together with the interior finishing, the work on modular grids traced (on the floors, ceilings, walls) by the Gregotti group in the definition of the constituent and combinatorial design rules. They were geometric principles which corresponded to prefabricated elements that were also modular. The curtain walls were an expression of the use of industrialized components.



Fig. 7. Department of Chemistry. On the left, photos of the complex in the 1980s (source: Gregotti V. Cronaca esemplare. Domus 673: 30, 1981). On the right, photos of the current state: in the foreground the low cubes (17D and 18D) and the high cubes (15C and 17C) with the suspended hall in the center (photo by the authors).

In the project phase, horizontal metal beams with a composite section and fixed glass sheets, joined on the vertical direction by means of special mastic, provided the curtain walls, but under construction designers used a frame with mullions and crossbars (Fig. 8). Some modules of the glazing could be opened. The modularity of the curtain wall was combined with that of the concrete walls, with a pattern (1.80x5.40 m) bordered by positive and negative mouldings, obtained with spacers inserted in the metal formworks [16]. The pattern, which alluded to the use of prefabricated components (Fig. 7) – the elements were cast on site – is not surprising and resembles research on modular grids of prefabricated walls conducted by Gregotti with Lodovico Meneghetti and Giotto Stoppino in the houses in Novara (1957) and in the three tower houses for employees of the municipality of Milan (1962). The finishing was not followed up in the subsequent phases of the campus project, apart from the volumes of the ex-rectorate offices (currently cubes 7-11). A construction system similar to that of cubes 15C and 17C, albeit simplified, can be found in buildings 17D and 18D, which were also part of the first phase of works. These had square plan (21.30x21.30) which, articulated on two floors above ground, represented the type of low cube established in the competition project. The structure was similar to that of the higher buildings. The cast on site reinforced concrete walls were combined with the internal supports of the floors, consisting in this case of two Vierendeel beams (Fig. 5), arranged in a cross along the axis of the plan. Prefabricated large tiles of the same type as the high cubes were used for the floors. The walls had a similar internal finishing, while the external finishing had a smooth surface, without flash gaps. Vertically arranged shaped sheet metal panels formed the cladding of the service volume.

## 5. CONCLUSION

The archival analysis conducted so far on the University of Calabria has highlighted some aspects of this case useful to place the realization in the background of the building industrialization in Italy. The transfer of the approaches and repertoire of industrialized solutions and components from the national context in the Calabrian construction site faced with executive difficulties that reduced the expectations of industrialization of the construction process declared in the design phase. The possible presence and effects of similar contextual inertia (logistic, technological) will be verified, in the subsequent phases of the research, on other Calabrian construction sites of the period which, although smaller in complexity and size, in the 1970s-1980s used prefabricated components, such as, for example, the Martensson residences

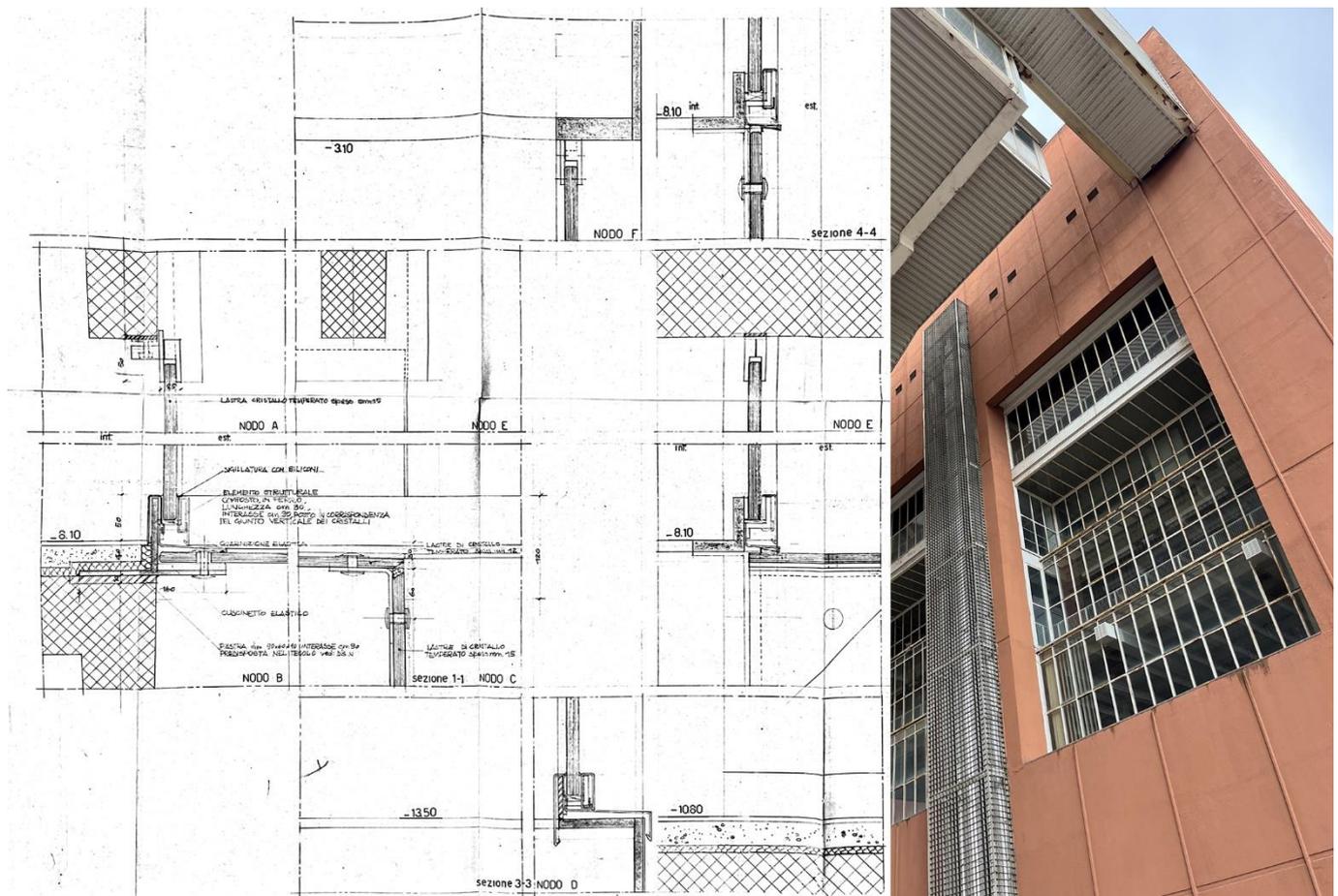


Fig. 8. The terraced curtain walls that occupied a large part of the elevations, overlooking the square protected by the zig-zagged profile of the hall. Left: construction detail of the project, then modified during construction (source: Archivio Direzione Tecnica e Patrimonio Immobiliare Università della Calabria). In the current state (on the right) the original version is preserved (photo by the authors).

within the same campus of Arcavacata, the new railway station of Cosenza and the nearby Gescal housing district of Vaglio Lise.

The analysis of the construction system of the case considered has so far shown that prefabrication concerned the use of lightweight components and of some structural parts within a mixed concrete-steel structure, which determined numerous unions between heterogeneous parts. Walls and floors were made, almost exclusively, of prefabricated components selected from a current catalogue (cladding panels, grilles for parapets, false ceilings, window frames), sometimes with a low technological profile, such as the metal frames of curtain walls.

Moving on to consider the survey of the buildings of the Chemistry department, it is possible to observe, considering the first exams conducted, a substantial correspondence between the current state and the original layout, unless there were functional variations compatible with the flexibility programmed in the project, such as the repositioning of the internal walls, and the insertion of new partitions, the replacement of the internal cladding panels. The functional and technological changes that took place were all made using prefabricated components and dry connections, thus making the processes reversible. The historical knowledge, in combination with the subsequent survey phases and the analysis of the state of conservation of the buildings – to be developed also on the basis of digital modelling – will complete the framework of knowledge of the buildings as well as detect the presence (and the presumed cause) of any phenomena of technological decay useful to arrange guidelines for redevelopment.

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