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THE INDUSTRIALIZATION OF CONSTRUCTION IN THE SECOND HALF OF THE XX CENTURY

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Cover illustration: MBM factory in Trezzano sul Naviglio (Milan), Italy.

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AFTERWORD: MATTER OF FACT AND OPEN ISSUES ON THE INDUSTRIALISED BUILDINGS HERITAGE

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Abstract

Within the postwar building stock, prefabricated buildings represent a significant subset in both terms of the quantity and the urgency of its safeguard, which is increasingly needed by their ongoing and extended deterioration phenomena. According to "The Twentieth-Century Historic Thematic Framework", published in 2021 by Getty Conservation Institute, the heritage of prefabricated buildings is outlined in Theme 2, "Accelerated scientific and technological development", enclosing the product of the large-scale pervasive effects of the technological progress of the 20th century. Nevertheless, at the time of this writing, the post-war industrialised buildings are still generally neglected and rarely protected: supported by the generalised public negative image of the prefabricated buildings – which have aged poorly – demolitions and the canceling of memories are broadly the case worldwide. In this text, some matters of fact and open issues functional to the reframing of industrialised buildings within the 20th-century architectural and technological heritage are outlined and discussed.

Keywords

Preservation, Prefabricated buildings, Postwar, Construction history, Digital catalogue.

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1. INTRODUCTION

Within the postwar building stock, prefabricated buildings represent a significant subset in both terms of the quantity and the urgency of its safeguard, which is increasingly needed by their ongoing and extended deterioration phenomena. In Europe, about 93 million housing units were built in the countries of the European Union between 1945 and 1979; an average of 67% were built using prefabrication techniques, but the percentages rise to 92-93% in most industrialised nations like France, West Germany, and Scandinavian countries, and 97-98 % in the former Eastern Europe [1]. At a global level, these figures grow quickly: in the former Soviet Union's countries, 1,689.8 million m^2, that is 161.7 million dwellings, were built between 1956 and 1982, out of which 95% was made by using prefabricated techniques [2]; in China from 1949 to 1999 the government built 35.2 billion m^2 resorting to imported techniques from USSR and other socialist countries [3]. However, this process was neither an isolated case nor was it exclusive to Eastern countries or the Soviet Bloc. In fact, on a truly global scale, concrete panel systems made countless journeys from Asia (Mongolia, Vietnam, Nepal, China, Japan, Taiwan, and North Korea), to Africa (Morocco, Egypt, Zaire, Gabon, and Zanzibar); to the Middle East (Iraq,

Kuwait, Syria, and Bahrain), to America (the US, Cuba, Colombia, Venezuela, and Chile), including Australia, to name just a few.

According to "The Twentieth-Century Historic Thematic Framework", published in 2021 by Getty Conservation Institute, the heritage of prefabricated buildings is outlined in Theme 2, "Accelerated scientific and technological development", enclosing the product of the large-scale pervasive effects of the technological progress of the 20th century. In particular, the document outlines that «the increasingly widespread use of new types of building materials and prefabrication in construction transformed the built environment», representing, thus, a specific subtheme of 20th-century cultural heritage [4].

Nevertheless, prefabricated buildings, apparently lacking unique or exceptional architectural value due to their mass production, are frequently neglected and rarely protected [5]: demolitions and canceling of memories are broadly adopted to face the poor or outdated condition of the buildings, supported by the generalised public negative image of the prefabricated building. Indeed, if the industrialised buildings have aged poorly is induced by the insufficient experience of the adopted new types of materials and the limited span of the expected life, considered in the original design process, it is mostly the product of the lack of care, in the broad sense of a lack of in-depth knowledge, even about the materiality of those buildings. In this sense, the Construction History studies propose a challenging shift based on the use of material culture approaches to disclose the intangible values of the prefabricated buildings related to the «tremendous ramification of the building world» as the socio-economic and technological backgrounds, supporting awareness of the prefabricated building contribution to the heritage of the 20th century and construction [6-9].

This text outlines some matters of fact and open issues functional to the reframing of industrialised buildings within the 20th-century architectural and technological heritage. In Section 2, the prefabricated building as a "cultural object" is presented and discussed, referring to current research and cultural initiatives carried out by the international scientific community. Section 3 discusses some "traditional" topics from the 1980s debate about the preservation of 20th-century architecture, adapting them to the inherent characteristics of industrialised buildings. Section 4 focuses on the opportunity to develop a specific cataloging approach to document and protect industrialised buildings. In Section 5, some notes on the Italian case are drafted as a remarkable example of the locally based declination of internationally affirmed construction systems, technologies, and design approaches. Conclusions and further perspectives are reported in Section 6.

2. THE PREFABRICATED BUILDING AS A "CULTURAL OBJECT"

The history of the global distribution of industrialisation and prefabrication in buildings has remained at the margins of contemporary scientific debates for a long time. In the last decade, academic research and cultural initiatives have increasingly addressed the topic of post-war industrialised construction despite the difficulties posed by the multilingual nature of the research in the integration of German, French, and Italian studies, which are simultaneously overlooked by English-language research, thus obstructing the construction of a comprehensive historical framework.

The historical studies focused at first on the fascinating story of the delivery home: the "Home Delivery: Fabricating the Modern Dwelling" exhibition at MoMA in 2008, which displayed the process of architectural design and production, connecting past examples with contemporary ones (Fig. 1). By spanning 180 years of history, the projects were presented through a multimedia approach (film, architectural models, original drawings and blueprints, fragments, photographs, patents, games, sales materials and propaganda, toys, and partial reconstructions), underlining «how the prefabricated house has been and continues to be, not only a reflection on the house as a replicable object of design but also a critical agent in the discourse of sustainability, architectural invention, and new material and formal research» [10].

Afterwards, the exhibition "Architecture in Uniform. Designing and Building for the Second World War", held at the Canadian Center of Architecture in 2011, highlighted the relationship between prefabrication and Wartimes. The research based on archival and field research

Fig. 1. *Research initiatives. Left: "Home Delivery". Source: © MoMA 2008. Middle: "Flying panels". Source: © Dom Publishers 2019. Right: "Between conventional and experimental" covers. Source: © Leuven Press 2024.*

explored the different ways in which architects and engineers worked during the Second World War to improve the building technology supporting the war effort of different countries [11].

The exhibition "Flying Panels – How Concrete Panels Changed the World", held in 2019-20 at the ArkDes in Stockholm, proposed a holistic approach through models, posters, paintings, films, toys, and cartoons – exploring how concrete panels influenced culture for the developing of new settlement and society (Fig. 1). Special attention was paid to the internationality of the prefabrication both as a technical tool and cultural issue: «the exhibition tells the story of a time when flying concrete panels became a symbol of the future, both in politics and in art, and embodied the dream of a better world, from the second half of the twentieth century to the present day» [12].

In 2021, the congress "Between Conventional and Experimental. Mass Housing and Prefabrication in Modernist Architecture" organised by the Israeli and German section of the Docomomo pointed the attention to mass housing, referring to the stories of the builders and designers, or single geographic contexts. In 2024, the outcomes of the conference were collected in the homonymous book (Fig. 1), which reframed «how mass housing and prefabrication shaped global modernist architecture, offering a comprehensive exploration of how both conventional and experimental prototypes and series gave rise to an architecture for all and responded to crises, nation-building, and housing shortages within the context of transnational and regional research» [13].

The scientific literature also shows an increasing interest in discussing industrialised buildings in the context of heritage studies, focusing on the "heritage of the ordinary" demand for a rethink of the classic concepts and practices that inform architectural heritage conservation. In this sense, the 2020 book by Graft and Delemontey *Histoire et sauvegarde de l'architecture industrialisée et préfabriquée au XX^{e} siècle* was published aiming at recapturing the diversity and complexity of the century's construction systems, focusing on emblematic industrialised and prefabricated systems, opening at the problems of architectural conservation of those buildings [14].

Within this latter preservation approach, noteworthy are the ongoing research project addresses industrialised buildings in the German context, such as the topic related to "System halls as historical Monuments" within SSPP 2255 "Kulturerbe Konstruction" [15], the musealisation of the apartment within the WBS 70-system building in Berlin (Fig. 2) within the DDR museum [16], or the future exhibition "Prefabricated Building East / West" to be inaugurated in autumn 2025 at the Dresden Stadt Museum [17]. The preservation of Soviet

Fig. 2. *Technical brochure of the WBS-70 system and the musealised apartment in a WBS-70 prefabricated building in Berlin (former East Germany). Source: © Museumswohnung WBS 70.*

precast reinforced concrete buildings, opening the issue about preserving "buildings that are utterly generic", has been discussed by Kuba Snopek in the book *Belyayevo Forever: Preserving the Generic* [18]. Eventually, experimental preservation approaches of prefabricated buildings related to the topic of reuse and upcycling have recently been developed by the European project "Re-Create" [19] and the Italian one "Upcycling Architecture in Italy" [20].

3. OPEN ISSUES ABOUT PRESERVATION

The building stock of the postwar decades has been the subject of a broad discussion about historical preservation. In the evolving definition of architectural heritage conservation, changing from "individual" to "holistic" and from "holistic" to "sustainable", the actual "living preservation" approach focuses on a balance between architectural heritage and contemporary needs, grounding on the shift including intangible attributes in the conservation process [21]. In this research framework, for the specific subset of industrialised buildings, some of the topics that emerged in the 1980s debate about the preservation of 20th-century architecture can be broadened and further discussed. In the 1980s, the non-ideological matrix of architectural studies based on material culture played a crucial role in establishing 20th-century architecture within the historical heritage, allowing for overcoming and reconciling the inherent conceptions of transitoriness and functionalism with the conservation approach [22]. However, these inherent concepts must be stretched to be applied to industrialised buildings.

First, the preservation of industrialised buildings demands a further rethinking of the concept of "durability" associated with protection and safeguarding. In postwar industrialised architecture, the design process of classic Modernity is absorbed and stressed: if the question of durability has already been discussed and modified within the debate about the historical preservation of modern architecture, the concept of disposal and transitory in construction that featured prefabricated buildings deserves further consideration to embody this specific design syntax in the preservation approaches.

Second, the process demands the adaptation of the definition of "uniqueness", which is classically associated with the monument. Indeed, in postwar industrialised architecture, the mass production of the relation between the original and the copy is stressed and exploded. Is the uniqueness of the technical innovation in the state-of-the-art or the architectural design of the single construction system to be protected? Is instead the "replica" of the same construction system within the technological and productive adaptation to local contexts (Figs. 3-4) linked to the inner values of knowledge transfers?

At the same time, even the role of the "authorship", classically associated with the artistic value of the building, must be redefined. Indeed, in post-war industrialised architecture, the relationship between the author and the building is mediated by the industrial production process. How is the architectural design of the single building related to other authors' inventions? Moreover, in this specific case, how can the compresence of multi-authors be treated within the safeguard of the single building? Is instead the authorship of the single construction element,

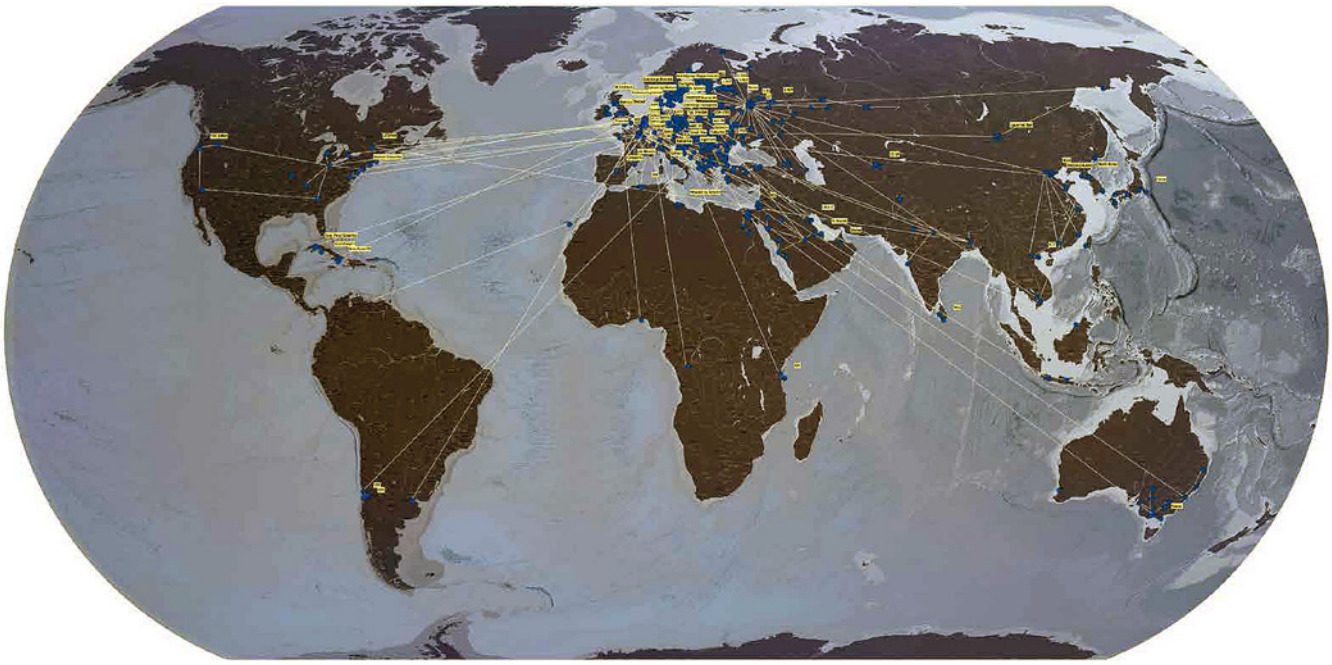

Fig. 3. *Global distribution of 98 trajectories of prefabricated systems, mapping by T. Carbonell Guillón and J. Hernández published in the book "Flyng Panels", Dom Publisher, 2019. Source: © J. Hernández and P.I. Alonso.*

Fig. 4. *The "global" construction systems in the 1960s: prefabricated buildings with large panels. Left: Prague. Source: © Národní Technické Muzeum. Right: Milan. Source: © Aler Archive, Milan.*

in terms of technological invention or design model, to be protected? Furthermore, expanding the topic, how can the authorship be traced in the international declination of the most affirmed construction systems?

To give a practical example, for the notable case of the "Camus" system, which was worldwide diffuses, how can be retraced, within the safeguard action, the significant contribution of the national dealers, producers, and design involved in the application of the system? In fact, beyond the conventional authorial role of the architect, there is another group of less acclaimed agents comprising politicians such as Khrushchev in the USSR and George Romney in the US, together with industrialists and entrepreneurs such as Raymond Camus in France, Allan Skarne in Sweden, and Nares Craig in the UK. The group also includes lesser-known engineers such as Hiroshi Yoshida in Japan, Milo Shemie, William F. Dawson, and Zenon Zielisnki in Canada, and Josh. F. Munch-Petersen in Denmark; and architects such as Hugo D'Acosta and Edmundo Azze in Cuba, Wilfried Stallknecht, Hubert Scholz, Konrad Püschel, and the DAH group (Deutsche Arbeitsgruppe Hamhung) in the GDR, Mart Port in Estonia, the Pécs Group in Hungary, and Vitaly Pavlovich Lagutenko in the Soviet Union.

There are also more celebrated architects, such as Marcel Lods, who designed ensembles with the Camus system in Fontainebleau; James Stirling, who designed Saint Andrews' Dormitory in Scotland; or César Tacchini, who founded the IGÉCO factory in Switzerland. Tacchini, himself a combination of architect, engineer, and entrepreneur, reveals how working with panel systems went beyond disciplinary and professional boundaries and played a role in the gradual, collective transformation of systems globally.

The questions are manifold and call for the multiplication of studies that rigorously focus on the reconstruction of the design and building process rather than the product of the building itself, retracing the network of productive, economic, and social actors concurring on the "collective" ideation and construction of the industrialised building. Exploiting the affinity between the concept of "monument" and that of "document", it is the act of documenting the entire process of ideation, production, and construction that supports the construction of the collective identity of the industrialised building.

4. TOWARDS A GLOBAL CATALOG OF INDUSTRIALISED BUILDINGS

In this research framework, a significant strategy for the preservation of industrial buildings is traced by the historical-relational path [23], exploiting, on the one hand, the consideration of the industrial building within its territorial and landscape context; from the other, the consideration of the industrial building within its historical-relational network with heteronomies such as the cultural or technological histories.

The application of the historical-relational approach urgently demands the public dissemination of the base knowledge of industrialised buildings at a global scale, based on the established "cataloging approach" already adopted for Modern architecture [24] and in the field of industrial archaeology [25].

In this sense, the catalog can support the construction of a historical series based on the definition of paradigmatic exempla, considered as the prototypes of the application of a specific artistic or technological innovation, that devolves in a process persistent in time, providing, thus, a remapping of the significant local developments and modification of the internationally affirmed construction systems.

In particular, the catalog can produce an in-depth knowledge framework regarding the construction process, technical innovation in the state-of-art, manufacturing process, and technological design approaches embodied immaterial values of the prefabricated buildings that require their protection, even if they are not fully detectable in the materiality of the built work.

International action should be undertaken to produce an effective catalog rooted in a shared classification of available sources and the development of specific tools to display and represent the results. In the following, some considerations about the documental sources and the digital tools significant to the study and the cataloging of industrialised buildings are synthetically outlined.

4.1. SOURCES

The post-war buildings feature as documentary double, which returns significant traces of the project, construction, and modification of the buildings over time. The act of building produced a massive number of documents, which represent, at the same time, a resource and an obstacle for the historical and technical knowledge of the building: if, on the one hand, the papers' capillarity allows us to reach remarkably accurate information about the design and building processes, providing valuable evidence to retrace the building in its cultural and technological network; on the other hand, their mass, their capillarity and, at the same time, heterogeneity requires systematization and iterative verification to achieve some valuable knowledge, including unavoidable irresolution, about the materiality of the buildings [26]. For the specific case of industrialised buildings, the act of building features the proliferation of the documents, including, in a broader sense, specific categories related to multi-actors' involvement within the industrial building process.

The classic collections produced by the traditional building process – drawings, technical reports, diaries,

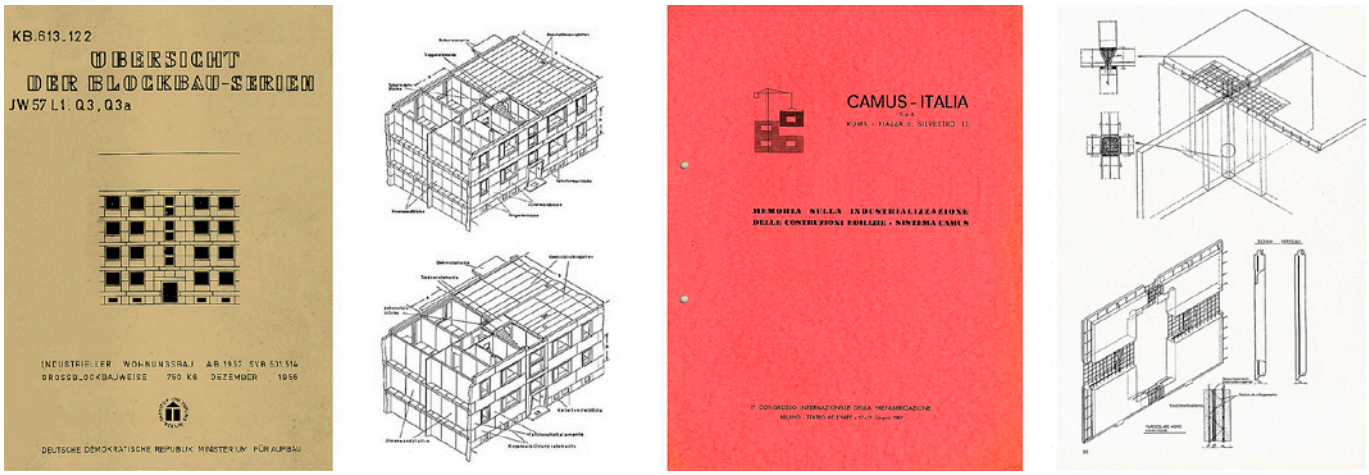

Fig. 5. *Left: commercial documents of East-Germany series. Source: © Berliner Zentralarchiv. Right: Italian-Frech Camus system. Source © Aler, Milano.*

and photographs of construction sites – are, in this case, widened by the special documentary series produced by the styling and marketing process of the industrialised construction systems (Fig. 5).

In this sense, a unique documental collection is represented by the industrial patents protecting prefabricated systems (Fig. 6): similarly to the pattern of the stages of reinforced concrete development in the years 1900-1950, throughout the massive industrialisation undergone by building since the late 1940s, industrial patents afforded the means to make technical innovations commercially available; thanks to patents, in fact, performances (essential when dealing with industrial products) could be codified. At the same time, the intellectual property of products could be protected to allow them to be used in a wide range of markets. On the one hand, patent-based production was essentially getting the trade of inventions underway; on the other, the exchange of technical know-how – triggered by the availability of patents – led to resorting to "international" building patterns, extended further by a gradual resort to common-acknowledged technical norms. In this sense, the invention timeline reveals (besides an interesting chart of the paths of know-how) various local interpretations prompted by the natural need to suit them to the features of the countries they "journeyed through", as regards production-patterns and technology and – more generally – the cultural and technological background of projects. Most of the time, industrial patents were accompanied by commercial brochures of the prefabricated systems, elaborated

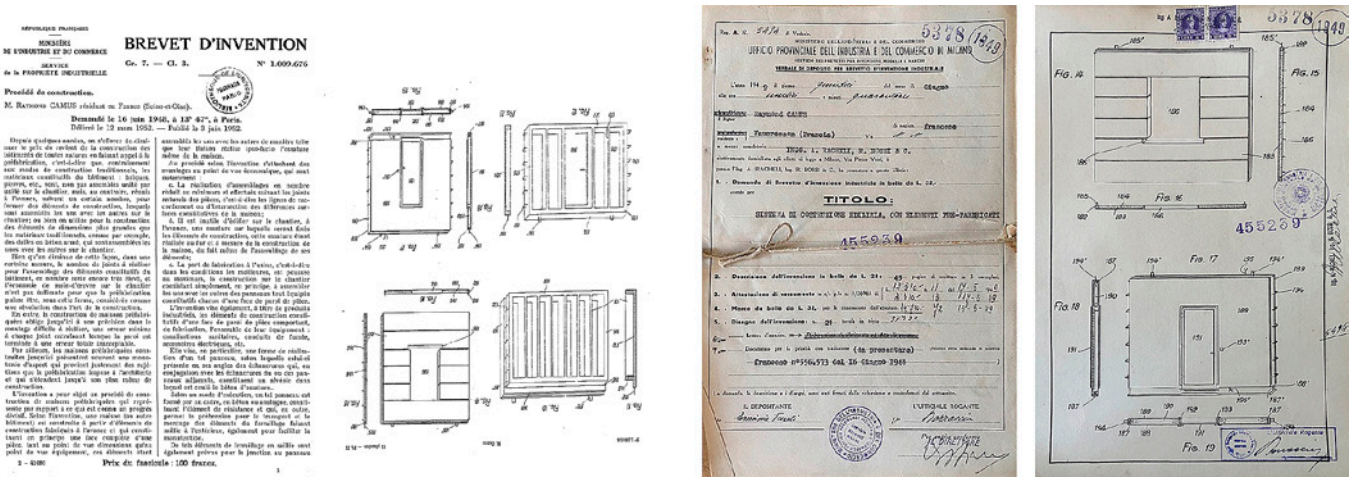

Fig. 6. *Left: industrial patent of the Camus system in France. Source: © Espacenet INPI. Right: industrial patent of the Camus system in Italy. Source: © Archivio Centrale dello Stato, Fondo Ufficio Italiano Brevetti e Marchi.*

by the leading producers and, thus, by the national dealer. These documents, embedding valuable photographic evidence on the production and assembly process and by a repertoire of standard projects, bear witness to the original design of the most affirmed construction systems and, thus, to their worldwide commercial transfer and technical modifications.

Since the late 1960s, the special documentary series that characterize the industrial building process have been enriched by pioneering "digital" documents generated by the pioneering application of computers to support the design and control of the production process. The analysis and conservation of this latest series of sources, produced by the first attempts of the "*Sfida elettronica*" (Electorinc Challenge) [27] phases, remains an open issue, which requires the development of dedicated studies.

4.2. TOOLS

Three-dimensional and informative modeling tools have assumed a key role in the knowledge, protection, and valorization of the historical built heritage. Based on the historical material affinity between the industrialisation of buildings and the pioneering application of computer-based approaches, the construction of a catalog oriented to disseminating base knowledge framework and protecting industrialised buildings represents an ideal field of application.

On the one hand, by exploiting the modularity and the "component-based" construction that characterizes prefabricated systems, it is possible to obtain a detailed three-dimensional and informative restitution of a wide range of technological systems, fully exploiting the native functions of the current applications for parametric object-based modeling [28]; on the other hand, the structuring of databases linked to the three-dimensional geometric representation allows to transform the model into an effective "digital archive" to be used within public dissemination and pedagogical approaches.

The digital model can be exploited in a deep affinity with the philological approach [29], established in archaeology, serving respectively as a tool of investigation, systematization, and representation of the data provided by the documental sources: during the collection of documents, the model supports the classification and organization of the documentary series; in the analysis phase, it is, therefore, used as a reconstructive tool to support the cross-referencing and iterative verification of the data contained in the different series of documents and, thus, display the results as interactive visual representation and organised set of informative data (Fig. 7).

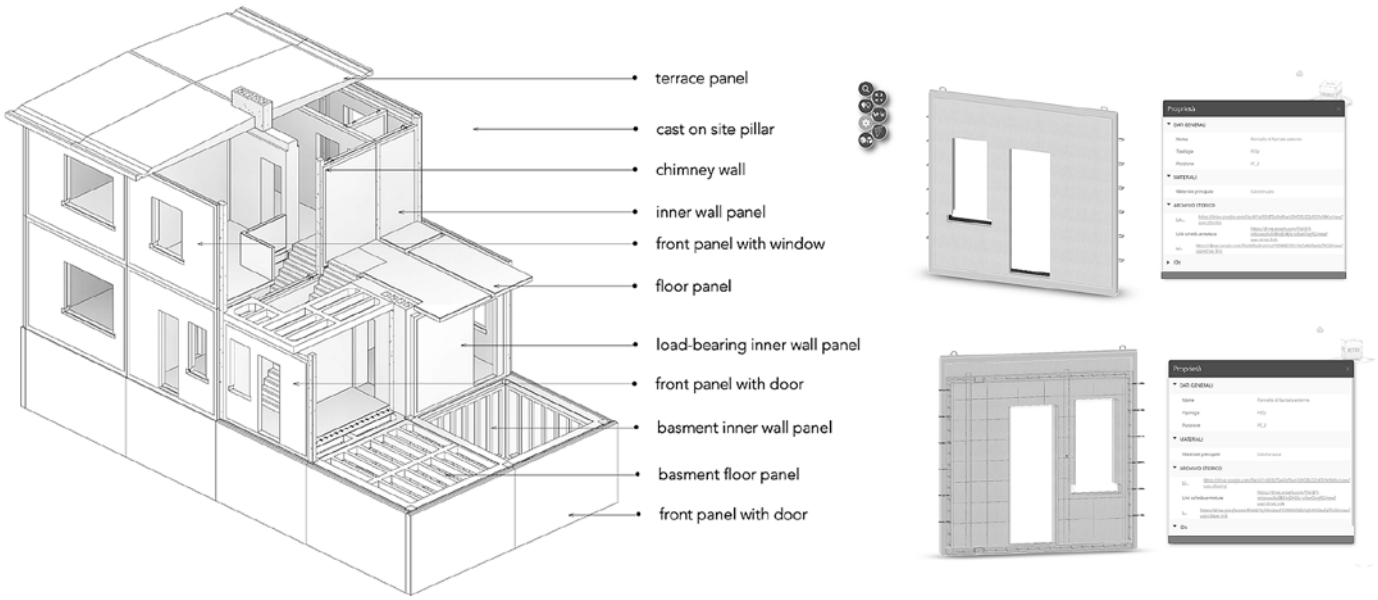

Fig. 7. *Left: philological digital models of the Camus system: the type building based on the1949-Italian industrial patent. Right: sample of the interactive viewer. Source: © [29].*

5. BETWEEN GLOBAL AND LOCAL: NOTES ON THE CASE OF ITALY

According to the proposed open issue about the definition and the safeguard of the specific heritage of industrialised buildings, the Italian case deserves some special notes. On the one hand, Italy features a law framework that presents significant issues concerning safeguarding modern architecture; on the other hand, Italy represents a significant case of the declination of internationally affirmed construction systems to specific technological-productive and cultural local frameworks.

Regarding the first aspect, the law constraint for the safeguard of the 20th-century architectural heritage avoided any graduality. For a vast heritage in terms of quantity and quality, such as that of 20th-century industrial buildings, that go far beyond the architecture of affirmed architects, the question arises of the fate of anonymous buildings [30, 31]. As mentioned above, the actual law framework grounds on the minimum life span, which extended to 70 years, represent the base condition for activating safeguard actions, opening a significant legislative gap for the younger architectures. In the case of anonymous or multi-author buildings, such as the case of industrialised architectures, the gap is amplified by the impossibility of recurring to the so-called "authorship right", usually called to protect specific architectural design [32].

Regarding the second aspect, in Italy, the singularity of the socio-technological and economic backgrounds that feature post-war Italy, the development of industrialised constructions followed a tortuous path. Starting from dense experimentation that arose in the urgency of Reconstruction, passing through a forced pause in the 1950s, with some noteworthy exceptions, the process restarts in the 1960s, looking at the foreign models. The progressive adaptation of foreign models in the backward economic and productive framework of the country allows for the establishment of a very special industrialisation in construction that never detached the building site. Quoting the worries expressed by Giulio Carlo Argan – in the noteworthy essay *Modulo-misura e modulo-oggetto* [33] – about the inevitable detachment of the design from the construction site, that featured most of the international dimension of Post-war building industrialisation with the subsequent break between ideation and the execution, are peacefully solved within the singularity of the Italian path (Fig. 8).

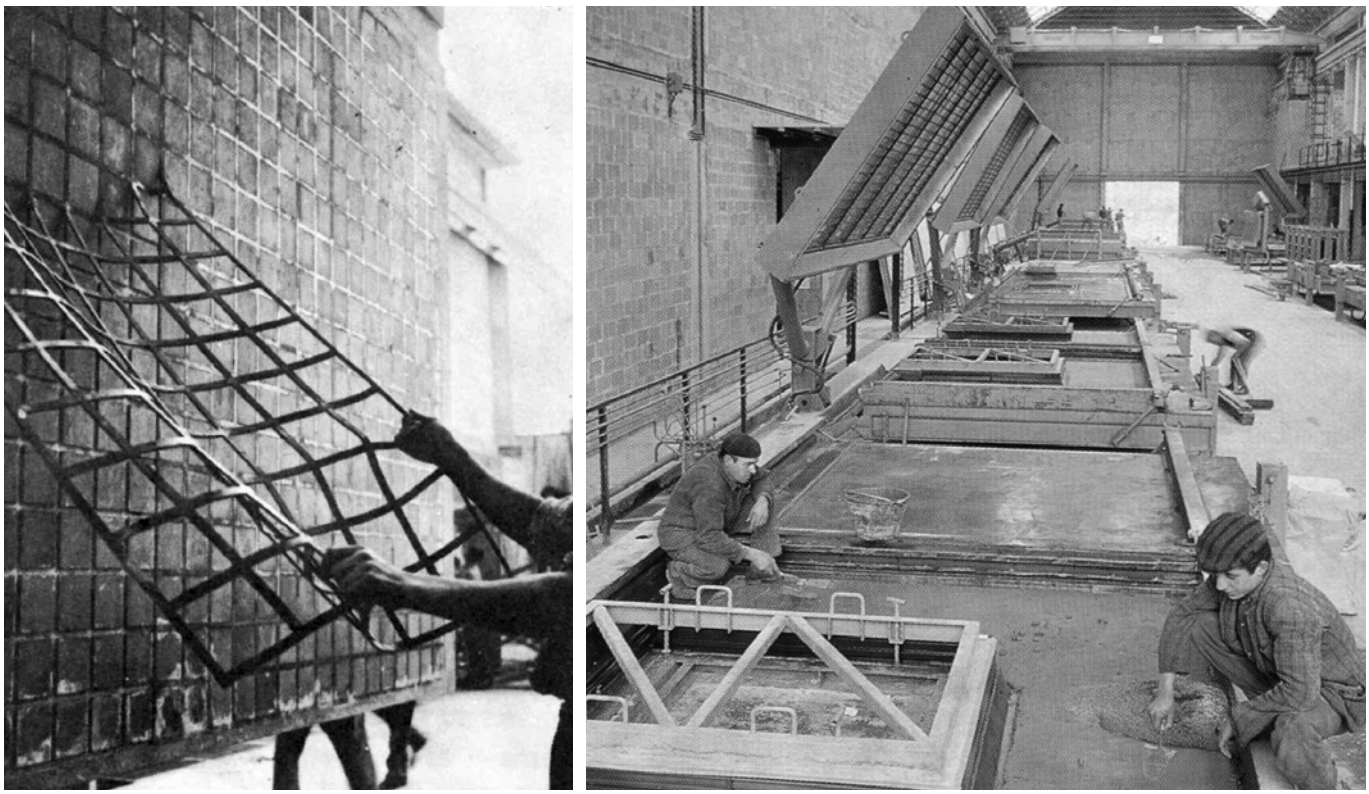

Fig. 8. *Tailored industrial manufacturing of the MBM-Balency prefabricated panels based on Balency French patent with new design features made by Vico Magistretti. Source: © AITEC, 1966.*

The construction site – relocated in the factory – remained the "cultural gym" where the traditional construction elements are progressively renamed in industrial products, approaching the boundaries of the industrial design [34]. According to this specific technological and cultural *milieu*, safeguarding actions should deal with the reconstruction of the specific microhistory of the single building and, thus, reframing it in the international history of building industrialisation.

6. CONCLUSION: RESEARCH TO BE DONE

At the time of this writing, the post-war industrialised buildings are still generally neglected and rarely protected: supported by the generalised public negative image of prefabricated buildings – which have aged poorly – demolitions and the canceling of memories are broadly the case worldwide. As a matter of fact, significant historical studies and safeguard actions have been conducted, producing a significant base of knowledge that is increasingly useful for reframing industrialised buildings within the 20th-century architectural and technological heritage. Nevertheless, a lot is still to be done to outline possible scenarios for their safeguard and preservation.

We can outline two urgent paths. The first is the improvement of the Construction History studies in support of the "historical-relational approach" to safeguarding and preservation. In this sense, the material histories of the building processes of the industrialised building – extended to the actions of the manifold actors and disciplinary fields involved – provide documentary evidence on the relational network between the industrial building itself and its socio-economic and technological backgrounds.

The second is the importance of developing a global catalog of industrialised buildings based on the historical series and the identification of paradigmatic examples at the scale of the construction systems. This catalog could provide, on the one hand, documentary evidence of the relationships between a given system and all its associated social and technological histories. On the other hand, it could provide documentary grounding to see and explore the systems' transnational movements, transformations, and adaptations in further inquiring into the "mode of existence" of a still overlooked kind of collective design processes that, for over a century now, have worked both at the levels of the typologies and the level of the technologies.

Authors contribution

The authors are listed in alphabetical order. They contributed equally to conceptualisation and writing.

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