HISTORY OF CONSTRUCTION CULTURES

VOLUME 1

edited by
João Mascarenhas-Mateus
and **Ana Paula Pires**

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History of Construction Cultures

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Introduction: *History of Construction Cultures*

We are what we build and how we build; thus, the study of Construction History is now more than ever at the centre of current debates as to the shape of a sustainable future for humankind. Embracing that statement, the present work takes the title *History of Construction Cultures* and aims to celebrate and expand our understanding of the ways in which everyday building activities have been perceived and experienced in different cultures, times and places.

This two-volume publication brings together the communications that were presented at the 7ICCH – Seventh International Congress on Construction History, broadcast live from Lisbon, Portugal on 12–16 July 2021. The 7ICCH was organized by the Sociedade Portuguesa de Estudos de História da Construção (Portuguese Society for Construction History Studies – SPEHC); the Lisbon School of Architecture, University of Lisbon; its Research Centre (CIAUD); and the College of Social and Human Sciences of the NOVA University of Lisbon (NOVA FCSH).

This is the first time the International Congresses on Construction History (ICCH) Proceedings will be available in open access format in addition to the traditional printed and digital formats, embracing open science principles and increasing the societal impact of research. The work embodies and reflects the research done in different contexts worldwide in the sphere of Construction History with a view to advancing on the path opened by earlier ICCH editions. The first edition of ICCH took place in Madrid in 2003. Since then, it has been a regular event organized at three-year intervals: Cambridge (2006), Cottbus (2009), Paris (2012), Chicago (2015) and Brussels (2018).

7ICCH focused on the many problems involved in the millennia-old human activity of building practiced in the most diverse cultures of the world, stimulating the cross-over with other disciplines. The response to this broad invitation materialized in 357 paper proposals. A thorough evaluation and selection process involving the International Scientific Committee resulted in the 206 papers of this work, authored by researchers from 37 countries: Australia, Austria, Belgium, Brazil, Bulgaria, Canada, China, Dominican Republic, Ecuador, Egypt, Estonia, France, Germany, India, Iran, Ireland, Italy, Japan, Mexico, Netherlands, New Zealand, Norway, Peru, Poland, Portugal, Puerto Rico, Russia, Serbia, Spain, South Africa, Sweden, Switzerland, Thailand, United Arab Emirates, United Kingdom, United States of America, and Venezuela.

The study of construction cultures entails the analysis of the transformation of a community's knowledge capital expressed in the activity of construction. As such, Construction History is a broad field of knowledge that encompasses all of the actors involved in that activity, whether collective (contractors, materials producers and suppliers, schools, associations, and institutions) or individual (engineers, architects, entrepreneurs, craftsmen). In each given location and historical period, these actors have engaged in building using particular technologies, tools, machines and materials. They have followed specific rules and laws, and transferred knowledge on construction in specific ways. Their activity has had an economic value and belonged to a particular political context, and it has been organized following a set of social and cultural models.

This broad range of issues was debated during the Congress in general open sessions, as well as in special thematic sessions. Open sessions covered a wide variety of aspects related to Construction History. Thematic sessions were selected by the Scientific Committee after a call for proposals: they highlight themes of recent debate, approaches and directions, fostering transnational and interdisciplinary collaboration on promising and propitious subjects. The open sessions topics were:

- Cultural translation of construction cultures: Colonial building processes and autochthonous cultures; hybridization of construction cultures, local interpretation of imported cultures of building; adaptation of building processes to different material conditions;
- The discipline of Construction History: Epistemological issues, methodology; teaching; historiography; sources on Construction History;
- Building actors: Contractors, architects, engineers; master builders, craftspeople, trade unions and guilds; institutions and organizations;
- Building materials: Their history, extraction, transformation and manipulation (timber; earth, brick and tiles; iron and steel; binders; concrete and reinforced concrete; plaster and mortar; glass and glazing; composite materials);

– Building machines, tools and equipment: Simple machines, steam operated-machines, hand tools, pneumatic tools, scaffolding;
– Construction processes: Design, execution and protective operations related to durability and maintenance; organization of the construction site; prefabrication and industrialization; craftsmanship and workshops; foundations, superstructures, roofs, coatings, paint;
– Building services and techniques: Lighting; heating; ventilation; health and comfort;
– Structural theory and analysis: Stereotomy; modelling and simulation; structural theory and structural forms; applied sciences; relation between theory and practice;
– Political, social and economic aspects: Economics of construction; law and juridical aspects; politics and policies; hierarchy of actors; public works and territory management, marketing and propaganda;
– Knowledge transfer: Technical literature, rules and standards; building regulations; training and education; drawings; patents; scientific dissemination, innovations, experiments and events.

The thematic sessions selected were:

– Form with no formwork (vault construction with reduced formwork);
– Understanding the culture of building expertise in situations of uncertainty (Middle Ages-Modern times);
– Historical timber constructions between regional tradition and supra-regional influences;
– Historicizing material properties: Between technological and cultural history;
– South-South cooperation and non-alignment in the construction world 1950s–1980s;
– Construction cultures of the recent past: Building materials and building techniques 1950–2000;
– Hypar concrete shells: A structural, geometric and constructive revolution in the mid-20th century;
– Can engineering culture be improved by construction history?

Volume 1 begins with the open session "Cultural translation of construction cultures" and continues with all of the thematic sessions, each one preceded by an introductory text by the session chairs. The volume ends with the first part of the papers presented at the open sessions, organized chronologically. Volume 2 is dedicated to the remaining topics within the general themes, also in chronological order.

Four keynote speakers were chosen to present their most recent research results on different historical periods: Marco Fabbri on "Building in Ancient Rome: The fortifications of Pompeii"; Stefan Holzer "The role of temporary works on the medieval and early modern construction site"; Vitale Zanchettin "Raphael's architecture: Buildings and materials" and Beatriz Mugayar Kühl "Railways in São Paulo (Brazil): Impacts on the construction culture and on the transformation of the territory".

The editors and the organizers wish to express their immense gratitude to all members of the International Scientific Committee, who, despite the difficult context of the pandemic, worked intensively every time they were called on to give their rigorous evaluation of the different papers.

The 7ICCH was the first congress convened under the aegis of the International Federation of Construction History, founded in July 2018 in Brussels. Therefore, we are also very grateful to all the members of the Federation, composed of the presidents of the British, Spanish, Francophone, German, U.S. and Portuguese Societies and its Belgian co-opted member. A special thanks is due for all the expertise and experience that was passed on by our colleagues who have been organizing this unique and world significant event since 2003, and in particular to our predecessors from all the Belgian universities who organized 6ICCH.

The editors wish to extend their sincerest thanks to authors and co-authors for their support, patience, and efforts. This two-volume work would not exist but for the time, knowledge, and generosity they invested in the initiative.

Our sincere thanks also go out to Kate Major Patience, Terry Lee Little, Kevin Rose and Anne Samson for proofreading every paper included here, and to the team at Taylor & Francis (Netherlands), in particular Germaine Seijger and Leon Bijnsdorp.

Finally, we are grateful to all members of the Local Committee and to the institutions that have supported both the 7ICCH event and the publication of these proceedings.

The Editors
João Mascarenhas-Mateus and Ana Paula Pires

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Prefabrication and participation by users: A challenge in Italy (1960–1976)

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ABSTRACT: In post-war Italy, research on prefabrication went beyond the functional use of the elements. The theme of modularity, seriality and prefabrication was explored with many nuances: from the desire to combine the theme of prefabrication with the limits and compositional and architectural potential of the systems, to the theme of modular coordination of architecture, which allowed for a greater or lesser number of components, whose assembly could lead to almost endless variations. Unlike other European countries, Italy never opted decisively and in a widespread way for this type of approach. The paper investigates the use of prefabricated systems in real plans for the construction of residential buildings and schools in the north of Italy. The need for middle-class housing in the boom years and requests by the Ministry of Education transformed the theoretical studies and singular experiences into real programmes for construction of prefabricated buildings with the participation of users.

1 INTRODUCTION

"The problem of reconstruction is not a problem to be resolved with moderate coordinated action by sensible, ordinary administration: it is a problem awaiting a solution, at least in Italy, based on revolutionary measures and bold innovations in all areas." (Calcaprina 1945). So wrote Cino Calcaprina in the first edition of the magazine *Metron* in 1945, stressing the necessity for organic new plans to address the needs of society, conditions of habitability and the backwardness of the housing industry, conditions present before World War Two and even worse thereafter. The need to plan reconstruction, the role of private initiative in those projects, and the need to have houses available within a reasonable amount of time – and "not for our grandchildren, if we keep making eternal houses, with artisanal methods" – triggered a debate centred increasingly on prefabrication, a theme that had been marginal in Italy until then.

This theme had already been addressed between the two wars in detail by influential figures from the world of engineering and architecture. Now, however, it acquired a broader, more diverse dimension. Considered in relation to the housing problem, the controversy became heated, with parties taking sides for or against industrialization of the housing sector – without actually bringing the arguments up to date with reference to the international debate, technical problems, economic questions or the compatibility of their own position – or prejudice – about new methods of construction.

"The Italian housing industry has an absolute and urgent need to review and refine the theoretical and technical procedures that are the basis for the design and realization of buildings. A more rigid and totalitarian economy of materials and labour is the last chance we have left to reduce the terrible and paralyzing disproportion between scarce national resources and the unlimited mass of reconstructive needs" (Nervi 1945). With these words, Pier Luigi Nervi outlined the urgent problems of reconstruction immediately after the war, which compelled Italian architects and planners not only to revise and refine housing but above all to investigate new possibilities and experiment with different methods in order to find possible solutions to the housing problem in a country devastated by wartime destruction.

After the Second World War, the situation in Italy regarding studies of prefabrication and its use in the construction process was highly developed and multifaceted. After an initial phase, characterized by a substantial time lag in this sector (Albani 2012), in the 1950s, a mature approach to the theme of industrialization in building was addressed at numerous national and international conferences, as well as in numerous technical publications and bulletins. Nonetheless, the country's economic policy prevented development of the Italian systems experimented with between 1947 and 1951, although the idea of resorting to prefabrication to meet the country's housing needs was widely accepted (Petrignani 1965). The arguments tended in the direction of what was termed "heavy" prefabrication (Koncz, Mazzocchi, Tealdi 1979) in

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which France was at the forefront in Europe (Delemontey 2015). The implementation of the French system by IACP of Milan in the construction of public housing lasted approximately one decade. Superficially, it can be seen as the annihilation of more than 15 years of studies, strategies and policies encouraging forms of prefabrication linked to Italy's cultural, technical and, especially, productive capability (Albani 2013). Although, for its housing construction, Italy opted for well-tested systems that had been used elsewhere, research and experimentation continued regardless, thanks to the influence of a number of architect/industrial designers (Albani 2015) – among them Marco Zanuso (Burkhardt 1994) Angelo Mangiarotti and Gino Valle – who placed this theme at the centre of their own architectural production and contributed to an eventual "Italian" response (Associazione Italiana Prefabbricazione per l'Edilizia Industrializzata 1980).

The experiments in Italy were largely concentrated in two aspects: prefabrication of the load-bearing structure, in particular, in reinforced concrete; and prefabrication of the building's envelope in relation to the interior space. There are several examples in which this prefabrication of the envelope acquired the ulterior role of including user participation in defining the architecture. Specifically, the desire on the part of the planners to actively engage clients in the planning phase opened the way to interesting social, formal and construction considerations.

2 MIDDLE CLASS HOUSING: PREFABRICATION AND PARTICIPATION

2.1 *The economic boom*

In the 1950s, the economic boom in Italy and the consequent expansion of well-being created a climate of great enthusiasm for reconstruction, which, however, had to face the reality of the forces and capacity of the country. The protagonists of the architectural debate of the period participated in this climate, especially in the north, where industries in areas like Lombardy were just discovering their role as drivers of the country's economic development (Bagnasco 2008). Of particular excellence was the production of designer objects for the home, based on an artistic approach and refined craftsmanship (Crippa 2007). The way in which a living space is defined, with the participation of the user, is intimately related to social life and the way in which a social class identifies itself (Caramellino & Zanfi 2016). Thus, active participation in the design offers the possibility of consolidating one's position within an extremely diverse social group (Bose 2008).

2.2 *Angelo Mangiarotti and the residential building in Monza 1968–75*

"My activity in architecture […] I believe to be part of the line of works whose technical reproducibility possesses a notable theoretical importance. It can be said that in this type of expression reproducibility becomes constitutive" (Mangiarotti et al. 1987). With these words Mangiarotti himself, by then over sixty years old, sought to sum up a life of work and research on the themes of modularity, seriality and assembly (Albani & Graf 2019), which went beyond the architectural artefact in its finished and unique aspect (Nardi 1997). It was an activity that was structured and proceeded by means of prototypes representative of a process that sought to define new relations between those who devise, those who produce and those who use architecture and which came to fruition only when the design purpose was transformed into physical reality. Angelo Mangiarotti's work is closely related in many ways to the research conducted by architects, artists, inventors and builders such as Konrad Wachsmann, Max Bill, Richard Buckminster Fuller and Jean Prouvé, who interpreted the concept of "prefabrication", a theme that in the 20th century represented a sort of utopia defined as "industrial". The economy and rationalization of means in post-war Milan provided Mangiarotti with an opportunity to exploit the multiplicity of relations between architecture and technology and, in some cases, through an aesthetic and symbolic dimension, his research went far beyond the functional use of the elements. Mangiarotti interpreted the theme of modularity and seriality with many nuances: from the desire to combine the theme of prefabrication with the limits and compositional and architectural potential of the trilithic system, to the theme of a modular coordination of architecture, in which he found space for a greater or lesser number of components, whose assembly led to almost endless variations (Albani & Graf 2015). In the case of middle-class housing, Angelo Mangiarotti built two buildings near Milan in which he explored the theme of the flexibility of interiors and façades with a view to fostering participation by the inhabitants already in the design phase (Bona 1980). The different ways of living made it possible, therefore, to produce the "unpredictable", the random. The neutral and configurable components included all possible geometrical combinations: continuity, recessed or protruding corner solutions. This was Mangiarotti's way of introducing variation starting from a rigid grid and of interpreting industrialization and prefabrication as a new principle of figuration that does not limit creative activity (Mangiarotti 1977). The building in Monza is the first of two middle-class housing buildings. It has a compact plan, consisting of eight floors and standing isolated on a lot of irregular form, with no relation to the surrounding buildings. The load-bearing structure made of concrete cast on site, whose only fixed elements are the stairwell and the elevator, determines a free plan organized on the basis of a 32cm grid, which allows for complete freedom in the configuration of the apartments. Calculations of the load-bearing structure were made by the engineers Giulio Ballio, Giovanni Colombo and Alberto Vintani of Milan (Bauen + Wohnen 1977). The internal organization of each apartment is reflected in the

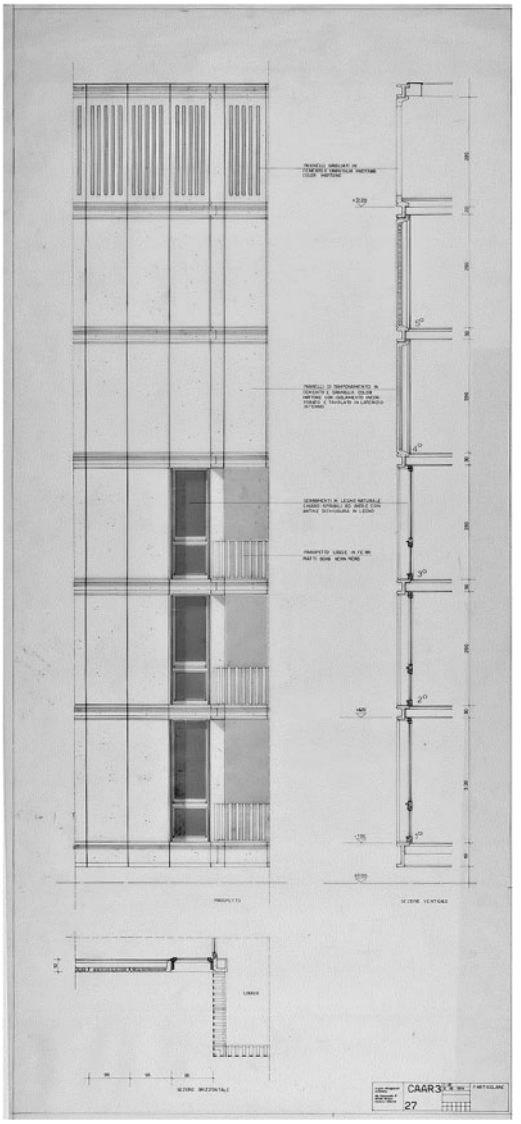

Figure 1. Residential building, Angelo Mangiarotti, Monza 1968–75 (Archive Angelo Mangiarotti, Milano).

overall design of the façade, which is also based on a modular grid of 96cm, in which opaque, glazed or openwork prefabricated panels or balconies with metal parapets alternate, resulting in an elegant and highly articulated composition. The opaque panels are made of reinforced concrete with interposed poly-urethane foam insulation, an outer cladding of Vicenza grit-stone and string courses with C-shaped profiles. The panels of the façade are attached to a prefabricated element that creates a continuous string course. The single façade module allows inhabitants to position the external walls and galleries as desired while it is still under construction. Thus, both the internal distribution of the rooms and the external appearance of the building vary from floor to floor (Figure 1).

Figure 2. Details of façade, residential building in Monza (Archive Angelo Mangiarotti, Milano).

2.3 *Angelo Mangiarotti and the building in Arosio 1974–78*

The building in Arosio, a municipality of Brianza, is the second middle-class residence built by Mangiarotti that combines prefabrication with user participation in the planning phase. The clients for this building were the same owners of an important furniture company for whom Mangiarotti had previously built several factories using prefabricated, reinforced concrete systems. The residence, built on a lot with a trapezoidal shape, is in many ways a variation on the one in Monza. The themes are the same: flexibility, modular coordination, participation by the inhabitants, prefabrication of the envelope (Mangiarotti 1963). Laid out on six floors, the building has a more complex floor plan than its predecessor because of the presence of balconies and more pronounced setbacks, although it uses the same 32 cm grid as that in Monza. Access is provided by a path that traverses the lot diagonally and along a ramp that leads scenically to the semi-basement level, where the concierge's lodge is located (Figure 2).

The load-bearing structure is in traditional reinforced concrete cast in situ with slabs in hollow-core concrete, while the façades are made of panels precast in reinforced concrete with brick powder aggregate, a simplification of the typologies compared to the residential building in Monza. In the last version of the project, the openwork element was eliminated in the upper part and the string course was made thicker to ensure greater durability. The opaque panel in concrete with incorporated insulation envisaged, as in Monza, a brick counter-wall on the inside, while the wooden window fixtures had casements in natural wood with external shutters (Figure 3).

Figure 3. Building in Arosio, Angelo Mangiarotti, 1974–8 (Archive Angelo Mangiarotti, Milano).

3 PUBLIC SCHOOL BUILDING. VALDADIGE SYSTEM AND PARTICIPATION

3.1 *The new middle school. The 1962 school reform*

Law no. 1859 of 31 December 1962 sanctioning the reform of the single middle school is considered one of the most significant laws in the field of public education of the post-war period in Italy. This reform transformed the scholastic system that, at the end of the 1950s, was essentially the same as that in effect between the wars, wherein students could complete their studies after primary school either by studying one additional year or by attending middle school and then any high school. With the reform, the various types of middle school were standardized into one model, the "scuola media unica", which was free and intended to train young citizens. So began a process of mass education that generated profound changes throughout Italian society (Cambi 2005). The single middle school was the answer to the enormous need for schooling in Italy, which was clearly lagging behind the rest of Europe in this respect. At the same time, however, it created new needs. With the introduction of mandatory attendance for such a vast number of students, existing school spaces proved suddenly inadequate and insufficient in number. It was clearly necessary to initiate construction of new spaces to accommodate the growing number of students. To this end, a national commission was formed to study the construction of the new middle schools, and legislative initiatives were implemented to encourage the building of scholastic centres that would correspond specifically to the needs of the different communities. In this way, the theme of the school became linked to a vision of urban planning in which new constructions are to be integrated into the urban fabric.

This theme also entered into the ongoing debate about architecture. The fervour it generated is demonstrated by the 12th Triennale of Milan in 1960, entitled *La casa e la scuola*, a crucial moment of reflection about the evolution of typological choices for school buildings in which many authoritative Italian and foreign experts participated.

3.2 *The Valdadige system*

Together, the new school reform, public investments and architectural debate triggered a virtuous circle of research, experimentation and proposals of new prefabricated systems to satisfy the growing demand for suitable scholastic spaces. Crucial guidelines for school planning were provided by the Ministerial Decree of 18/12/1975. Many companies and planners grappled with the issue of the development of new construction technologies for building schools. The simultaneous presence of diverse factors, however, determined the success of the Valdadige system, developed by Gino Valle and Giorgio Macola and employed in the construction of more than 30 schools in northern Italy (Virgioli 2016). The prefabricated system is quite sophisticated, while the study of light, colour and space aims to achieve school environments that take into account and enhance the children's various activities. The *Valdadige – Edilizia Scolastica-Elementari e Medie* catalogue was drafted with the intention of illustrating how the system operated thereby encouraging participation of local administrations in the planning phase. These authorities could thus modulate the system on the basis of the construction site and their particular needs (Figures 4 and 5).

The Valdadige PTK (pillar-beam-vault) system is a punctiform system whose basic components are a 40×40 cm pillar, a main beam with an inverted T-section, and a vault ceiling element (*coppella*) with a 2.4 m wide double T-section. The work of architects Valle and Macola used a basic system like the PTK for the school typology, facilitating simple solutions that made it possible to build schools quickly, inexpensively and according to the regulations. Furthermore, all components are clearly illustrated in the catalogue. The pillars are all equal, except in height (single-floor and two-floor pillars), made of reinforced concrete with supports for the beams. There are three types of beams: intermediate beams with an inverse T-section; Z-shaped edge beams to support the ceiling, and ring beams, which are only half beams so that the edge of the structure is uniform. The vaults are made of yielded reinforced concrete, 2.4×6 m

Figure 4. Top part of the building (Archive Angelo Mangiarotti, Milano).

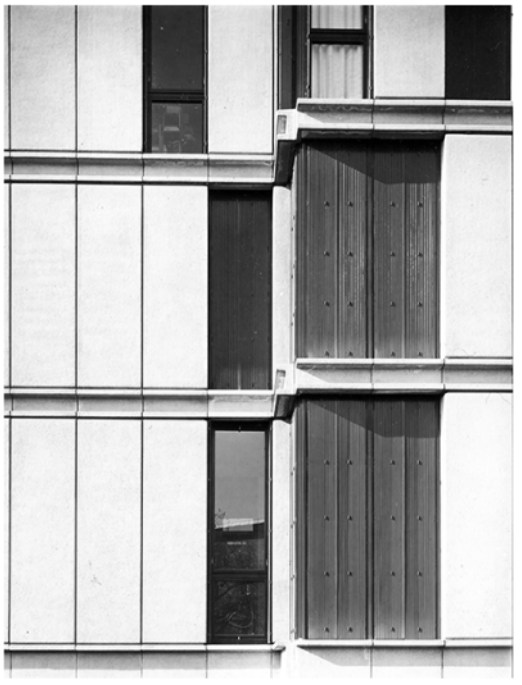

Figure 5. Prefabricated panels of façades (Archive Angelo Mangiarotti, Milano).

for the first floor and 2.4 × 12 m for the roof. The ribs are perpendicular to the longitudinal façades, corresponding to possible divisions of the interior. The horizontal elements are designed to be mounted to the vertical elements by means of mechanical devices and subsequently secured with a supplementary casting. This also guarantees that the structure can withstand an earthquake in areas such as the north-east, which has suffered serious earthquakes in the past (Vitali 2010). The foundations, cast in place, are reinforced concrete plinths on which rests the slab, separated from the earth by a ventilated crawlspace and isolated with a layer of polyethylene foam. The façade panels extend further than the extrados of the ceiling slab to create an edge beam covered with an anodized aluminium flashing. The roof panels are isolated with a 5cm layer of cork placed on top of a layer of polyethylene that serves as a vapour barrier, wrapped in a layer of PVC waterproofing and covered with gravel. The panels that form the flat roof are the 2.4 × 12 m vaults, slightly curved to ensure the flow of water through downspouts in the pillars of the façade. Finally, the façade is made of 22 cm thick concrete panels with expanded clay to meet the standards for isolation in force at the time. The panels can be mounted in a variety of ways, allowing diverse solutions depending on the orientation of the façades. On the east and west façades, the panels can be mounted horizontally to allow for ribbon windows, while on the north and south façades, generally without windows, the panels are mounted vertically. As for the interior spaces, the concrete of the prefabricated elements is left exposed. In the common spaces, the systems are also left exposed whereas the classrooms are provided with a false ceiling to improve the acoustics and are divided from one another with plasterboard walls. Colour plays an important role as well. Valle experimented with acrylic paints with quartz to make the façade panel surfaces bright in contrast with the grey of the exposed concrete. At first, he used metallic grey, as seen in the school in Bissuola a Mestre; then he introduced red for the windowpanes and floors so as to highlight the common space and connecting canopy. The introduction of green, as a complementary colour to red, emerged from the idea of continuing to experiment with colour (Croset & Skansi 2010) (Figure 6).

3.3 *The school in Paisan di Prato*

The first part of the Valdadige catalogue provides information for users to help plan, along with the planner, a school that would meet their specific needs, related to the number of students and the construction site. The school complex called for the organization of spaces into educational units of variable dimensions integrated with the classrooms. The standard floor plans of the primary schools have 6, 9, 12, 15, 20 or 25 classrooms while the middle schools have 9, 12, 15, 18, 21 or 24. The system allowed for users to organize the spaces in a variety of typological layouts, depending on the number of students. The various components of the school (classrooms, cafeteria, gym, technical spaces) could be combined according to a series of diagrams appearing in the catalogue. The result was essentially a

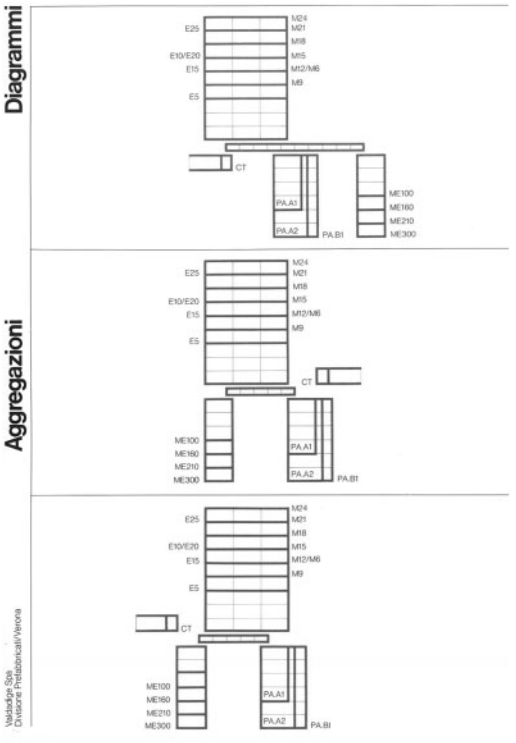

Figure 6. Diagrams of Valdadige prefabricated system (Archive Gino Valle, Udine).

Figure 7. School in Paisan di Prato built with Valdadige system (Albani 2017).

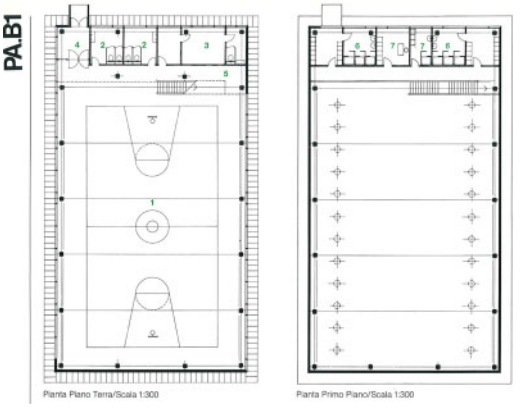

Figure 8. Plans of the school in Paisan di Prato, Udine (Valdadige 1977).

Figure 9. Gym in school in Paisan di Prato, type B1 (Valdadige 1977).

small urban centre that the user (the municipal administration) could define on the basis of the demands and characteristics of the construction site. "This type of organization by nuclei leaves ample space for flexibility in the definition of individual projects regarding both the choice of "containers" and their composition around a connecting pedestrian axis. Furthermore, it is possible to mediate the relationship with the existing urban environment given that the assembling of the "containers" itself organizes the environment, converting the school from a building into a portion of the urban fabric, open towards the exterior and capable of transforming itself by adding onto the basic nuclei or by later aggregations" (Macola & Valle 1977) (Figures 7–9).

The middle school of Pasian di Prato, near Udine, is a school complex designed by Gino Valle himself, applying the Valdadige system. The school's two buildings develop along a covered east-west pedestrian axis that connects with the street. The teaching building has two floors with 15 classrooms distributed around a large central atrium, 36 metres wide. There are also special classrooms, larger than the others, for the science and chemistry laboratories. The second two-storey structure is 19.20 metres wide (B1 gym type). In these prefabricated school buildings, there is clear evidence in their design of reflections on colour, light and spaces for aggregation that focus on the children's quality of life. Gino Valle uses colours, especially red and green, that create a contrast with the exposed reinforced concrete surface of the prefabricated system (Figures 10 and 11).

Figure 10. Interiors of the school in Paisan di Prato (Archive Gino Valle, Udine).

Figure 11. Atrium of the school in Paisan di Prato (Albani 2017).

4 CONCLUDING REMARKS

Prefabrication had been accused of compromising the compositional freedom of architecture, but, by the 1960s, this more controversial aspect had been subdued, and prefabricated elements began to be used widely. The topic was approached from many angles in conferences, publications and debates (AITEC 1964), in an environment that had changed from the previous period of precise, tasteful experiments with no real impact on construction plans.

In particular, in the 1960s and thereafter, the theme of industrialization, variation in modularity and prefabrication was explored in the architectural debate by numerous architects/industrial designers, including Angelo Mangiarotti and Gino Valle. Their considerations embraced diverse aspects, including the participation of users in the planning phase. In the society of the boom years, with its widespread well-being and desire for social affirmation, middle-class housing and school design (following the major school reform introducing obligatory middle school) became the territory of experimentation and reflection, in particular with regard to the participation of users in defining these symbolic places for the new society – their own homes and new schools for all.

As regards middle-class housing, the architects of the time were dealing with a clientele distinct from that of the past (Irace 1996), who viewed their home as a source of distinction and social affirmation. However, the presence of the architect created a sort of imbalance within the participatory process that influenced the users, whose lack of architectural culture led them to simply follow the advice of the architect. Regardless, a new approach to the definition of architecture took hold, in which the architects no longer determined the formal definition of the façades or the distribution of the interior spaces single-handedly; instead, they set rules within which the users participated in defining the architecture. There were various experiments in this regard in Italy, including those of De Carlo, Minoletti and Gardella, although they did not combine this approach with prefabrication and the industrialization of the building process.

In contrast, in the process of constructing new schools, especially those realized with the Valdadige system – thanks to the availability of catalogues and repertoires – municipal administrations participated fully in defining the school buildings based on their needs (number of students and classrooms) and the characteristics of the construction site. The Valdadige prefabricated system in reinforced concrete was applied in more than 30 schools in northern Italy, each representing its own variant within the system. In essence, the variety is determined by the participatory process in which the role of the planner and of the construction company is mediated by the possibilities established in the catalogue.

Comparing the two experiences, it can be seen that the schools managed to achieve many interesting and successful results, symbolic of a society in which mass education has become a priority. In middle-class housing, however, results were limited, but, even more importantly, the influence of the planner prevailed at the expense of user participation in the planning phase due to the lack of architectural culture on the part of the owners, who entrusted the design of their homes to the planner.

REFERENCES

Albani & Graf 2019. *Variation and modularity*. Interlinea: Novara.

Albani, F. 2012. Post-war experimentation in Italy: the QT8 housing estate in Milan. Construction, episodes, perspectives. In F. Graf & Y. Delemontey (eds.), *Understanding and conserving Industrilised and Prefabricated Architecture*: 241–271. Lausanne: Presses Polytechniques et Universitares Romandes.

Albani, F. 2013. La prefabbricazione, strategie per la ricostruzione a Milano. Dalle sperimentazioni alle realizzazioni. In F. Albani, F. & C. Di Biase (eds.), *Architettura minore del XX secolo. Strategie di tutela e intervento*: 111–135. Santarcangelo di Romagna: Maggioli Editore.

Albani, F. 2015. The Prefabrication in Italy after the World War II. Zanuso versus Camus. In B. Bowen & al. (eds.), *Proceedings of the fifth international congress on construction history, Chicago, 3–7 giugno 2015:* 39–46. Chicago: Construction history society of America.

Associazione Italiana Prefabbricazione per l'Edilizia Industrializzata 1980. *Repertorio*. Milano: Tipografia Ronda.

Bagnasco, A. (ed.) 2008. *Ceto medio, come e perché occuparsene*. Bologna: Il Mulino.

Bona, E.D. 1980. *Angelo Mangiarotti. Il processo del costruire*. Milano: Electa.

Bose, S. 2008. *Sociologie des classe moyennes*. Paris : La Decouvérte.

Burkhardt, F. (ed.) 1994. *Marco Zanuso*. Motta Editore: Milano.

Calcaprina, C. 1945. L'abitazione: problema tecnico o politico?. *Metron* 1 August: 50.

Cambi, 2005. *Le pedagogie del Novecento*. Urbino: Laterza.

Caramellino, G. & Zanfi, F. 2016. *Post-War Middle-Class Housing: Models, Construction and Change*. Bern: Peter Lang Pub Inc.

Crippa, M.A. 2007. Modernità e Benessere nella Milano negli anni '50/'70. In A. Piva & V. Prina (eds.), *Marco Zanuso*: 11–19. Roma: Gangemi.

Croset, P.A. & Skansi, L. 2010. *Gino Valle.* Milano: Electa.

Delemontey, Y. 2015. *Reconstruire la France. L'aventure du béton assemblé, 1940–1955*. Paris: Editions de La Villette.

Graf, F. & Albani F. (eds.). 2015. *Angelo Mangiarotti. La tettonica dell'assemblaggio. The Tectonics of assembly.* Mendrisio/Cinisello Balsamo: Mendrisio Academy Press, Silvana Editoriale

Koncz, T., Mazzocchi, T. & Tealdi, E. 1979. *Prefabbricare: architettura e industria delle costruzioni*. Milano: Hoepli.

Macola, G. & Valle, G. 1977. *Relazione Tecnica, Criteri Progettuali Generali.* Udine: Archivio Valle.

Mangiarotti A. 1977. Prefabrication/Partecipation, gli utenti partecipano al progetto. *Domus* 567 February: 5–8.

Mangiarotti A. et al. 1987. *In nome dell'architettura*. Milano: Jaca Book.

Mangiarotti, A. 1963. Sul principio della continuità dei prospetti. In *Domus*, 398 January: 1–10.

Nardi, G. 1997. *Angelo Mangiarotti*. Rimini: Maggioli Editore.

Nervi, P.L. 1945. Per gli studi e la sperimentazione nell'edilizia. *Metron* October: 36.

Petrignani, Achille (ed.) 1965. *Industrializzazione edilizia*. Bari: Dedalo libri.

Valdadige, 1977. *Catalogo Valdadige. Edilizia scolastica.* Verona: Valdadige.

Virgioli P. 2016. 35 Italian schools to save: the "Valdadige" schools designed by the Studio Architetti Valle. In *Do.Co.Mo.Mo 14th international conference proceedings, Adaptive Reuse. The Modern Movement Towards the Future:* 208–213. Lisboa: Do.Co.Mo.Mo International Casa de Arquitectura.

Vitali, P. 2010. Sistema Valdadige. In *Ark Supplemento all'Eco di Bergamo*, (2): 48–52. Bergamo: Litostampa.

Industrialisiertes Bauen und Nutzerbeteiligung. Wohnhaus in Monza (Industrialized construction and user participation. Residential building in Monza) 1977. In *Bauen + Wohnen* 6: 225–227.