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Davide Del Curto · Simona Salvo *Editors*

Planned Conservation of 20th-century Architecture

Research in Italy and Brazil

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ISSN 2191-530X ISSN 2191-5318 (electronic)
SpringerBriefs in Applied Sciences and Technology
ISSN 2282-2577 ISSN 2282-2585 (electronic)
PoliMI SpringerBriefs
ISBN 978-3-031-67817-2 ISBN 978-3-031-67818-9 (eBook)
https://doi.org/10.1007/978-3-031-67818-9

Foreword

The essays gathered in this book introduce a series of conservation plans, which have been developed in different countries with the support of one granting program issued by Getty Foundation, focused on the conservation of modern architecture. Therefore, it provides a rather new opportunity to discuss at least two crucial questions: the comparison of different approaches to conservation understood as a long-term process, as well as the aims, limits and methods of the conservation of modern buildings.

As becoming more and more an international issue, conservation of built cultural heritage had to re-think its roots, opening doubts on ideas and practices rooted in the past and reinforced even by some international document, used as sacred texts in spite of their sometimes ambiguous wording.

Whilst for artworks and for the collections conserved in museums the concept of preventive conservation has been well developed to take into account the various types of risks, easily including the ones related to human behaviours and environmental changes, the step towards a long-term approach for architectural objects had to deal with several aporias, in my opinion not yet solved.

Should we treat buildings (obviously: the ones recognized for their cultural significance) as artworks, implementing the same risk analysis techniques and special maintenance procedures prioritizing material authenticity? The answer varies according to different backgrounds, as we had the opportunity to observe during several years of international collaboration in these kind of researches.[1] Actually, differences or nuances exist not only between scholars from Europe and Asia, but also among European Countries, in spite of the pretended common reference to the often quoted Venice Charter: a document that still serves just because everybody can use it, to endorse anything and the reverse of anything.

[1] Koenraad Van Balen & Aziliz Vandesande (ed.), Reflections on Preventive Conservation, Maintenance and Monitoring, Leuven, Acco, 2013. ISBN 978-90-334-9342-3; Vandesande, A., Verstrynge, E., Van Balen, K. (Eds.). (2020). Preventive Conservation—From Climate and Damage Monitoring to a Systemic and Integrated Approach. London: CRC Press. ISBN 978-0-367-43548-6.

Nevertheless, even after the 1994 Nara document, it is difficult to underestimate the value of material authenticity, as related to an approach to architecture that is capable to develop a special knowledge by merging archaeological and anthropological methods. The latest research is actually building a common ground far beyond the differences between traditional western and eastern meanings of authenticity. Preventing the loss of material substance doesn't mean that architectural objects can be dealt with implementing an exclusive priority for their physical conservation. I see two conceptual knots here, which I don't dare to attempt solving, but I consider useful to point them out so to frame the topics presented in this volume.

The first knot, is that architecture cannot be understood, nor conserved, without focusing on its use and the role and rights of the users. If this statement holds, the consistent values get multiplied, and authoriality becomes more and more a secondary and misleading criterion.

The second knot, concerns the meaning of conservation: the same word is used for natural environments, and for food, becoming the synonymous of managing complexity, as well as of freezing, e.g. vegetables.

Architectural conservation cannot be understood as freezing buildings, even if the cultural background and the disciplinary traditions emphasize on recognizing and maintaining the historic elements. This means that architectural preservation means to make built cultural heritage coevolve with society, so that historic buildings can extend their service life, while providing inspiration and cultural richness to the future. The concept is a bit more complex than the popular "adaptive reuse", but it could work better.[2]

This is why the idea of "conservation as the management of change", a pragmatical concept that can be retraced both in anglo-saxon tradition and in Italian reflections, is extremely productive: but it is challenging indeed as implemented on modern architecture. Here, actually, some conservation practices could be easier, in some cases even keeping the buildings could be meant as the implementation of a simple maintenance plan. But nothing is really simple: the new paradigms of environmental impact reduction, energy efficiency, circular economy, are fostering new reasons of change, which require new thoughts about the reasons of conservation.

For recent buildings, the reasons to conserve are often rooted in an approach to the projects of modern architects as undisputable masterpieces, to be conserved with some fetishism based on authorship, even when they clearly are not up to comply with rapidly evolving requirements, in spite of their newness. The step from a freezing conservation to a coevolutionary approach is even more necessary for modern architecture: the issue of energy efficiency, for instance, reveals the limits

[2] S. Della Torre, A Coevolutionary Approach to the Reuse of Built Cultural Heritage, in G. Biscontin, G. Driussi (eds), Il patrimonio culturale in mutamento. Le sfide dell'uso, Venezia, Arcadia Ricerche, 2019, pp. 25–34; S. Della Torre, A coevolutionary approach as the theoretical foundation of planned conservation of built cultural heritage, in Vandesande, A., Verstrynge, E., Van Balen, K. (eds.), Preventive Conservation - From Climate and Damage Monitoring to a Systemic and Integrated Approach. London: CRC Press, 2020, pp. 11–18; S. Della Torre, Coevolutionary Thinking put into Practice, "Inrecci", 3, 2023, pp. 6–17.

of some celebrated recent buildings. For the sake of taking into account the environmental impact, ancient important monuments are facing deep transformations: it's unbelievable that contemporary (pretended) masterpieces are kept as they have been designed, even if the vision of the project proves to have been, at least, short-sighted.

Therefore, this book is very important because in the following pages the reader will find a variety of projects, which are at the crossroads of cutting-edge international reflections on architectural conservation, focusing on two keys for advancement in the research in the field: namely, long-term vision and coevolutionary needs.

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Preface

This book deals with the planned conservation of modern architecture and proposes a comparative discussion between eight research programs recently completed in Italy and Brazil as part of the "Keeping It Modern" program by means of which the Getty Foundation supported the drafting of conservation management planning for major architectural masterpieces of the 20th-century worldwide, between 2014 and 2020.

The scientific results of this program are maturing, and also resulting in publications promoted by universities and research centers involved by the Getty Foundation. Within this framework of initiatives, we dedicate this book to the comparison among research projects carried out in Italy and in Brazil, starting from the distinctive characteristics that modern architecture has gained in the two countries and evaluating the impact of Conservation Management Plans on the cultural scenario of each country and on the corresponding protection systems. We asked the co-authors to reconsider the research experience faced within the KIM program, but overcoming their description and proposing to describe instead its specific reflection about the role that management plans play for 20th-century architecture and about how the outcomes of this experience have contributed to the debate on the conservation of contemporary architecture.

Finally, the book presents many transversal topics and highlights numerous similarities in approach between the two countries, but also profound differences in the way of understanding the conservation of 20th century architectural heritage.

Milan, Italy — Davide Del Curto
Roma, Italy — Simona Salvo

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Twentieth-century Architecture and Conservation Management Planning. Experiences in Italy and in Brazil

Davide Del Curto and Simona Salvo

Abstract This book presents a comparative discussion of the experiences developed on the topic of management and conservation of 20th-century architecture in Italy and Brazil with the support of the Getty Foundation in Los Angeles. Building upon the scholarly findings compiled by experts in the field, this book publication offers an analysis of the management and conservation plans developed in the two countries and attempts to evaluate their tangible effects on architectural conservation practices and institutional protective measures. Our aim is to contribute to the international debate on the protection of modern architecture catalysed by the Getty Foundation's "Keeping it Modern" program between 2014 and 2020 by providing insights into the impact of this investment in human and financial resources in Italy and Brazil.

Keywords Conservation management plan · Modern architecture · Italy · Brazil · Planned conservation

1 Introduction

The book includes eight essays written by researchers who were instrumental in formulating the conservation plans, reflecting on the true impact of these projects on the conservation of the buildings drawing upon the research descriptions outlined in the final reports compiled by the Getty Foundation, and on other publications (https://www.getty.edu/foundation/initiatives/current/keeping_it_modern/report_library/) [1–3].

Several significant variables need to be considered when evaluating research and projects in the two countries. These include the differing timelines for their development and publication, and the time elapsed since their effective dissemination. For

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D. Del Curto and S. Salvo (eds.), *Planned Conservation of 20th-century Architecture*, PoliMI SpringerBriefs, https://doi.org/10.1007/978-3-031-67818-9_1

instance, projects for the Edificio Artigas at the Universidade de São Paulo were documented in 2017, for the Casa de Vidro in São Paulo in 2018, for the Museo das Artes de São Paulo-MASP in 2019, for the Stadio Flaminio in Rome in 2020, for the School of Mathematics at Rome's University Campus in 2021, for the School of the Arts in Cuba in 2022, and for the Torino Esposizioni Hall B in 2023. The following considerations also consider the Conservation Management Plans completed in 2017 for the Collegi del Colle in Urbino (Giancarlo De Carlo, 1962–1986) and for the Arthur Neiva Pavilion of the Oswaldo Cruz Foundation in Rio de Janeiro (Jorge Ferreira, 1942–1948), already published extensively and not included in this publication for editorial reasons [4, 5].

It is therefore crucial to allow more time for a comprehensive assessment of the ultimate impact of these experiences, based on the actual implementation (or non-implementation) of the planned interventions, also considering the lingering effects of the pandemic crisis, which significantly impacted the projects between 2020 and 2021.

Furthermore, it is important to note that the "Keeping it Modern" programme could not directly act on the buildings due to the diverse ownership regime, legislative framework, and the distinct institutional arrangements for protection across the involved countries. The programme's primary aim is instead fully cultural, serving as a catalyst to foster dialogue on the conservation of 20th-century architecture. This dialogue is intended to occur primarily among specialists, conservation institutions and the communities of 'inhabitants', facilitating a discourse on balancing heritage conservation with the needs of collective use.

Therefore, the assessment of the impact of the conservation plans discussed in this volume primarily focuses on the capacity that the drafting of these documents has developed in researchers while planning modern heritage conservation, thus cultivating a sense of belonging within the communities inhabiting these spaces, and promoting their conservation efforts, albeit indirectly.

Moreover, the decision to focus on a comparative analysis between Italy and Brazil stems from the substantial number of projects funded by the Getty Foundation: apart from the United States of America, which participated with 17 projects, and the United Kingdom that received five grants, Italy and Brazil contributed most to the project, respectively with 4 and 5 projects (Fig. 1a, b).

Additionally, the choice is influenced by direct and collaborative dialogue established amongst the working groups involved in these projects. This collaboration is built upon the long-standing scientific and academic cooperation between universities and research centres in both countries, particularly regarding 20th-century architecture. Furthermore, it is based on a deep-rooted cultural connection between the two countries, addressing questions of architectural historiography and of 20th-century architectural conservation and restoration, which are of mutual interest despite some notable differences. While modernism in Brazil symbolises independence, post-colonialism and the creative vitality of a country in constant socio-cultural evolution, Italian 20th-century architectural production occupies a complex historical–critical position, marked by historical events that separate the first half of the century, which is

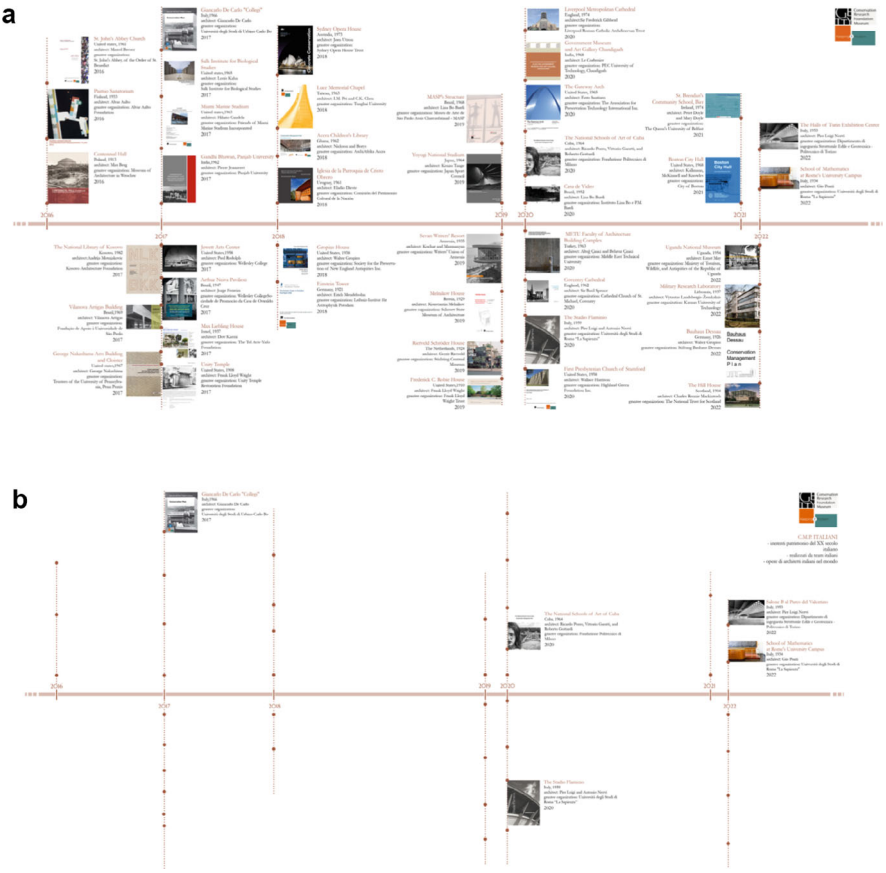

Fig. 1. **a** Development of "Keeping It Modern" projects in the world between 2007 and 2023. **b** Development of "Keeping It Modern" projects in Italy and Brazil between 2007 and 2023

associated with the Fascist dictatorship, from the second, which is linked to building speculation and aggression against historic urban centres.

Moreover, while Brazil legislation governing the conservation of cultural heritage provides that protection can be initiated almost concurrently with the achievement of the building itself, placing no chronological limits on the protection of cultural heritage, in Italy the progression of historiography is more gradual and deliberate, particularly concerning recent architectural heritage. The tendency to centre historical–critical assessments around the more well-known works, often elevated to the status of 'icons', links the two countries instead, with some recent openness towards residential historical estates and widespread cultural heritage, especially in Italy. Some profound differences between the two countries also exist in terms of heritage conservation implementation—perhaps even in their fundamental conceptualisations—as well as in the management of maintenance and, notably, in the

varying degrees of emphasis placed on integrating conservation plans with broader issues such as sustainability, resilience, community involvement, artefact usage, and the concept of 'risk'. The conservation and management plan for the National Art Schools of Cuba, among others, has tried to include some of these issues within its framework, for example investigating the hydraulic risk to which buildings are exposed due to their proximity to the Caribbean Sea and the violence of tropical rainfall, which is increasing due to global climate change [6].

However, before delving into any comparison it is crucial to acknowledge the distinct theoretical and methodological frameworks that underpin conservation planning and management in the Anglo-Saxon cultural context that rules the approach of the Getty Foundation, and those inherent to the purely Italian and 'Latin' context. With its historical and cultural precedence in conservation, viewed as an "act of culture" rather than as the mere functional recovery of a historical asset, Italy actually struggles with a long-standing inertia in embracing maintenance as a protective practice. This may stem from deep-rooted attitudes within individuals and communities, or may be considered the output of the country's administrative, political and social organization. Nonetheless, this reluctance to assume responsibility for the maintenance of architectural heritage (especially public properties), which instead is a more common practice in Anglo-Saxon countries, diminishes the effectiveness of any conservation planning efforts. Contrastingly, despite sharing a Latin cultural background with Italy, Brazil exhibits a greater readiness for accountability and an understanding of the advantages that shifting perspectives toward maintenance practices can yield.

2 Cultures of Conservation

The Conservation Management Plan (CMP) proposed by the Getty Foundation is structured in five operational steps defined by the Australia International Council on Monuments and Sites back in 2013 based on the Burra Charter, drafted by the Australia ICOMOS in 1979 and subsequently updated up to the version adopted in 2013 [7], and in stark contrast to the Venice Charter of 1964 and to its principles of material conservation (Fig. 2).

In the Anglo-Saxon cultural context, which is strongly marked by pragmatism, conservation and management plans are understood as tools "to manage change for an adequate balance between preservation of values and evolution of use", identifying "operational methodologies and process organization to enable managers and owners of historical assets to operate consciously, in a planned and controlled manner": the criteria identified for ensuring architectural conservation are therefore conceptualised "in terms of hierarchies of values and tolerance to change, not design proposals". This condition stems from a preliminary "statement of significance" that underpins the conservative approach.

The Italian cultural and methodological context, instead, presents a markedly different approach characterised by processes of "value assessment", rooted in a

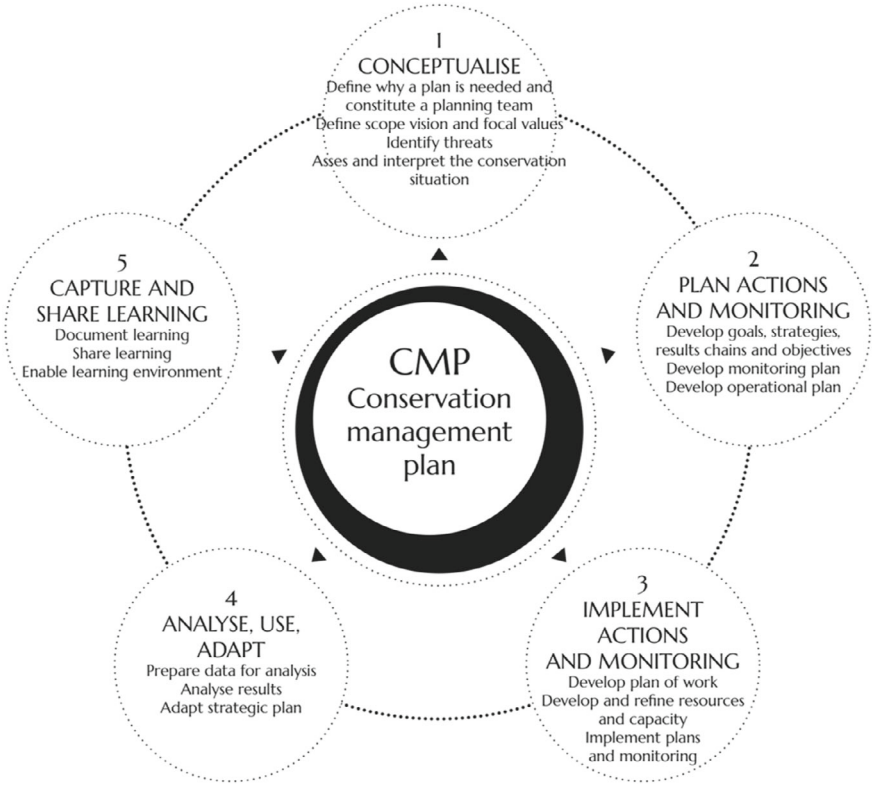

Fig. 2 The phases of a CMP

theoretical framework derived from philosophy and art criticism rather than in more contingent cultural, socio-economic and political circumstances. Brazil also follows this approach in many ways, albeit with a value scale that encompasses historical, aesthetic, socio-cultural, anthropological and political dimensions. In Italy, the commitment to prioritizing material conservation, even at the expense of considerations about use and functionality [8], poses a significant contrast to the Anglo-Saxon framework that informs the development of CMPs. These disparities represent significant challenges that have already emerged in the attempts to formulate a global approach to the conservation of the world's cultural heritage, which require extensive collaboration and mutual understanding to ensure benefits for the community in a broad, inclusive and intercultural sense.

3 Opportunities

A consistent theme shared by all the researchers involved in the Keeping It Modern projects emerges from the experiences narrated in this volume, which concerns the opportunity provided by the Getty Foundation to conduct scientific, systematic and multidisciplinary research on works that had never been carefully studied before despite their undeniable architectural and testimonial value. This opportunity is an undoubtedly unique and exceptional endeavour in the context of contemporary heritage conservation as it also ensures full organisational autonomy in proposing organisations and in covering the costs without imposing any restrictions.

The Getty Foundation's support has in fact facilitated a substantial investment of energy and resources aimed at deepening knowledge of the studied properties, being this an indispensable prerequisite to identify protection strategies. In the cases herein examined, the development of CMPs has in fact necessitated investigations into the historical construction phases, direct studies of building materials and construction techniques, in-depth studies of the cultural, socio-economic and political context in which the buildings were constructed and the consequences of its changes over time, and the original and current usage patterns, among others. These investigations, often carried out for the first time, have produced fundamental and original information that finally sheds light on individual works, their authors and the historical context in which they were conceived. Thus, while primarily serving as predictive tools, CMPs also possess a hermeneutic potential, fostering the advancement of scientific knowledge and unveiling previously unknown aspects of the artefacts, sometimes even suggesting their repositioning in the historiographical context, as in the case of the National Schools of Art in Cuba, where preliminary CMP investigations revealed the actual structural mechanisms underlying thin concrete and brick vaults [1].

The drafting of CMPs, in certain instances, has also played a significant role in fostering experimentation with restoration techniques, prompting the refinement of maintenance practices. The CMP for the University Colleges of Urbino, characterised by Brutalist architecture featuring reinforced concrete façades, includes a chapter dedicated to the conservation of this challenging material. In order to maximise the applicability of the research results, the compilers of the plan for the Urbino Colleges tested a selection of commercially available products for cleaning, consolidation and protection of concrete, rather than relying on experimental laboratory-developed products. This approach aimed to align the Conservation Plan with the needs of maintenance personnel by recommending easily implementable techniques and readily available products, particularly within the context of public tendering procedures for routine maintenance services [9].

In the case of the Torino Esposizioni Hall, the application of Geomatics to analyse the vast reinforced concrete structure designed by Nervi facilitated the creation of an incredibly detailed and accurate survey. This survey served as a "digital twin" of the structure, offering a scaled representation that enables precise evaluation of its structural layout. Here, and in the case of the Stadio Flaminio, the comparison with structural safety regulations—rather strict and restrictive in that it imposes high seismic

safety requirements to guarantee the durability of the work (which, however, lead to an underestimation of the building's actual structural capacity)—greatly influences the type of intervention that can be carried out, even in the case of listed buildings. In Torino, the strategic use of three-dimensional models made it possible to identify the main structural weaknesses in the reinforced concrete structure and an insufficiency in the shear reinforcement (which is a typical feature of the structural design of the time, and not a 'design error'), thus defining minimal intervention strategies. Similarly, in the case of the Stadio Flaminio in Rome, the use of Heritage Building Information Modelling (H-BIM) facilitated dialogue with public administration, leading to the adoption of the CMP as a scientific reference in tenders calls for the renovation of the building, with a promise to enhance the quality of future projects. In Brazil, on the other hand, greater emphasis was placed on investigating structural aspects to assess the building's resistance under changed conditions of use, as evidenced in the Museo das Artes de São Paulo (MASP) where the actual functioning of the structure (which closely coincides with the architectural form) was previously unknown. However, in this latter case a regrettable discontinuity occurred between the drafting of the CMP, as identified by researchers who meticulously examined the building's structure with entirely new insights, and its subsequent implementation. This discontinuity reflects a disconnect between the philological reading of the artefact, conservation planning and its implementation, ultimately leading to a reduction in the effectiveness of the conservation process.

In other cases, the financial support from the Getty Foundation arrived late, after projects had already been executed. Unfortunately, these projects proved to be empirical and unsuccessful due to a lack of comprehensive understanding of the artefact, as in the case of the building designed by Vilanova Artigas for the Faculty of Architecture of São Paulo, where the façade and the roofing, characterised by a network of skylights embedded in the reinforced concrete structure, underwent repairs through radical but ultimately ineffective and aesthetically intrusive replacement operations.

However, even in these cases, the opportunity provided by the Getty Foundation proved to be a beneficial platform for conducting applied scientific research. It is no coincidence that out of a total of 64 projects funded by the Getty Foundation, many were proposed by universities and research centres to study university buildings. The experiences gleaned from academic contexts in Italy and Brazil—the School of Mathematics at Rome's University Campus and the Vilanova Artigas Building at the University Campus of São Paulo—highlight differing approaches by the universities in systematizing the outcomes of in-house scientific research. Despite Italy's long-standing conservation tradition, exemplified by Sapienza University of Rome, little attention has been directed towards the CMP developed for the building designed by Gio Ponti in 1935. In contrast, the university in São Paulo demonstrated a better understanding of the significance of coordinating scientific research and its practical implications, fostering a culture of care for the university's historic assets and facilitating greater involvement in the management of the public assets by the academic community and the by students themselves.

The projects carried out in Italy and Brazil have further significant similarities. Firstly, they share a common methodological approach characterised by an

operational investigation methodology. This approach typically involves historical research, direct surveys, and critical-comparative analyses. In Italy, there is an increasing reliance on three-dimensional digital tools (albeit sometimes to excess) such as Heritage Building Information Model, which in Italian projects, does not depend on a methodological proposal put is forward by the Getty Foundation as much as on the results of scientific research carried out within the Research Projects of National Significance financed by the Ministry of Education over the past decade, and the very recent publication of the new public procurement act; see in this regard the essays dedicated to Rome's Stadio Flaminio, Torino Esposizioni Hall B and Rome's School of Mathematics. A few other projects in the Keeping It Modern programme make use of BIM, but none of those carried out in Brazil. Yet, Italy and Brazil place strong emphasis on the analysis of construction elements, considered as constituent architectural features. In particular, in Italian and Brazilian CMPs, there is a recurring focus on modern materials and construction techniques whose preservation often proves problematic and strongly in contrast with the instances of use, or difficult to resolve in terms of effective material conservation. Indeed, the reference to reinforced concrete is immediate and dominant. Whether utilised as a structural system for creating new spaces or left exposed as a design element, reinforced concrete poses significant preservation hurdles: chief among these preservation challenges is the material's inherent reluctancy to acquire patinas and 'traces of time' without compromising its form and appearance (Fig. 3).

Another important issue concerns the protection of door and window frames and opening systems, which are integral elements of 20th-century architecture alongside reinforced concrete, cut seldom retained during processes of transformation and adaptation, often sacrificed to accommodate functional requirements considered of higher-order. Fixtures and finishes, however, suffer far less conservative attention than reinforced concrete, even though they (the finishes) are responsible for much of the image of the artefacts, and the real sustainability of the building's functional upgrade (the fixtures). The functionality and intended use, both original and current, play pivotal roles in determining the survival of historical heritage, particularly from the twentieth century. In many instances, however, the intended use has undergone radical transformations albeit retaining the original function. For instance, early 20th-century university buildings have been consistently repurposed due to university reforms, as seen in the cases of the Roman School of Mathematics and the Brazilian Faculty of Architecture, and residential buildings face challenges related to energy efficiency regulations alongside distribution issues, exemplified by the University Colleges in Urbino.

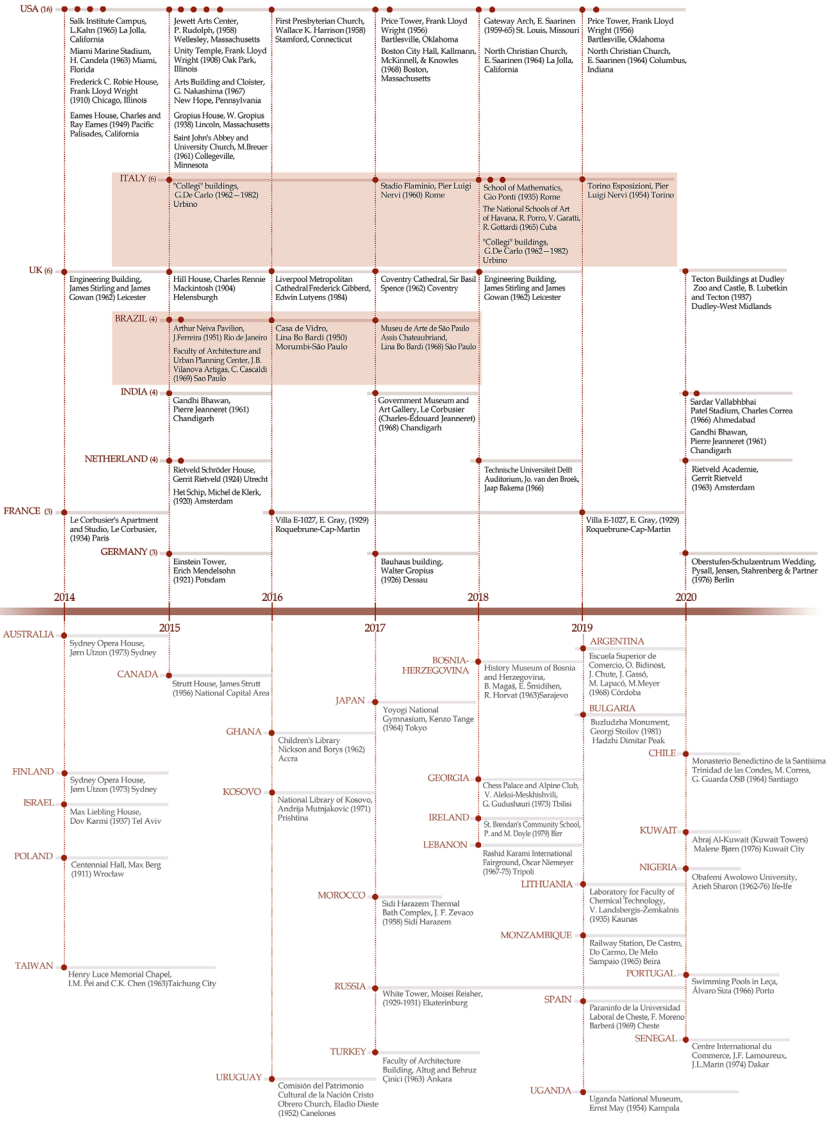

Fig. 3 Framework of the "Keeping It Modern" program in the world; projects in Italy and Brazil are highlighted in red

4 The CMP in Italian legislation between Code of Cultural Heritage and Heritage and Legislative Decree No 42/2004

When contextualising the CMP within the Italian legal framework, it is plausible to consider its alignment with the Codice dei Beni Culturali e Paesaggio (Code of Cultural Heritage and Landscape) and the Codice degli Appalti (Public Procurement Code) as outlined in Italian Legislative Decree n. 36/2023.

In the first case, we observe a shared objective and a distinct variance in approach concerning the process of determining the cultural significance of a historical building or cultural asset in general. The "statement of significance", which represents steps 1 and 2 of the CMP process, aims to identify the elements that define the cultural value of the site or building, to assess its characteristics of integrity and authenticity, to compare it with similar examples, to ascertain its cultural significance, and to identify levels of value relative to each specific element of the property. With obvious differences in method, this procedure therefore aims to establish the cultural value of the building by addressing the fundamental question "why does it matter?" and bears resemblance to the verification of cultural interest procedure, regulated by Article 12 of the Code.

Another parallel can be drawn between 'Step 3' and 'Step 4' of the CMP Process, which focus on defining procedures and actions to preserve the identified cultural value of the building (addressing the question: "how to retain the building's significance?"). In this regard, we observe a similarity in intent with the conservation and restoration activities outlined in Article 29 of the Italian Code of Cultural Heritage and Landscape.

A third parallel arises from the shared and well-established inclination to view conservation as an ongoing process of "taking care", rather than a sporadic intervention aimed at addressing emergencies or imposing an authorial stamp. In this context, the broad and inclusive definition of conservation provided in the Italian Code, defined as "coherent, coordinated and planned study, prevention, maintenance and restoration activities" (Article 29, paragraph 1), served as reference in drafting Italian Ministerial Decree n. 154/2017 "Regulations on public works contracts concerning protected cultural heritage", which recommends planned conservation as the framework reference for planning and implementation of heritage conservation, in close alignment with the principles outlined in the Burra Charter. In the final analysis, we can therefore recognise a convergence of activities between the CMP and the objectives of protection delineated in Art. 3 of the Italian Code: to identify cultural heritage ("to assess the building's significance") and ensure their protection and preservation ("to retain the building's significance").

In the case of the Procurement Code, the CMP occupies an intermediate position between the "Design Guidance Document" and the "Technical and Economic Feasibility Plan" due to their shared objectives and similar content. The CMP, resembling the programmatic nature of the former, serves as a document initiated by the contracting authority. However, in comparison to the "Design Guidance Document", the CMP advances beyond the preliminary stage by outlining priorities and project

phases more explicitly. Moreover, as observed so far, the CMP encompasses a vital phase of documentation and building analysis, essential for determining its cultural value and thereby justifying its inclusion in the list of buildings meriting protection and special conservation measures. Therefore, the CMP contributes to the broader definition of a planning strategy for protection projects and aids in drafting the Three-Year Programme of Works that regulates the planning of investments and the definition of priorities within the Italian public administration.

5 Plans in the Socio-cultural Context

The overall reading of the Brazilian and Italian experiences prompts several observations regarding the approach to the legacy of the twentieth century within the Western culture, manifesting in diverse institutional and cultural contexts within each country. While Italy boasts a widely recognized conservation culture rooted in its millennia-old heritage, Latin contexts face challenges in translating theoretical elaborations into practical planning due to administrative realities that are often unaccommodating, and at times reluctant. Indeed, disparities among the experiences examined here stem not only from cultural differences but also from distinct political-administrative contexts at national and municipal levels. The notable difference in the ability of municipal administrations to implement CMPs underscores a significant gap between Brazil and Italy.

Given the same type of artefact, the different outcomes that have emerged from the experiences gained around Pierluigi Nervi's works—Stadio Flaminio in Rome and Torino Esposizioni Hall B—cannot be explained by the different contexts surrounding the two artefacts (eg state of conservation, structural consistency, urban location, demand for urban infrastructures on a neighbourhood or urban scale, speculative pressures that have affected Italian stadiums in recent years, and the prolonged impact of post-pandemic financing) unless one considers the contrasting administrative frameworks governing the two cities. In Torino, public ownership readily accepted and systematised research and projects developed by the Politecnico, while the Municipality of Rome initially supported the Conservation Plan for Stadio Flaminio drawn up by Sapienza, only to abandon the implementation of a restoration and functional recovery project.

Rome—undoubtedly the Italian city with the most complex political-administrative structure—values the conservation of 20th-century architectural heritage in principle but not in practice, despite most of the structures that welcome the daily life of its citizens are, in fact, buildings from the last century. The persistent inertia of Rome's Municipality in fostering collaboration with research organisations cannot be attributed solely to cyclical reasons; on the contrary, the considerable influx of post-pandemic funding justifies the opposite. Conversely, in a larger and more complex city than Rome as São Paulo, public administrations, private foundations and ordinary citizens demonstrate a marked awareness of the values associated with heritage conservation. Despite the dramatic social emergencies afflicting the

Brazilian society, this exhibits a greater commitment to cultural demands. This is largely demonstrated by the challenging case of the Casa de Vidro, a fragile and complex architectural piece that houses artworks, furniture, the Bo Bardi archive, and a tropical garden with precious plant species. Continuous and integrated maintenance is imperative here, prompting consideration for the establishment of a 'house museum'.

Apart from significant side effects of the activities facilitated by the "Keeping it modern" initiative—such as the designation of Stadio Flaminio in Rome as a listed cultural asset according to protection law No 42/2004 based on the documentation produced by the research team—it is evident that projects in Brazil have enjoyed attention from owners, public administrations and users, who have demonstrated conscientious and responsible response to the challenges posed by the research and projects more than in the Italian cases.

6 A Provisional Balance

The comparison between the Italian and Brazilian "Keeping It Modern" projects provide a nuanced understanding of current international conservation of 20th-century architecture. It becomes evident that in countries with more entrenched legislative structures and a long-lasting conservation tradition, the Getty Foundation's funding programme has served as a catalyst for more sophisticated and comprehensive research, encouraging specialists to delve deeper into the knowledge of often underexplored architectural heritage, in many cases subjected to inadequate use, and vulnerable to radical transformations or abandonment. Gio Ponti's School of Mathematics in Rome, despite being a renowned work by this master of Italian modern architecture, has often been overshadowed by his other achievements. Research supported by the Getty Foundation has shed light on the genesis of this work, its historical transformations and its material composition of buildings, and from these has led to the formulation of a conservation plan aimed at effectively preserving the building's material integrity; however, the document has remained a dead letter. Similarly (albeit to a lesser extent), the case of the Collegi del Colle in Urbino illustrates a missed opportunity. Although essential restoration work on exposed concrete surfaces was undertaken, it largely disregarded the valuable guidance provided by the CMP developed by Politecnico di Milano.

On the other side, in countries where conservation culture lacks a foundational role in national heritage management policies, the Getty Foundation's activities have yielded better results not only by sponsoring the study and knowledge of works, but also by providing operational tools to guide and facilitate conservation and restoration processes. This scenario parallels UNESCO's approach in declaring World Heritage Sites, where the designation can significantly influence protection efforts, especially in countries where architectural heritage is under severe threat due to armed conflicts

or regime changes. Conversely, in other nations, such declarations serve as additional encouragement to safeguard heritage, which is already extensively protected by national legislation.

While Conservation Plans in Italy may be perceived as 'blunt weapons' for the conservation of 20th-century architecture, given their weak (if not missing) engagement with technical-administrative protection bodies, in Brazil they serve as catalysts, playing a pivotal role in fostering research and projects, and in engaging stakeholders who can facilitate protection. Therefore, the success of the "Keeping It Modern" programme, in either case, is not contingent on technical or cultural factors, as there is certainly no lack of intellectual resources for developing projects dedicated to the protection of the built heritage of the last century, but rather hinges on the prevailing cultural policy and on the technical-administrative capacity to manage protection efforts of the respective country. It is worth noting that in Brazil, the awareness cultivated by the local community—whether it is the academic community regarding university buildings or the efforts of cultural foundations and organised groups of users (such as the management of Casa de Vidro or Museo de Arte Contemporanea in Sao Paulo)—partially offsets the inertia of the country's public administration, certainly more pronounced and effective than in Italy.

However, the outlined framework offers optimism, as the dialogue initiated among involved stakeholders—from the creation of the CMPs to the crafting of this very contribution—paints the picture of a community of specialists keen to engage, collaborate and exchange ideas not only to increase the quality of their work, but also (and perhaps more importantly), to contribute to the protection of a genuinely international heritage.

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Preservation and Restoration of Lina Bo Bardi's Casa de Vidro: A Comprehensive Review

Renato Anelli and Helena Ayoub

Abstract This text presents the Conservation Management Plan (CMP) for Casa de Vidro, a project designed by architect Lina Bo Bardi, built between 1951 and 1952 in São Paulo, Brazil. It highlights its contribution to the institutional development of the Bardi Institute and to the planning of conservation and restoration actions that have been implemented since 2022. The composition of the complex to be preserved is very elaborate: Main House, Caretaker's House, Garage, and Studio built in a garden planted by the architect on 7000 square meters of land. This includes preserving the collection of works of art, books, drawings, photographs and documents belonging to the couple Lina and Pietro Maria Bardi, and making them available for academic research, loans for exhibitions and the provision of copies for authorized publications. The CMP methodology greatly improved the Bardi Institute's management approach, providing a long-term vision for its objectives, and helping it to achieve its financial sustainability. Even so, since the conclusion of the CMP in 2019, several unforeseen events have occurred that required its adaptation. The most serious was the interruption of Casa de Vidro's activities due to the pandemic, which in addition to postponing interventions, momentarily damaged its financial stability. Having overcome these difficulties, the Bardi Institute presents here the results of the first phase of conservation and restoration works, and the plans for the second phase.

Keywords Lina Bo Bardi · Brazilian Modern Architecture · Restoration · Listing of modern buildings · Management and Conservation Plan

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D. Del Curto and S. Salvo (eds.), *Planned Conservation of 20th-century Architecture*, PoliMI SpringerBriefs, https://doi.org/10.1007/978-3-031-67818-9_2

1 Introduction

The residence of the couple Lina Bo Bardi and Pietro Maria Bardi in São Paulo was designed and built between 1949 and 1952 and now serves as the headquarters of the Bardi Institute, which is responsible for the preservation of the Casa de Vidro (Glass House) complex. It consists of four buildings, a garden with 832 tropical tree specimens, and a collection of documents and artworks.

The preservation effort began with a request for protection submitted by Lina Bo Bardi to CONDEPHAAT (Council for the Defense of Historical, Archaeological, Artistic and Touristic Heritage) in 1985, four years prior to the establishment of the Bardi Institute. In addition to physical preservation of buildings, garden, works of art and archive, the institution's mission is to carry on the intellectual legacy of the couple. For this purpose, they provided resources through the sale of an item from their collection of artworks.

The initiative is consistent with their pioneering work, both in expanding the horizons of Brazilian art and architectural history and in introducing new parameters for the restoration and adaptation of culturally significant buildings. Lina's first contributions to the renewal of restoration practices in Brazil occurred between 1961 and 1963, when she applied the principles of critical restoration in her adaptation of the Solar do Unhão to house the Museum of Modern Art of Bahia. Later, in 1977, she proposed the preservation of a modern factory built in 1936 to house the SESC Pompéia leisure center [1, p. 42].

Together with the request that Lina submitted to CONDEPHAAT to list the Casa de Vidro, Pietro Bardi stated and defined the institutional mission he hoped to assign to the property:

> I think that the Morumbi House, once restored at our expense, with its forest-garden, could be adapted with a series of works of art of a certain value, to be visited one day by a public interested in experiencing a portion of the history of the renovation of national museography. [3, p. 51]

According to the minutes of the general meeting of May 3rd 1990, the founding document of the Quadrante Institute as it was initially named, specified that the Institute's objectives were exclusively cultural and artistic, also relating to the history of art and architecture, with a focus on continuing the intellectual legacy of its founders.

Following Lina's death in 1992, the Institute was renamed to Lina Bo and P. M. Bardi and focused on systematizing its collection and on promoting the work of its founders through exhibitions, publications, and documentaries. In the subsequent years, the Institute developed these initiatives by introducing a significant publishing policy in the field of Brazilian art and architecture. Over time, the original project lost momentum, and the primary challenge became the preservation of the house, which was donated to the Institute by Bardi before his death in 1999.

Due to its innovative construction features and the harsh tropical garden environment, the house requires constant conservation efforts. Architect Marcelo Suzuki, a

collaborator of Lina, led the first restoration in 1993 and subsequent conservation actions such as the recovery of slabs, roofing, casements and glass in 2008.

During this same period, the systematization of the collection was resumed thanks to the project "Collection of the Lina Bo and P. M. Bardi Institute: cataloging, digitizing and assembling an online database" (2009/54901-3 and 2012/50291-9) implemented between 2011 and 2013 with resources from the Research Support Foundation of the State of São Paulo (FAPESP), Petrobras and Caixa Econômica Federal. The improved preservation of documents was accompanied by the creation of a website and an online database, enabling online archival research. The international accessibility to the collection allowed for the centenary of Lina Bo Bardi, born in Rome on December 5, 1914, to be celebrated through exhibitions and publications held in various regions of Brazil and in other countries. The Bardi Institute established that the centenary commemorative events would take place between July 2014 and June 2015.

2 Project, Research, and Inventory Supported by the Getty Foundation (2016–2018)

It was during this time that the Bardi Institute developed its proposal for the Keeping It Modern program promoted by The Getty Foundation. Prepared by researchers from the Institute of Architecture and Urbanism of the University of São Paulo and the Bardi Institute itself, the proposal of the Conservation Management Plan (CMP) aimed to establish an institutional development policy linked to the conservation of the property, encompassing the buildings, the garden, and the collection. Four tasks were envisaged: documentation, digital surveys, building diagnostics, and garden diagnostics. The Project Coordinators were responsible for bringing these four tasks together and for summarizing them into a Declaration of Cultural Significance and a Plan of Goals and Actions that would guide a phased Restoration Project. This effort thus contributed to a long-term conservation policy for the Institute, which was approved by its Board on October 10, 2019 (Fig. 1).

The CMP recognized the importance of the garden to the architecture and treated them in an integrated manner. The lush tropical garden that currently surrounds the house was almost entirely planted by Lina after its construction. The anticipation of the garden existence was part of the architectural design, resulting in a dense vegetation mass across the 7000 square meters of land. The effects of the coexistence of architecture with vegetation are positive for creating an environment similar to a forest, with a specific microclimate, but are also negative to the preservation of the buildings, which suffer from interference from branches and roots. The conservation of the architecture and the control of the garden should be considered together in the CMP.

The assessments of the state of conservation of the garden and the buildings were equally important and were compiled in the inventory. Each component's record

Fig. 1 Frontspiece of the conservation management plan for the Casa de Vidro, available at https://www.getty.edu/foundation/pdfs/kim/instituto_bardi_casa_de_vidro_cmp_english.pdf

included drawings, photos, descriptions, diagnostics, identified pathologies, and guidance, and received a code for its location in the general and partial perspectives generated in the BIM system. Conservation diagnosis was made for the Main House, Caretaker's House, Garage, Studio, and landscaping, which included both vegetation and built components (retaining walls, garden walls, stairs, ramps, rainwater reservoirs, floors, and sitting areas) (Fig. 2).

The analysis of the Main House's structure brought together the documentation and engineering team to produce a structural capacity verification report. The existing structure is the result of the adaptation carried out by engineer Tulio Stucchi from the original design by Pier Luigi Nervi. Documents in the Bardi Institute's collection record the exchange of correspondence between Lina and Nervi from 1950 to 1951,

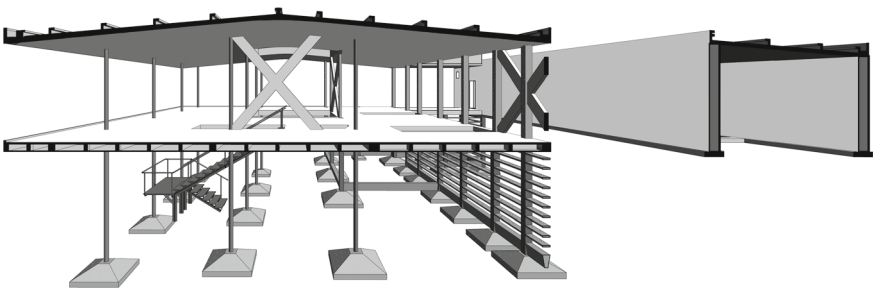

Fig. 2 Example of an inventory form that systematizes the CMP surveys and diagnosis

but there are no drawings regarding the project by the Italian engineer. For knowledge and analysis, research was required in the Nervi archive at the Centro Studi e Archivio della Comunicazione—CSAC in Parma. Five drawings present a structural design using rolled steel, with 'I'- and C-shaped profiles, developed from the structural grid of 5 × 5 meters established by Lina. The project features cylindrical tubular columns that characterize the suspended and transparent room, the only item from the original design that was retained in the construction.

The challenges of steel construction in Brazil in the early 1950s led to the adaptation of the structure to reinforced concrete, carried out by engineer Tulio Stucchi. This resulted in a structure with alveolar slabs that conceal the beams with a thin reinforced mortar lining.

In the Bardi Institute's collection no drawings were found of the tubular cylindrical columns from Stucchi's project, and this prevented precise knowledge of their interior. For simulation purposes, the reinforcement proposed by Nervi for the connection of columns and slabs was adopted.

Specialized structural analysis found that, considering its age, the structure is in a satisfactory state of conservation and the carbonation process has not yet reached the concrete reinforcement bars. A capacity limit of 42 people per 10 m^2 was established for the living room slab. At the time of the analysis, neither visual inspection nor laser scanning identified any structural cracks. However, in 2021, cracks appeared in the service sector and on the external retaining walls, which will be discussed later.

In the Main House, the conservation state of the window iron casements and roofs was a priority. Documentary research revealed frequent glass breakage since the construction of the house, while frame oxidation remained recurrent even after maintenance actions. According to the diagnosis made, the most likely cause of glass breakages was that no elastomers were used for fixing the glass panes to their frames, which prevented the accommodation of slab and glass expansions. With no elastomers to absorb movements, the stresses generated by the warping of the iron profiles caused by differential oxidation of both the internal and external layers of the metal are directly transmitted to the glass. The design guideline is to adapt the casements to accommodate elastomers and 12 mm laminated glass with UV protection.

The Main House's roof is made up of asbestos-containing fiber-cement tiles and thermal insulation made of bagged glass wool, directly placed on the sloping slab. It was identified as the most fragile part of the house, considering the risk of falling branches, trunks, fruits (jackfruit and avocados), and the potential toxicity of asbestos and fiberglass. Its complete replacement with asbestos-free fiber-cement tiles incorporating a thermal protection layer should be accompanied by maintenance and adaptations to the gutters, exposed gargoyles and downspouts built into the wall.

The garden slabs over the kitchen, Garage, and Studio restroom were also analyzed. For the kitchen slab, it was proposed to remove the exposed water tank, boilers, and exhaust fans installed in the 1980s, which had altered the garden roof's appearance and caused infiltration points. This action is being coordinated with the hydraulic project for the construction of an external water tank tower. At that time, no infiltration points were identified on the garage garden slab, although small and

Fig. 3 Tree fallen over the collection area (photo Renato Anelli)

medium-sized trees had grown spontaneously and should be removed. However, there were infiltration points hidden due to superficial repairs carried out before the plan, which detached part of the lower cladding, which will be discussed later.

The Tree Management Plan assessed the vegetation's interference with boundary walls, garden infrastructure, garden environments, and buildings. It also identified individual trees of environmental relevance, their phytosanitary condition, and the potential for biological invasion. The plan proposed two levels of action: an emergency level, limited to pruning and removing a few individual trees in critical condition, and another with more extensive removal, affecting 159 individuals.(Fig. 3).

The inspection of the main retaining walls, made of large granite pieces, did not identify any pathologies. In the secondary walls, made of bricks and covered with mortar mixed with pebbles and ceramic fragments, damage caused by the growth of vegetation was mapped and conservation or reconstruction priorities were defined. A section of the wall next to the pizza oven and barbecue was heavily inclined and supported by tiebacks installed in the 1980s. There was the risk of collapse and therefore relieving the pressure caused by trees and building a new internal retaining wall were recommended.

Like other modern architects in that period, Lina preferred not to install guardrails on her ramps and stairs. This feature prevented the approval of the Institute's operation by the Fire Department and municipal authorities. An analysis was conducted in order to classify them as ramps, stairs, or stairways and evaluate whether the

recommendation to install handrails would alter the character of the protected property.

Following the methodology of the Burra Charter, proposed by the Keeping it Modern program and aiming to guide long-term planning, the CMP is structured as follows: Declaration of Cultural Significance; Management and Conservation Policy; Plan of Goals, Actions, and Projects, and finally, a Master Plan for Expansion and Urban Integration was also added.

The Declaration of Cultural Significance was developed in collaboration with the Institute's board and directors, establishing a set of values that should guide management, conservation, and restoration actions. It emphasizes the importance of the Casa de Vidro in the context of Modern Architecture produced in Brazil in the 1950s, highlighting the role of transparency, the lightness of the structure, and the colors of the sky-blue glass tile floor for spatial continuity with the garden. It considers the three attachments realized over the years as an expression of the transformations Lina went through in her life as an architect: from international architecture in the Main House and Caretaker's House, she moved closer to organicism in the Garage and expressed an interpretation of popular architecture in the Studio. "The preservation of Casa de Vidro is inseparable from the mission of the Bardi Institute, and both are the legacy of the couple Lina and Pietro Maria Bardi" [2, p. 377].

The Significance Matrix assigns the Casa de Vidro Aesthetic Value, Historical Value, Authenticity, an Irreplaceability Degree, and a General Significance, and sets the guiding criteria for conservation, restoration, and adaptation interventions.

The Plan of Goals, Actions, and Projects derives from the Declaration of Cultural Significance and is structured around six goals:

Goal 1: Preserve the modern aesthetic integrity of Casa de Vidro as an outstanding example in amidst the vast array of Modern Architecture built in Brazil in the 1950s.
Goal 2: Preserve the attached buildings (Caretaker's House, Garage, and Studio)—as testimony of the transformations in the architectural and cultural conception of the Bardi couple.
Goal 3: Make the garden enjoyable for visitors, and not just a complement to architecture
Goal 4: Institutional—Consolidate its use as a house-museum, headquarters of the Bardi Institute, with a significant collection, consisting of the personal documents of the couple Lina and Pietro Maria Bardi, and their collection of works of art.
Goal 5: Provide the Casa de Vidro with facilities, infrastructure and routines suitable for its use as a cultural institution and as a listed historical heritage site.
Goal 6: Plan new buildings and expand the urban/social insertion of the Casa de Vidro.

Based on the urgency classification established in the Plan of Goals, a summary of projects and phases was developed, identifying the necessary financial resources and actions to be taken.

The Master Plan for expansion and urban integration developed Goal 6, proposing the following guidelines:

1. Plan of Stairs and Ramps to provide conditions for universal accessibility to all buildings. Proposal for the location of new restrooms and a water tank.
2. Urban Integration Plan with the immediate neighborhood: Carlos Drummond de Andrade Square to the east and, to the west, Casa Valeria P. Cirell (Lina's second residential project in São Paulo), and the Morumbi Chapel (an exhibition space designed by Gregori Warchavchik that serves as one of the locations of the City Museum).
3. Map showing the location of Casa de Vidro in the municipality of São Paulo. Reference to the boundaries of the urban area as they were when it was built and as they currently are. Potential for social action with the Paraisópolis favela, located less than one kilometer away.
4. Volumetric studies of three alternatives for the implementation of new attachments to house the collection.

3 Restoration Plan Phase One, Revision, Emergency Actions, and Phase Two

Developed in 2019, while the PGC was in graphic production, the First Phase Restoration Plan sought to gather the most urgent actions for which there were reserved resources for implementation. It was submitted to the three preservation bodies where Casa de Vidro is listed: CONPRESP (Municipal Council for the Preservation of Historic Heritage), CONDEPHAAT (state), and IPHAN (National Heritage Protection Institute) between November and December 2019. The priorities were:

1. Roof and gutters
2. Tree management plan
3. Accessible ramps and restrooms
4. Adaptation of window frames and replacement of glass
5. Replacement of Garage and entrance gates
6. Maintenance plan

The plan organized, in a preliminary project standard, drawings and specifications taken directly from the CMP, with two exceptions that were reworked: ramps, and accessible restrooms (Fig. 4).

The ramp, originally planned as a cut and fill, was elevated from the ground through a reinforced concrete structure and thus acquired a visual prominence that induced IPHAN to block it.

We also suggested studying alternative solutions to the one presented that cause the least possible visual impact on the architectural ensemble's landscape.[1]

However, CONDEPHAAT did not confirm the restriction imposed by IPHAN and in July fully approved the original proposal.[2] CONPRESP commented on the

[1] Technical report 104/2020, 17/04/2020. IPHAN Process 01506.004815/2019-58.

[2] CONDEPHAAT Process 85265/2019.

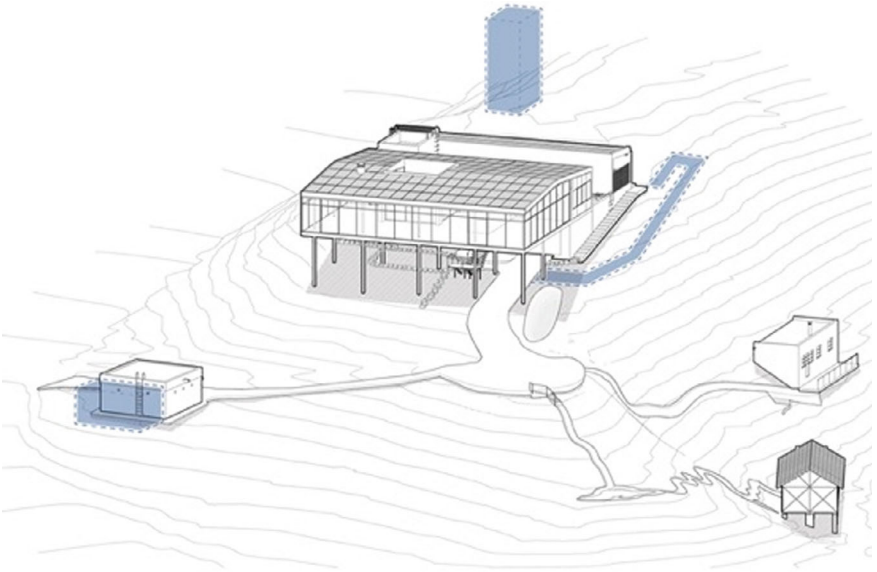

Fig. 4 Scheme of development of proposals in the phase 1 restoration plan

First Phase Restoration Plan only in June 2023, with no content analysis and only formal presentation requirements. The discrepancy in evaluations between the bodies required that emergency actions be submitted separately between 2021 and 2023, thus complicating the joint action proposed by the CMP.

The impact of the pandemic on the Bardi Institute's operational capacity was high as it jeopardized its main sources of income. Without in-person operation, Casa de Vidro's conservation was compromised. The roofs had been severely damaged by vegetation, and new pathologies had emerged during this period, changing the order of some priorities established in the CMP.

The stability of the retaining walls emerged as a new priority in early 2021, and the Caretaker's House showed a sudden evolution in cracks and flooding. After inspection, engineer Yopanan Rebello warned of the risk of mass movement of the slopes and the need to monitor the evolution of the cracks that had appeared.

In July of the same year, a new crack and erosion appeared, now on the main access ramp's floor (7.6 m in length), and movement was discovered of the granite blocks in the retaining wall. In the rear patio, the floor and retaining wall also moved. Geologist Nestor Kenji, after an inspection, recommended shoring up the retaining wall, restoring the ramp's floor, and monitoring the soil movement with instruments.

The change in the Institute's board during this period made it only possible to start conservation and monitoring actions as late as in 2022, with architect Helena Ayub being hired to coordinate projects and works.

Fig. 5 Beginning of tree management, team working on pruning of the large fig tree next to the house (photo Renato Anelli)

The first action to be started was tree management, which was carried out manually by personnel specialized in mountaineering, due to the area not being accessible by machinery with mechanical platforms. Pruning and the most severe removals were prioritized and the work was carried out over four months (Fig. 5).

Simultaneously, the ramp's floor and retaining wall were restored, and the rear retaining wall was shored; these works were coordinated with the removal of the trees which had contributed to the damage (Fig. 6, 7 and 8).

In April 2022, part of the Garage's slab finishing came loose, revealing the oxidized reinforcement of the structure. The unforeseen and urgent intervention required structural restoration of the slab, new waterproofing, and garden restoration. The Main House and Studio also received roof maintenance, correcting the damage occurred during the pandemic period.

As part of the Phase I of the Restoration Plan, the stratigraphic investigation of the pilotis' paint allowed for the identification and restoration of the original color.

The monitoring of land movement through instruments as well as the revision and expansion of the executive projects from the first phase, were made possible by public resources obtained at the end of 2022 responding to the PROAC Program announcement 49/2022.

Still in the first phase, the executive projects were developed for the window casements and roof of the Main House. In the case of the window casements, it was

Fig. 6 The top of the stabilization structure built in the 1980s is no longer effective and needs to be re-built (photo Renato Anelli)

Fig. 7 Stratigraphy to identify previous paint layers and choose the correct color (photo Renato Anelli)

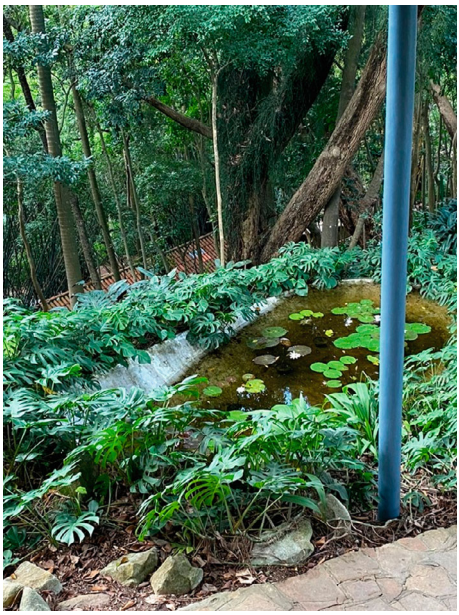

Fig. 8 Restored pilotis and rainwater retention basin in their original condition, with aquatic plants

found that the existing ones needed full replacement. The current profile dimensions will be maintained by adding details for water drainage and accommodation for thicker elastomers and glass, in line with current standards.

The project for the removal of the current water tank was detailed in the plumbing project, which provided for a single stainless steel tower reservoir at the highest point of the terrain.

For universal accessibility, IPHAN's recommendation was followed and the ramp was replaced with a small elevator tower to be installed 1.5 m from the southwest glass facade, connected to it by a thin walkway, designed by Marcelo Ferraz, André Vainer e Marcelo Suzuki.(Fig. 9).

To reduce the external visual impact, the accessible bathroom was designed within the Garage. A continuous maintenance plan and sub-forest landscaping are part of the set of interventions made possible by the resources obtained.

A geotechnical company, the MMF Infrastructure Projects, was contracted to perform percussion probing and instrument monitoring. It was discovered that the rear part of the house is supported by a large embankment of over 2 m in depth, sustained by the lateral retaining walls, which exhibit fissures. Monitoring ruled out the hypothesis of circular mass movement but confirmed a vertical subsidence of 3 mm per month in the western portion of the embankment, with a tendency to continue in the medium and long term. The proposed project suggested the construction of anchored curtain walls to reinforce the existing retaining walls, anchored by root piles of up to 20 m in depth. In addition to being compatible with the architectural features of the listed property, the report highlighted that the project poses a high risk to human life, due to people circulating on the street. As the budget was not

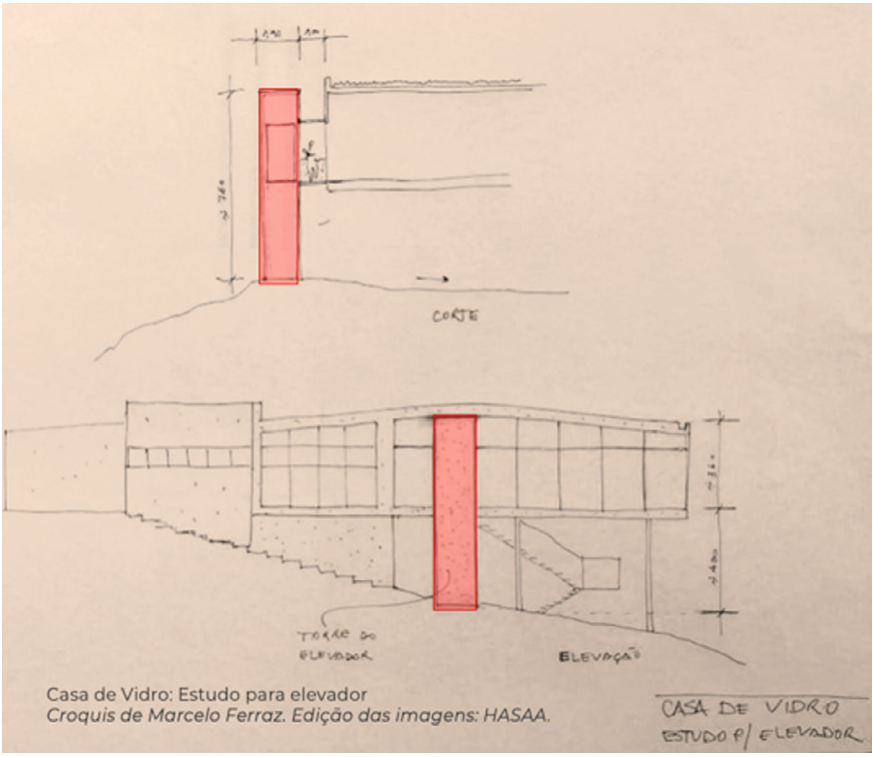

Fig. 9 Study of an external elevator for universal direct access to the room, replacing the ramp (sketch by Marcelo Ferraz)

sufficient to cover this work, a cultural project was developed for public sponsorship through tax incentives.

In 2023, two unplanned projects were also implemented. In April, one of the granite slabs that make up the main staircase's flooring broke, which required its removal, the performance of an integrity assessment, and the reinstallation of all the slabs. The main adaptation involved the placement of elastomers between the slab and the metal structure, to prevent wear from friction between the stones and the supporting bolts. In the same period, negotiations were concluded to obtain the Certificate of Inspection from the Fire Department. The requests to preserve the architectural integrity of the listed property were accepted, and the interventions were limited to an escape route on the side, with the addition of a handrail set away from the walls of the Main House.

4 Conclusions and Perspectives

The CMP has highlighted the potential and challenges of the integrated preservation of the Bardi Institute and the Casa de Vidro. The governance policy of the Institute needs to be aligned with cultural, management, and preservation techniques. Without this alignment, the Plan cannot be effectively implemented in everyday actions. The progressive deterioration of the listed property presents unpredictable rhythms and unexpected surprises, requiring the continuation of this integration. The narrative above demonstrates the pace to follow to overcome this challenge.

In addition to the physical preservation of the property, the Institute has the mission of preserving the documentary collection and the continuity of the social and cultural legacy of the Bardi couple. The integration of these two fronts, the collection and legacy, was explicitly stated in Goal 4 of the CMP, which reflects on whether the Institute should assume the configuration of a house museum, or not.

In this sense, important steps were taken in the post-pandemic period, following the description of this Goal through a program of curatorship of exhibitions and events that follows criteria aimed at preserving the transparent living room as close as possible as it was in 1999, when Bardi passed away. More specifically, Action 7 of Goal 1 (Establish expographic criteria to guide art and collection exhibitions in the living room, house, and garden) and Action 1 of Goal 4 (Curatorial planning specific to the collection—exhibitions at the house and at other institutions, use of the website for dissemination, publishing, promotion of courses, seminars and conferences) define periodicity for exhibitions so that the living room remains for most of the year in the same configuration as existed at the time of Pietro Maria Bardi's death in 1999.

The interaction of the Casa de Vidro with neighboring institutions and communities (Goal 6) was also initiated with exhibitions by the artist Júlio Villani in the Main House and in the Morumbi Chapel; the most recent exhibition put on display works produced by embroiderers from Paraisópolis working in Lina's Studio between July and September 2023. Plans for the expansion of the Institute to neighboring properties are being developed, taking advantage of the urban planning guidelines of the Strategic Master Plan of the Municipality of São Paulo.

Recently, the Bardi Institute was invited to participate in a university research project—"City, Infrastructure and Adaptation to Climate Change" supported by National Council for Research and Technological Development (CNPq) and Mack-Pesquisa of the Presbyterian University Mackenzie—that addresses the topic of climate justice by comparing the Casa de Vidro region and the Paraisópolis favela, which is located 1 km away. In addition to social aspects, the research addresses contrasts in temperature, density, urban morphology, and vegetation cover. The first results indicate a difference in air temperature of up to 5 C higher in Paraisópolis, due to the lack of vegetation cover. With this cooperation, the Bardi Institute updates the Bardi couple's social interest toward the topic of climate change, which is central in our time.

An important step toward institutional stability was taken with the creation of Essensa—an association that brings together Eugenio Montale Escola International, the Institute of Italian-Brazilian Culture, Convita—Patronato Assistencial Imigrantes Italianos and the Institute Bardi Casa de Vidro—which is a synergistic effort for the joint management and funding of projects. Both initiatives, interaction with neighboring institutions and Essensa, lead the Institute to go beyond its walls, establishing essential partnerships for its development and expanding its social function beyond the cultural field.

Although it is consistent with its previous history, the recent trajectory of the Bardi Institute demonstrates that the Getty Foundation's Keeping It Modern program was a valuable stimulus for new methods of institutional organization for the conservation of a listed property and the continuity of the legacy of its founders (Fig. 10).

Acknowledgements The "Keeping It Modern" research group for the Casa de Vidro was composed as folles: Coordinator: Renato Anelli, Adjunct coordinator: Ana Lúcia Cerávolo, Supervisor: Marcelo Suzuki. Tasks coordinators: Aline Coelho Sanches (historic documentation), Márcio Fabríccio (Digital documentation), Marcelo Balzani (3D scanning), João Rossignolo (Construction pathology), Ricardo Bento (Structure) Luciana Schenk (Historical Garden), Andre Graziano (Landscaping Management Plan/Trees), Darkon Roque (Graphic Design), Sol Camacho (Cultural Director of Instituto Bardi).

Fig. 10 Production of embroidery on the fabric of Julio Villani's artwork Paraiso that was installed on the ceiling of the Morumbi chapel. Embroiderers Camila Prado e Flauzina Rocha, from the cooperative Costurando Sonhos in the Paraisópolis favela

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Lina Bo Bardi's Museu de Arte De São Paulo. A Conservation Plan for a 20th-Century Masterpiece

Silvio Oksman

Abstract This article presents the development of the Museu de Arte de São Paulo (MASP) Conservation Plan. It thoroughly investigates the complex structural system of the building designed and constructed in the 1960s by architect Lina Bo Bardi. The Museum was awarded a grant under the Getty Foundation's Keeping It Modern program in 2017. The research is divided into documentary investigations, including studies of the Museum's archives and those of other institutions, as well as examinations conducted within the building itself. These include metric surveys and explorations, as well as laboratory tests. This comprehensive approach has enabled an understanding of how the system was conceived, constructed, and its current state of preservation, considering all the transformations that have occurred over time. This in-depth understanding facilitates the establishment of specific urgent conservation procedures for the short, medium, and long term. It also contributes to proposals for conserving other infrastructure renovations as well as any future intervention.

Keywords Modern heritage · MASP · Conservation plan · Lina Bo Bardi · Keeping it modern

1 A Brief History of MASP

The Museu de Arte de São Paulo Assis Chateaubriand (MASP) was created in 1947 by entrepreneur and journalist Francisco de Assis Chateaubriand (1892–1968) in partnership with Italian journalist and art critic Pietro Maria Bardi (1900–1999). The Museum was initially housed on various floors of a commercial building in downtown São Paulo, until in 1968 it moved to its current site on Avenida Paulista, designed by Italian-Brazilian architect Lina Bo Bardi (1914–1992) [1, 2].

Since its inauguration, MASP's programming includes not only permanent and temporary exhibitions but also various cultural activities such as courses, national and international seminars and lectures, films, shows, and workshops, based on the

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D. Del Curto and S. Salvo (eds.), *Planned Conservation of 20th-century Architecture*, PoliMI SpringerBriefs, https://doi.org/10.1007/978-3-031-67818-9_3

notion of the museum as a social and educational institution. It currently houses a continuously evolving collection of over ten thousand works including paintings, sculptures, prints, items of clothing, photographs, drawings, installations, videos, objects, and tapestries. It is considered the most important collection of European art in the Southern Hemisphere, while also holding national and international works from the Americas, Asia and Africa from a wide range of historical periods. Its history, vast collection and offering of social cultural activities make MASP one of the most significant institutions in the Brazilian cultural scene and ranks among the most important museums in South America.

The design and construction of the Museum's current building were carried out from 1957 to 1968 on Avenida Paulista. During this period, this main street started to be lined by skyscrapers, transforming the cityscape /skyline by systematically replacing the mansions built in the early twentieth century with modern commercial and residential high-rises. It was within this shifting urban context that the Museum was inaugurated. To create the new Museum, the city block on which the old Trianon Belvedere was located was demolished to be occupied by an architectural ensemble consisting of an upper building suspended 8 m above ground, an accessible public square at ground level, and an underground building [3, 4]. The plaza faces Avenida 9 de Julho, which was built across the Saracura River Valley from which one can get a view toward the city center (Figs. 1, 2 and 3).

Fig. 1 The old Trianon Belvedere (https://commons.wikimedia.org/wiki/File:Belvedere_Trianon_01.jpg)

Fig. 2 Avenida Paulista at the beginning of the twentieth century (Guilherme Gaensly/Acervo Instituto Moreira Salles)

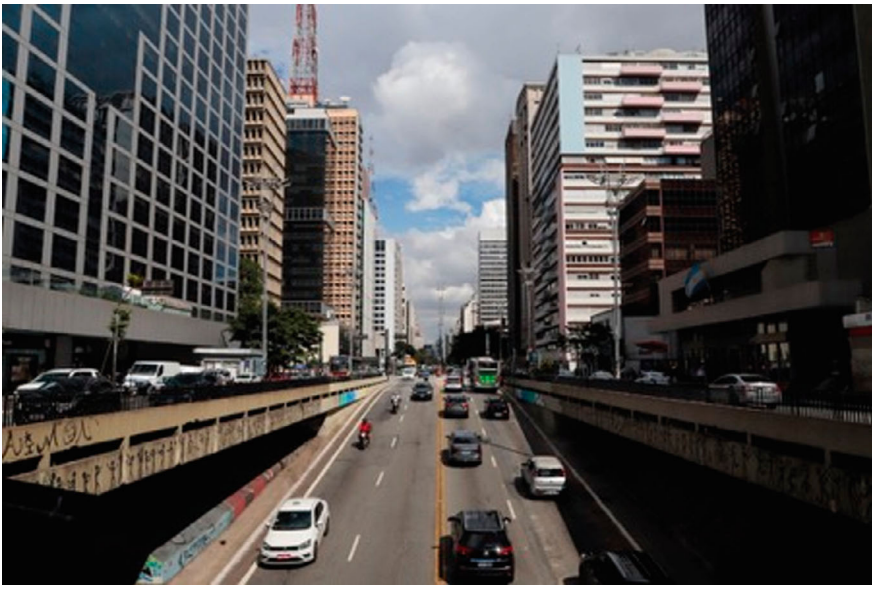

Fig. 3 A view of the Avenida Paulista https://www.flickr.com/photos/governosp/52693657583

2 The Structure of the Conservation Management Plan

In 2017, MASP obtained financial support from the Getty Foundation's "Keeping It Modern Program" for the development of a Conservation Management Plan (CMP) for the building. The program represented an opportunity for projects that advanced the preservation practices and policies for 20th-century buildings of relevance to the international architectural discipline.

The proposal of a CMP for MASP was based on the understanding that this building features a unique integration of architecture and structure. This ensured the in-depth study of the building's structure to be comprehensive, including its technical aspects as well as its symbolic, aesthetic, and architectural dimensions. This approach was aimed at preserving the building's values, while understanding the need for interventions that respond to the demands of a contemporary museum.

The CMP was developed by architects Silvio Oksman, Lucia Furlan, Luiza Nadalutti, with consultancy from Juca Pires and Heloisa Maringoni [6].

Lina Bo Bardi, together with engineer Figueiredo Ferraz, devised an extremely sophisticated structural system to allow for MASP's building to float, leaving a large plaza underneath open to a free public use. This extraordinary structural prowess, besides leaving the ground floor clear, also allowed for the space of the upper building to be clear from internal structural elements (Fig. 4).

3 The Structure of the MASP

3.1 The Upper Volume

The upper volume of the building consists of three slabs, four columns, and two pairs of main beams—an external pair (across the roof) and an internal (intermediate) pair not visible from the outside. The exterior pair consists of two large pre-stressed concrete box-beams measuring 2.5 × 3.5 m, spanning 74 m with a constant cross-section, supported immovably at one end and laying on top the columns, with the ability to slide, at the other end. The internal pair also consists of 3.5 m high box-beams, pre-stressed, with a free span of 74 m. However, they have a variable compression flange and are supported by consoles placed on the columns.

3.2 The Planes

The three planes of the upper volume are cantilevered out to the building's sidewalls. The plane of the first story consists of a waffle slab with 50-cm-thick internal waffling, suspended by tie rods from the intermediate means. The plane of the second story, whose structure is visible from below, is a 1.5-m-high ribbed slab resting on top of

Fig. 4 The MASP under construction https://www.getty.edu/foundation/initiatives/current/keeping_it_modern/report_library/masp.html

the intermediate beams. The plane of the roof is composed by the juxtaposition of transversal beams. It is supported by the large roof beams, attached to lower surface of the beams.

3.3 The Main Beams

The pair of roof beams have a total length of 78.0 m, a rectangular hollow cross-section of 2.5 m in width by 3.5 m in height, the lower flange is 12 cm thick, the upper flange is 33 cm thick, with side webs of 25 cm, thick and transverse webs each 3.5 m along its length. These beams are pre-stressed with steel cables along their lateral faces. Due to the impossibility of working with the Freyssinet system for anchoring the pre-stressing cables, Figueiredo Ferraz developed an anchorage system that has become known as the "Ferraz System." The system makes a loop in the cable at the fixed anchorage, in such a way that the continuous steel cable returns through

the sheath to the mobile anchorage. The sheaths of the pre-stressing system were also used to decrease the heat during the curing process, as the high consumption of cement in the mix proportion developed for the high-performance concrete released a great deal of heat during the hydration process.

The pair of intermediate beams has the same structural conception, except that their compression flanges (the beam's upper part) have a variable cross-section. This solution allows each beam to support greater weights, as it holds not only the first floor, which is suspended below, but the second floor as well, resting atop.

3.4 The Columns

The external geometry of the four main columns is defined by a constant rectangular cross-section of 2.5 m × 4 m. Structurally, however, they are divided into three different segments (see images below). Starting at the bottom surface of the footing, the total height of the columns is 35.35 m, of which 14.10 m remain underground.

The research developed during the CMP made it possible to understand the upper part of this columns, which was not well known before. Its structural part consists of a single column of solid reinforced concrete measuring 2.5 m by 1.0 m, concealed within an outer box of non-structural concrete just 6 inches thick, to maintain the same outer geometry up to the top. The inner parts of columns P1 and P2 are equipped with Freyssinet-type pivots allowing for the articulation of one of the supports. This prevents the transmission of a bending force to the columns by allowing for horizontal movement and isostatic condition of the roof beams, which is ideal for the pre-stressing.

3.5 The Footings

The columns absorb the normal forces and bending moments generated by the eccentricity of the beam supports and discharge these forces through the footings. Their geometric center was positioned eccentrically to distribute forces evenly over the ground. Its geometric center is displaced inward in relation to the building's projection, at a distance of 2.7 m from the column it supports.

3.6 The Lower Volume

The lower volume consists of four semi-underground levels. The ground-level plaza consists of a continuous plane, the first sublevel is on a plane partly supported directly on the ground (theater section) and partly suspended in a grid structure (gallery); the second sublevel, originally supported directly on the ground, but later structured as

a solid slab for the excavation and creation of the third sublevel (collection storage area), which is supported directly on the ground.

3.7 The Ground-level Plaza

The upper surface of the ground-level slab is configured visually as an open plaza. Its structure is divided in two structural types. The part directly under the upper volume, corresponding to the roof of the auditoriums in the lower volume, consists of a waffled slab. Its 1.2-m-high beams are spaced 3.2 m apart and span over a distance of 20 m, from the retaining wall along Avenida Paulista to the top of columns supported on the retaining wall on the other side, made for the creation of the second sublevel. The part that extends out from under the upper volume also has a waffle structure, with beams 1.5 m high and the same spacing as the other Sect. (3.20 m). This grid is supported on the columns of the facade along Avenida 9 de Julho.

3.8 The First Sublevel

In the auditoriums section of the 1st sublevel, the floor rests on the ground, while in the gallery section the floor is a suspended slab with the same structural solution as the waffled slab of the ground-level plaza.

3.9 The Second and Third Sublevels and Foundations

The second sublevel originally rested directly on the ground, with footings supported directly on the ridge along which Avenida Paulista runs. In 1997, when the third sublevel was created, the foundation was complemented with piles in the form of stakes and pipes (Figs. 5, 6 and 7).

After more than 50 years since MASP first opened, the challenge is to understand: (1) the behavior of the structure over time, (2) its current condition, and (3) its maintenance needs, avoiding interventions that could jeopardize the building's iconic image. Understanding the building's current condition required not only profound awareness of Lina Bo Bardi's design and intentions but also a thorough knowledge of the original structure. It should be noted that the drawings found in the archives invariably do not correspond to what was built. Furthermore, understanding the system also requires one to know the interventions carried out in the building after its completion. Hence, a complete diagnosis of MASP's structure was essential to initiate an effective conservation process.

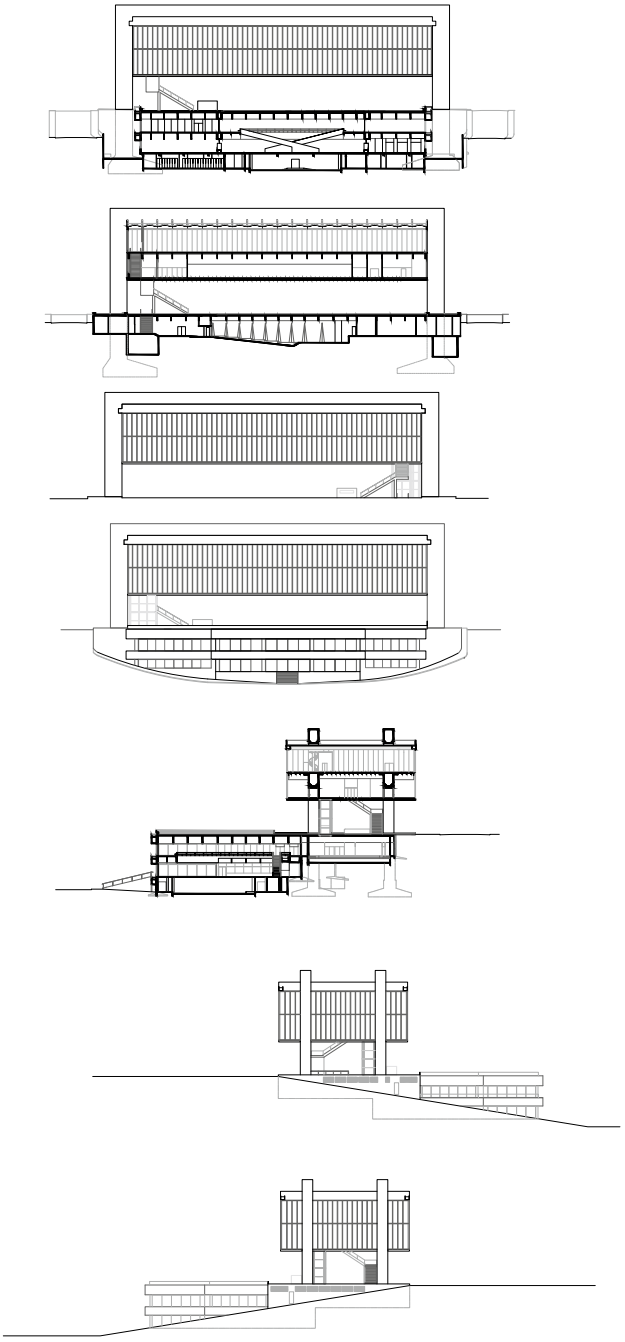

Fig. 5 Sections of the building https://www.getty.edu/foundation/initiatives/current/keeping_it_modern/report_library/masp.html

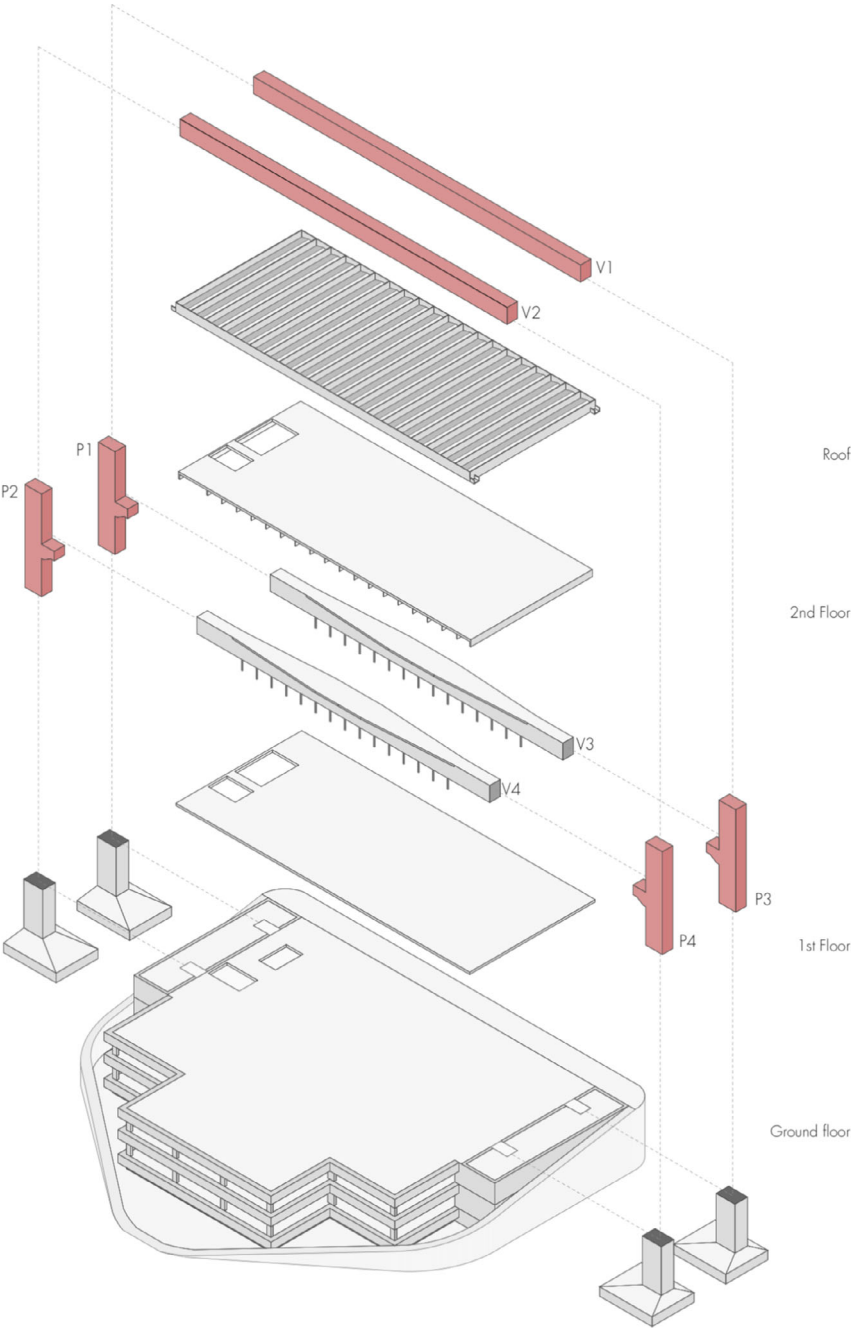

Fig. 6 Isometric perspective of the upper volume highlighting structural components of the MASP

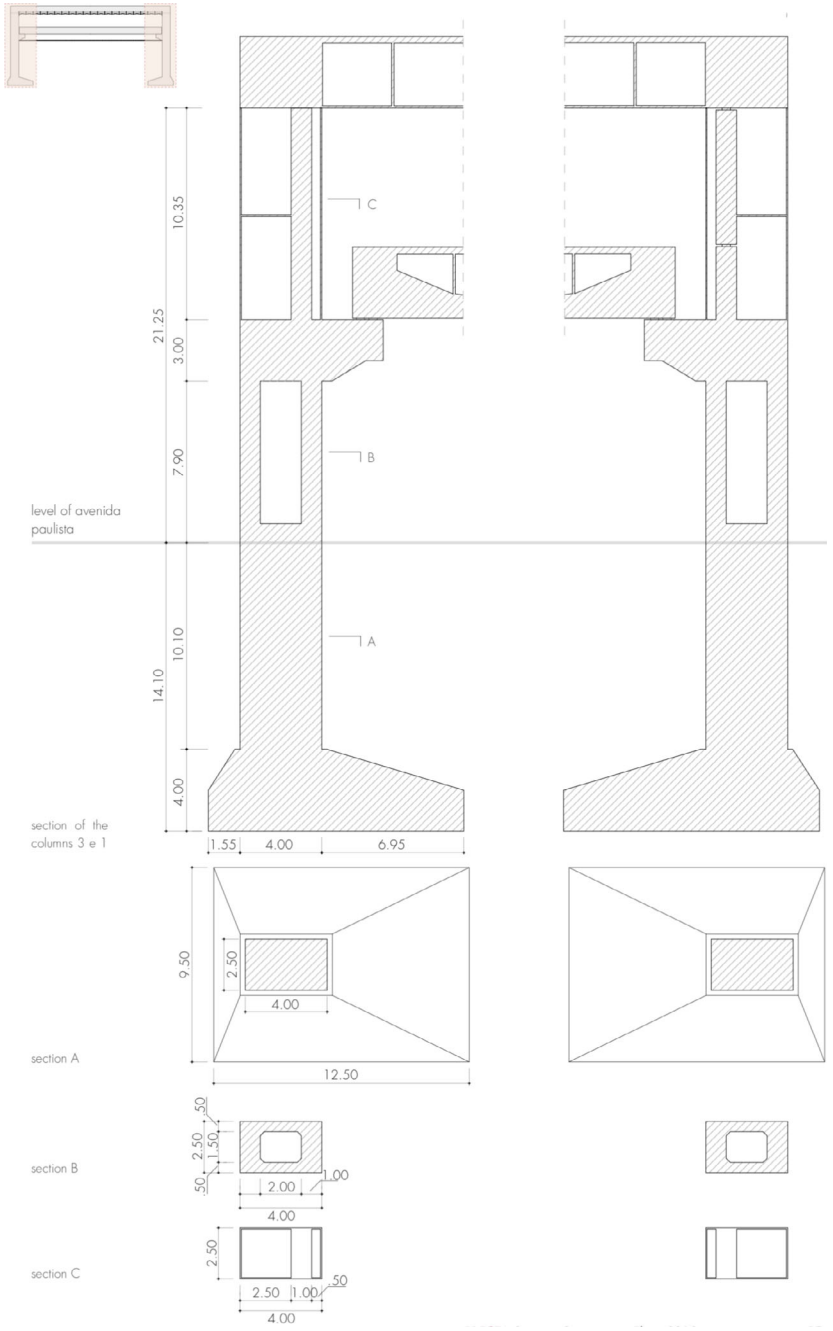

Fig. 7 Sections of MASP's structural components https://www.getty.edu/foundation/initiatives/current/keeping_it_modern/report_library/masp.html

MASP's structure should be seen in its relation to all the other systems of the building. The window casements are attached to the slab's edges; the roof and the rainwater runoff system, which are attached to the upper beams, have suffered severely from the deflection of these beams over time. Similarly, the conduits of the electrical and air-conditioning systems are installed inside the beams and the floor and ceiling slabs. Complete knowledge of the slab's load capacity is therefore needed to ensure proper new infrastructural installations or appropriate exhibition designs.

3.10 Phases of the Research

The first phase of CMP for MASP's structure involved the collection and organization of a vast array of physical and digital documentation regarding the structure. This process uncovered blueprints from the Figueiredo Ferraz civil engineering firm that were thought to have been lost during a fire in the archives of the firm. The research team organized reports of interventions carried out on the building that included alterations of the layout, creation of new spaces, maintenance actions, recovery of infrastructure systems, structural reinforcements, and waterproofing. All the data collected allowed us to trace the structure's history and was fundamental for the following steps of the project (Fig. 8).

Fig. 8 Archival research (© Silvio Oksman)

3.11 State of Conservation

Surveys and analyses of various aspects were carried out to understand the current state of conservation of the building. Some of the problems found are typical of concrete such as spalling of the superficial layer, corrosion of the rebars, carbonation, and cracks: recommended treatments are largely possible with existing technology.

However, our in-depth research led to understand the causes of said damage. To this end, the various tests and measurements carried out provided grounds for hypothesis on the structure's current condition. These observations allowed for an understanding of the general condition of the building's structure and pointed out specific questions about its behavior.

3.12 Design and Behavior

The information obtained in the research phase served as a basis for the construction of a virtual structural model developed with STRAP software, which allowed us to understand of the system in relation to its design. Experience has shown that some decisions made during the construction site were never documented. In the case of MASP, only part of these changes was duly reported, while others were not recorded. Hence, the understanding of the building's structure could never be based exclusively on archival documents.

The STRAP software allowed us to import the information found in current structural reports and new surveys made during the CMP to complete an approximate analysis of the structure's current condition and problems. The conclusions resulting from the digital model led to immediate and short-term actions.

Besides serving as the base for MASP's conservation plan, the digital model is a tool that can also be used in future projects, as it allows for simulating of situations in order to evaluate the impacts of loads, vibration, movements, etc. However, given that the model was based on certain assumptions, new research and information should be implemented to gain a deeper knowledge of the structure and its behavior.

The plan establishes various technical studies to be led in the future such as: map of damage – mapping of pathologies (complete diagnosis); verification of the strength of the reinforced concrete, homogeneity, and compactness; the "as built" analysis of the structure – survey of measurements.

It also establishes guidelines for reinforced concrete surface treatment such as: procedures for pathologies (biological patina and black crust, carbonation, corrosion of steel reinforcing, delamination, and cracks.

Finally, it establishes procedures that must be carried out permanently such as: the periodic cleaning and maintenance procedures, general procedures for structural recovery, monitoring of recurrent pathologies, monitoring of cracks, periodic monitoring of the expansion joints and monitoring of deformations.

3.13 Assessing Significance, Assessing Problems

The research developed to assess MASP's significance went beyond the understanding of the materiality of the building, as it also integrated its cultural dimension, including the ways the citizens develop a sense of appropriation towards the museum spaces and the open plaza.

The building of MASP, floating 8 m off the ground, is a landmark within the cityscape of Avenida Paulista. This box is closed by the metallic window frames of its facades, marked by a regular rhythm of vertical framing elements and the transparency of glass. This configuration allows a visual relation to be created between the outer and the inner space, mirroring the surroundings during the day and revealing the interior at night, like a lantern above the street. The first floor houses the administrative offices, distributed longitudinally along the building into bands that follow the window framing, as well as a large room for temporary exhibitions in the central area, without any relation to the outside of the building. The second floor is the Museum's art gallery, conceived as a large room without partitions, where the Museum's collection is on permanent display. Art works are showcased on site-specific glass display easels designed by Lina Bo Bardi (Figs. 9 and 10).

The public square at the ground level is a large open space that extends as a scenic lookout with a view toward Avenida Nove de Julho. Its floor acts as the roof of the lower, sunken three-story building of the Museum. The plaza is barrier-free and open to Avenida Paulista Avenue. It has become the most important civic square in town.

Delineated by retaining walls, the lower semi-subterranean building is connected to Avenida 9 de Julho. The façades of this building feature linear exposed concrete

Fig. 9 The Art Gallery with the glass easels designed by Lina Bo Bardi, Cleber Vallin, CC BY-SA 4.0 https://creativecommons.org/licenses/by-sa/4.0

Fig. 10 The public square (© Silvio Oksman)

planters and metallic window frames. The architectural program is divided into two floors, which may be accessed from the main plaza. On the first sublevel, a welcoming lobby provides connections to various parts of the lower building: a small and a large auditorium, exhibition and collection storage areas. A mezzanine gives access to the second sublevel by way of two red colored stairways. This floor is configured by large exhibition spaces. The large, spacious double height central space interlinks the two sublevels. On both floors the structural grid of the concrete floors is fully apparent from beneath (Fig. 11).

The intimate relationship between structure and architecture in MASP is essential in defining its internal circulation logic, configuring its spaces, and outlining its main values—transparency, fluidity, permeability, and spatial vastness. The building's interior and exterior expression is based on the intrinsic characteristics of the materials used—rough surfaces with little ornamentation.

Fig. 11 The two red colored stairways of the lower volume

The transparent façades on both the lower and high buildings create a strong connection between the inside and the outside. In MASP, Bo Bardi considered various scales equally, as she encompassed the macro, urban and collective scale with the personal and sensitive small-scale experience of the individual [5].

Today, the MASP has reached its 5th decade charged with a strong popular recognition. The ground-level plaza under the free span, often used as a stage for various social demonstrations, political and cultural events. The building, with its red pillars and beams (painted in the 90s as a waterproofing system for the structure) and its large, suspended volume, is perceived as a symbol of both Avenida Paulista and of the city of São Paulo. The Museum has accomplished the mission defined by its new management team in 2017: "MASP, a diverse, inclusive and plural museum, has the mission to establish, in a critical and creative way, dialogues between past and present, cultures and territories, based on the visual arts. To this end, it should enlarge, preserve, research and raise the public's awareness about its collection, while also promoting the encounter between various public segments and art through transformative and welcoming experiences".

4 Declaration of Significance

In 1982 the MASP was listed as a cultural heritage site by the São Paulo State Council for the Defense of Historical, Archaeological, Artistic and Touristic Heritage (CONDEPHAAT). In 1992, the building was declared an official heritage site by the Municipal Council for the Preservation of the Historical, Cultural and Environmental Heritage of the City of São Paulo (CONPRESP). In 2003, the building was also recognized by the National Institute for Historic and Artistic Heritage (IPHAN), which in 1969 had already declared that of MASP a heritage collection.

The reports on the official recognition of MASP as a heritage site by CONDEPHAAT and CONPRESP do not make any statement about the cultural values to be recognized. However, the listing process by IPHAN resulted in an extensive amount of work that aimed to develop a wide-ranging reading of the building as a multi-faceted cultural heritage.

4.1 Urban Value

The Museu de Arte de São Paulo is considered an urban landmark due to its unique position along Avenida Paulista. As a horizontal building, MASP stands out amidst the verticality of the high-rises stretching along Avenida Paulista. The ground-level plaza under the MASP elevated building is a characteristic and fundamental element of the design, serving as a scenic overlook that frames a view toward Avenida 9 de Julho and beyond. This architectural-urbanistic solution also provides a breath of fresh air, insofar as it creates a pause along the dense mass of buildings along Avenida Paulista. MASP's design goes beyond the limits of the building as it has shaped an entire block. Its design demonstrates that Bo Bardi took full advantage of the geomorphology of the site—as she created a fluid relationship between the highest point of the city, located on Avenida Paulista.

4.2 Historical Value

MASP is one of the highest expressions of Brazilian modern architecture. The originality of its conception and construction lies not only in its high degree of experimentation but also in its invention of a creative technical solution. This pioneering approach is also found in the field of exhibition design: the solution of Bo Bardi's Glass Display Easels in conjunction with their spatial arrangement in the Art Gallery is an exhibition design innovation that represents a rupture with the traditional European museum typologies that had pervasively been adopted in Brazil until then. Last but not least, MASP's collection is considered the most important collection of European art in Brazil. It has been recognized internationally for its relevance,

as it gathers national and international artworks from various periods. It includes paintings, sculptures, prints, textiles, photographs, drawings, installations, videos, objects, and tapestries, and also holds national and international artworks from the Americas, Asia, and Africa from different periods.

4.3 Social Value

MASP's ground-level plaza under the building's free span is a place recognized for its use and its public dimension. In addition to being a place of encounter and shared experience among a wide range of social actors, it is also a stage for cultural, social, and political demonstrations, with performance shows, performances, installations, etc. This public appropriation, together with its location on Avenida Paulista are fundamental factors for MASP's popular recognition as a symbolic building. Moreover, there is a strong link between the building and its use. MASP is a building-museum that reveals the powerful relation between the building and the institution it houses, and has maintained this relation since its very conception, while at the same time also experimenting with the use and occupation of its spaces. The Museum has a socio-cultural mission it unfolds through various activities and reinforces with the relations between its spatial configuration and its exhibitions. The freedom of taking various paths through the building empowers the visitor with autonomy.

Of special note is the contemporary reading that enhances the fact that the building was designed by one of the very few women architect recognized in the history of architecture in Brazil.

5 Developing Policies

Consideration of these cultural values has made it possible to establish guidelines for developing preservation policies. Even if the conservation plan is focused on the building's structural systems, these guidelines should be considered in the future actions for the preservation of the building:

- Ensure the building's outstanding status and visibility as defined by its implantation, maintaining its relationship with Trianon Park and the valley of Avenida 9 de Julho, and with Avenida Paulista.
- Preserve the relationship with Trianon Park and the Avenida Paulista axis, in order to ensure the permanence of the recognized values of the building and the public space. Regarding the alterations in the adjacent lots along the avenue, these have little influence on the issues of MASP's conservation, as they do not interfere directly with the Museum's visual setting.
- Every intervention carried out on MASP's block should be related to the building, in such a way that everything in the block can be read as a unit.

- Ensure the correct understanding of the volumes that compose the building without losing sight of the interrelated facets of the design.
- Ensure that the ground-level plaza under the free span is kept permanently unaltered and integrated with Avenida Paulista as a continuous space, without fragmentations, with its visual aspects and its public appropriation.
- Maintain the characteristics of the materials and their visual composition of rhythms, textures, and forms, preserving the consolidated image of the work.
- Include the red color of the exterior pillars and beams of the upper volume as part of the building's consolidated image.
- Ensure the mutual visibility and transparencies between the interior and exterior spaces, enhancing the relations between the building and the city.
- Ensure respect of and prioritize the main values of the building's design—spatial vastness, permeability, and transparency—allowing the spatial reading of the different environments.
- Allow for interventions that explore new possibilities of experiencing the space. Interventions that can eventually fragment the reading of the spaces of the building should be temporary and in line with the Museum's mission.

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The Conservation of the Vilanova Artigas Building: A Long Journey

Beatriz Mugayar Kühl

Abstract This text explores conservation issues of the Vilanova Artigas Building, headquarters of the Faculty of Architecture and Urbanism (FAU), University of São Paulo. The aim is to shed light on the institutional approach to maintenance and preventive conservation issues surrounding the building. Renown in Brazilian architecture, the building is a paradigm of educational architecture and a distinguished example of São Paulo's brutalism. With its bold design—both spatially and structurally—the building has faced continuous challenges, particularly water infiltration, which have been ongoing concerns for the FAU administration. This paper begins by examining the architectural characteristics of the building and its recurrent maintenance issues. It then explores the institution's shift from reactive problem-solving to a proactive approach, emphasizing the understanding of root causes to prevent future issues, culminating in the Participatory Master Plan. The text then analyzes the outcomes of this plan and proceeds to scrutinize the characteristics of proposals put forward under the Getty Foundation's Keeping It Modern initiative. This initiative enabled something that is rare in Brazil: systematic research on the building, its documentation, current condition, materials, construction systems, and pathological manifestations for conservation purposes. The ensuing analysis of the plan's results involves a discussion of the gap between FAU's ability to conduct studies and formulate proposals and its ability to implement these proposals in practice. This examination sheds light on the challenges in bridging the divide between theoretical advancements and practical implementation within the realm of the Vilanova Artigas Building conservation efforts.

Keywords Vilanova Artigas Building · Conservation Management Plan · Keeping It Modern Initiative · Preventive Conservation

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D. Del Curto and S. Salvo (eds.), *Planned Conservation of 20th-century Architecture*,
PoliMI SpringerBriefs, https://doi.org/10.1007/978-3-031-67818-9_4

Fig. 1 Vilanova Artigas building seen from its Southwest corner, 2010 (Photo Nelson Kon)

1 Vilanova Artigas Building: Maintenance Issues

The Vilanova Artigas Building, headquarters of the Faculty of Architecture and Urbanism (FAU) of the University of São Paulo (USP) at the University City, is a significant landmark in Brazilian architecture. Since its inauguration in 1969, the building designed by João Batista Vilanova Artigas and Carlos Cascaldi has been considered a paradigm for educational architecture and a distinguished example of São Paulo's brutalism (Fig. 1).[1] It is a relevant example of the use of exposed reinforced concrete in construction: foundations, columns, pillars, roof, as well as the large blind façade that shapes its perimeter [11]. The building measures c. 110 by 66 m and is 15 m high. One of the innovations in its design was that the building was conceived in harmony with the restructuring of FAU's curriculum, where the interconnectedness of spaces results from the activities developed in the school. The functions unfold in partial levels, connected by ramps and stairs, around a large central atrium, the Caramel Hall—so named due to the color of the epoxy floor—and the entire structure is crowned by a roof with translucent domes that allow for the incidence of natural light (Fig. 2).

In Artigas's own words: "The FAU building […] supports the idea of spatial continuity. Its six floors are connected by smooth and broad ramps, situated at different

[1] The building has been widely studied. Numerous references were mobilized in this research; see Kühl et al. [2, 6, 11].

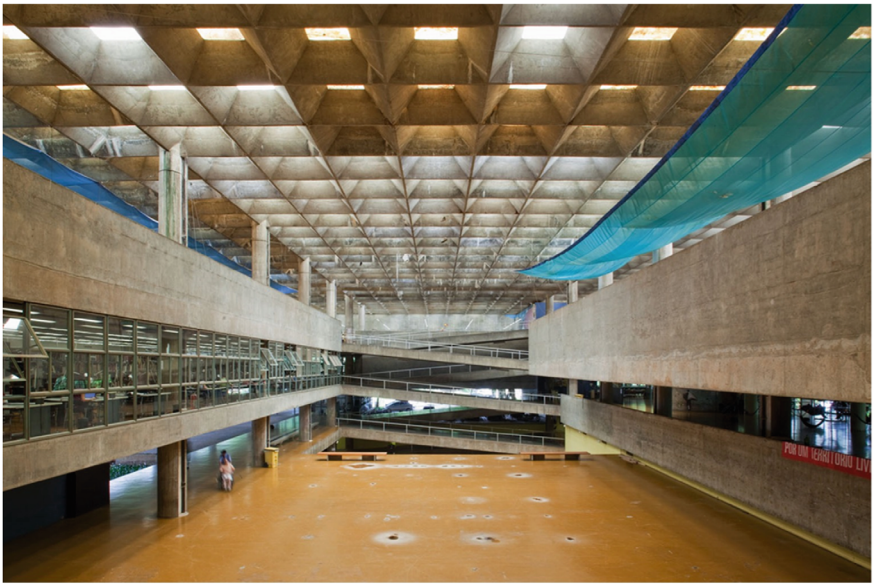

Fig. 2 Vilanova Artigas building: Caramel Hall, 2009 (Photo Nelson Kon)

levels that aim to create the sensation of a single plane. There is a constant physical interconnectedness throughout the building. […] The concrete employed is not merely a more cost-effective solution, but also aligns with the necessity of discovering means of artistic expression by utilizing the building's structure, its most dignified element. For the architect, the structure shouldn't merely assume the modest role of a skeleton; it should convey the elegance through which new materials can master cosmic forms, with the grace of larger spans and lightweight configurations" [2, p. 128].

The roof itself is bound by the concrete blind façade. Its structural system comprises inverted beams, 1.9 m in height and 0.4 m in width, spaced 5.5 m apart in the longitudinal direction and 22.0 m apart in the transversal direction. The peripheral inverted beams coincide with the façade walls. This primary structure, which defines the modules, is supplemented by a grid of inverted "A" shaped secondary beams. Each of these beams is 2.75 × 2.75 m and 0.485 m in height and they form a continuous 8 cm-thick slab (the crossbar of the "A"), which is integrated with the pyramid trunks (formed by the upper part of the stem of the inverted A), thus allowing for zenith light to enter through 16% of the roof area.. Due to its size, the roof structure is divided into four sections by two expansion joints. Each of these modules defines a rainwater collection zone, sloping at 0.5% towards the central pillars, where the drainage pipes descend. During construction, fewer vertical pipes were installed than originally planned, resulting in inadequate drainage capacity. Furthermore, the deformation of the structure due to the large spans resulted in significant deflections and the accumulation of water in the central parts of the modules [3].

Fig. 3 Vilanova Artigas building: infiltrations, 2002 (Photo Beatriz Kühl)

Due its bold design—both spatially and structurally—the building presented problems, especially regarding the roof, which proved to be its most vulnerable part since construction, with water infiltration issues (Fig. 3). This has always been a concern of the FAU administration, which tried various waterproofing methods and attempted to correct the slope, but the results were insufficient.

A second set of problems concerns the way the spaces of the school were treated over time. Both academic and administrative activities became increasingly complex, which led to the open areas being occupied with no consideration of the logic of spatial composition. Furthermore, the building maintenance has always been corrective rather than preventive, due to budget limitations that also prevented systematic periodic reviews of various systems, such as the hydraulic and electrical systems. Despite all the efforts made, FAU's administration has never had sufficient funds to address the problems and treat the building as a whole, and therefore, issues have accumulated over the decades.

FAU, like many other public institutions, faces multiple complications in providing preventive maintenance for its buildings, such as the difficulty in obtaining funds for studies and diagnostics that may lead to better-founded proposals and projects; lack of sufficient funds to address maintenance needs; service procurement procedures that are usually quite slow and often result in contracts being mostly awarded to cheap bidders, which leads to poor quality of works.

Over time, the problems became more serious and led to a collective effort to address them differently, resulting in the development of the Participatory Master

Plan between 2009 and 2011. As a consequence of the challenges posed by the plan, FAU applied for funding from the Getty Foundation's Keeping It Modern (KIM) initiative.

2 The Participatory Master Plan

The Board responsible for the buildings of the school decided to develop a Participatory Master Plan (PMP). The process began in early 2010 with the conceptualization of the plan and was completed in 2011 [8]. The PMP was not conceived as a project to be immediately implemented in practice, as it involved the participation of the entire FAU community, consisting of administrative staff, students, and faculty.

This unprecedented process within USP was motivated by unusual circumstances. FAU is responsible for five buildings: at the Armando de Salles Oliveira University City, there are the Vilanova Artigas Building, the Annex, the Antonio Domingos Battaglia Workshop, and the Fraccaroli Studio, where activities related to undergraduate programs in Architecture and Urbanism and Design are carried out. In the Higienópolis neighborhood, in a more central area of the city, there is the Vila Penteado Building, primarily dedicated to postgraduate activities. Among these buildings, both the Vilanova Artigas and the Vila Penteado are cultural assets protected by state and municipal legislation.[2]

The Vilanova Artigas Building had its recurring maintenance issues exacerbated in the first decade of the 2000s, and one of the studios was closed off. Starting in 2009, safety nets were installed (see Fig. 2) over sections of the walkways to protect users from potential detachment of concrete from the roof; this process was later extended to the entire building.

During Silvio Sawaya's tenure as director (2006–2010), attempts were made to address these issues, although without careful planning. There was not a project that unified and coordinated the multiple projects and actions to be implemented, and certain construction works disrupted the school's activities. Additionally, some projects were initiated without the necessary approval from preservation authorities, e.g., the transformation of the administrative sector, departments, and gardens. Furthermore, there were controversial proposals, such as the installation of an overroof structure. These interventions, which were not systematically discussed with internal FAU bodies or preservation authorities, raised questions that in 2009 led to the restructuring of the FAU's Board for buildings and the proposal to develop the PMP.

The new Board had an advisory rather than deliberative function and was made up of students, faculty, and administrative staff in equal number—which is uncommon in USP's organization. Working teams were formed, and in 2010 they conducted

[2] Brazil is a federative republic and has preservation authorities at the federal, state, and municipal levels, which operate independently of each other. Each level of government has its own legislation regarding listing of historical properties.

technical and participatory readings by area and by type of activities. In early 2011, principles, guidelines, and procedures were developed to be followed in future interventions on the buildings, ranging from routine maintenance to new constructions. This material was disseminated through the FAU website and public presentations of the proposals were held. It was possible for both individuals and groups to submit proposals for changes, additions or rejection of the proposals presented by the Board. The material was systematized and voted upon in parity-based forum, resulting in the consolidation of the PMP 2011–2018.

The PMP sets out, among others, specific requirement on the safety, use, and preservation of the buildings, and requires FAU to adopt proper methods and procedures, especially because its buildings are cultural assets. Interventions had to respect the architecture of the buildings and their relationship with the surroundings. Maintenance was a major concern: FAU should incorporate into its administrative structure a routine of both corrective and preventive maintenance. It was required to follow strict maintenance cycles, technically effective and based on multidisciplinary studies. The document also defines various types of actions, including conservation, restoration, and expansion, as well as the path to implementing each of them [5].

These issues were addressed based on documents from the International Council on Monuments and Sites (ICOMOS), starting with the Venice Charter. This is also due to the fact that USP's Center for Cultural Preservation is an institutional member of ICOMOS. According to the Ethical Commitment Statement of that time, members were required to act in accordance with the charters and doctrine of ICOMOS.

The proposal for the creation of an academic studio where professors, students, and administrative staff could work together on issues related to FAU's buildings was put forward, aiming to enhance the educational potential offered by these issues. However, this idea never materialized. Building upon this concept, though, an interdisciplinary optional course was established in 2013 in the Architecture program, involving professors from all of the three departments (Design, Technology and History): Antonio C. Barossi, Beatriz M. Kühl, Claudia T. A. de Oliveira, Helena Ayoub, Maria L. B. Pinheiro, and Roberta Kronka. The course focuses on building conservation issues, particularly those related to FAU and USP. This has been the first interdisciplinary optional course in the Architecture and Urban Planning program and has led to significant results.

One of the proposals of the PMP was to develop a preventive conservation plan, which was then disregarded. The non-implementation of the PMP proposals led to problems that absolutely needed to be addressed. The PMP advocated that any construction work within FAU had to be based on multidisciplinary studies and a specific project while also leaving room for emergency works, such as those for the roof and bathrooms, to continue before the final approval of the plan. This was because the modernization of the bathrooms had already undergone a thorough design and planning process and had been duly approved at all levels. The roof especially presented urgent issues, and multiple studies and experimental tests had been conducted on three of its modules with different types of waterproofing [3, pp. 155–167].

Thus, the proposal for the roof advanced independently of the PMP and the construction works were carried out from 2012 to 2015. Taking advantage of the procurement procedure launched for the roof, the restoration of the façades was also added to the call. Unlike the roof, the façades had never been thoroughly studied for maintenance purposes [9, pp. 229–233]. The same studio that was awarded the project for the roof restoration, PhD Engenharia, was also contracted to assist FAU with the façades. The bids had to be assessed also based on the technical expertise of the bidders and not only on the price offered as required by public procurement law. However, the legal department of USP, in order to avoid endless appeals, removed the technical clauses and assessed the bids on the sole basis of the lowest price. The winning company did not have the necessary expertise to handle this type of work, and the results were extremely problematic (see Fig. 5).

This is the context in which the professors involved in the interdisciplinary course proposed the Vilanova Artigas Building for the KIM initiative, with the support of FAU's administration.

3 Subsidies for a Conservation Management Plan for Vilanova Artigas Building

FAU was selected for the Getty Foundation's KIM initiative in 2015, along with the Arthur Neiva Pavilion of the Oswaldo Cruz Foundation, a project by Jorge Ferreira in Rio de Janeiro. These were the first two projects in the country to receive the funding. In the following years, two works by Lina Bo Bardi were selected: the Glass House in 2016, and the São Paulo Museum of Art Assis Chateaubriand in 2017.

This represents a significant achievement. The KIM initiative made possible something that is rare in Brazil: systematic research on the buildings, their documentation, current condition, materials, construction systems, and pathological manifestations for conservation purposes [4].[3] Securing substantial funding for this type of research can be a challenge, despite the recognized importance of Modernism and the numerous studies on the history of modern architecture in the country. The KIM initiative allowed these works, although consistently addressed by architectural historiography, to undergo in-depth studies for conservation purposes, which, in turn, provided various historiographical insights into these buildings.

The research for the Vilanova Artigas Building spanned from 2015 to early 2018. Recognizing that a comprehensive Conservation Management Plan (CMP) would require more time and resources than those provided by the KIM initiative, the proposal focused on the most relevant topics, with the anticipation that the work

[3] There are exceptions, such as the proposals for preventive conservation and risk management of the Casa de Rui Barbosa in Rio de Janeiro, which were led by Claudia Carvalho, a consultant later involved with KIM FAU. For issues related to preventive conservation in Brazil see: Carvalho [4]. The bibliography used in the KIM project for the Vilanova Artigas Building can be found in: Kühl et al. [pp. 111–112]. The plan is based on the Venice Charter, with a critical approach to the building, its configuration, and materiality.6

would continue in the future. Thus, one of its outcomes was to establish guidelines for the development of a complete plan. The work was structured into three lines of investigation, involving various professionals, undergraduate and postgraduate students, consultants, and specialized service laboratories (listed in Table 1).

The plan focused on two aspects: water control and management, which has been the primary agent of degradation of the building since its construction and addressing the effects of the repairs made to the concrete façades, which resulted in a fragmented image of the building. Despite being brutalist and displaying the marks of their construction process, the façades had always presented a unified and coherent image, which however got lost during the repairs (compare Figs. 1 and 5). The problematic outcome of the intervention can be attributed to various reasons, including the previously mentioned lack of research to support the proposal and the poor quality of the work execution.

Therefore, the CMP focuses on the performance of the building's protective elements: the roof (Task 2) and the façades (Task 3), but it operates on the assumption that these issues are related to the ways in which the building has been perceived and treated over time (Task 1).[4] A recurring problem is the way spaces and systems in the building have been handled, typically in response to specific and urgent issues, with no organic long-term planning. Many repairs and alterations have been carried out with no consideration for the spatial characteristics of the building, which is paradoxical for a school of architecture.

In terms of methodology, Task 1 [6] primarily relied on the following approaches: documentary research, involving the examination of textual and design sources related to the building and its construction, as well as its transformations over time; iconographic research; bibliographic research. Additionally, systematic records of the building's condition were made, including an architectural survey and three-dimensional laser scanning survey of the external façades conducted by the Research Department Centre for the Development of Integrated Automatic Procedures for Restoration of Monuments (DIAPReM) of the University of Ferrara [1, 7], as well as an arboreal survey. All this information was organized into a database, which was also used in Tasks 2 and 3. The information was also arranged into two timelines: one focused on institutional events, highlighting key moments in the life of the school, and the other showcasing the major architectural phases of FAU's buildings.

Task 1 aimed to document the building, its transformations, and the ways in which its spaces were used and perceived. It involved analyzing the spatial characteristics and developing guidelines for the appropriate treatment of the spaces, respecting their specificities, understood as values to be preserved. This approach also took into account the building's role in the cultural and socio-political life of São Paulo. General guidelines for the entire building were proposed, along with specific guidelines for each floor, suggesting potential ways of utilization. The external areas were examined, addressing issues such as the phytosanitary condition and the rhythm of vegetation, as well as accessibility, among other aspects. Finally, proposals and

[4] The author of this chapter was the coordinator for Task 1, and the outcomes, along with numerous bibliographic and documentary sources, can be found in Kühl et al. [pp. 9–119].6

Table 1 KIM Vilanova Artigas Building (2015): Research team (*Source* [12])

Applicant	Fundação de Apoio à Universidade de São Paulo (FUSP)	
FAUUSP	Director:	Maria Angela Faggin Pereira Leite
	Deputy Director:	Ricardo Marques de Azevedo
CMP Vilanova Artigas Building	Project Coordinators	Maria Lucia Bressan Pinheiro Claudia T. de Andrade Oliveira
Tasks Coordinators	Task 1 FAUUSP	Beatriz Mugayar Kühl; Silvio Oksman
	Task 2 Roof	Antonio Carlos Barossi; Claudia T. de A. Oliveira; Rodrigo C. Vergili
	Task 3 Façade	Claudia T. de Andrade Oliveira
Project Team	Advisors	Claudia S. R. de Carvalho
		Norberto C. Moura
	Professionals	Ana Paula A. Gonçalves
		Fábio Gallo Júnior
		Renata C. Campiotto
		Rodrigo A. Campagner Vergili
	Collaborator	Carmen S. Masseo de Castro
	Interns	Eric Palmeira
		Letícia de Almeida Chaves
		Luiza Nadalutti
Research Laboratories Collaborative Firms	Analysis of materials	IPT
	3D laser scanning	DIAPReM University of Ferrara Scientific Coordinator: Marcello Balzani Project Coordinator: Luca Rossato Survey Coordinator: Guido Galvani Technician: Daniele Felice Sasso Diagnostic: Federica Maietti
	Metric survey	Relevo
	Polyurea tests:	SGS do Brasil
	Concrete cleaning tests and mortars repair:	Pires Giovanetti e Guardia
	Arboreal survey:	Podarte

Fig. 4 Vilanova Artigas building: internal view, 2022 (Photo Beatriz Kühl)

guidelines for future developments of the plan were presented, and parameters for the revision of facilities were established as part of this comprehensive effort.

Regarding the roof and façades, it was crucial to assess their condition after the works completed in 2015 (Figs. 4 and 5). These assessments were built upon the same methodological foundation and material systematized by Task 1, with the addition of various tests, both destructive and non-destructive, to serve specific purposes, particularly in studying the concrete's strength and characteristics.

In Task 2 [3], a timeline of previous interventions was developed. The characteristics and morphology of the structure were studied, including deformations not foreseen in the structural design, as revealed by the topographic survey of the beam bottoms. This allowed for an understanding of its behavior and real geometry, which, in turn, led to the definition of appropriate procedures for maintenance and the selection of materials for future waterproofing. The polyurea membrane (applied during the 2012–2015 works) was monitored to identify any flaws, and tests were conducted to assess its performance and state of conservation. This process resulted in a monitoring plan that includes inspection, cleaning, and repair procedures, along with their frequency and methods.

Task 3, which focused on the reinforced concrete façades, aimed to understand the composition of the concrete, its strength, and its state of conservation. A timeline was developed, problems were mapped, including those related to the repairs from the last intervention, as well as pathological manifestations. It was observed that marks

Fig. 5 Vilanova Artigas building: façades after works, 2023 (Photo Beatriz Kühl)

of corrosion had reappeared on the surface. The area of the repairs was measured, and some of them were reopened for control purposes.[5] It was noted that the repair mortar did not completely cover the steel rebar, which has structural consequences and exacerbates corrosion. These repairs also created a significant issue of perception: a fragmented and pixelated image of the building, incongruent with the original design proposal and its historical image. Laser scanning, combined with on-site inspections and photographic documentation, allowed for the analysis of the precise geometry of the façades, their pathological manifestations, and the location and dimensions of the repairs. The results were systematized to guide future actions, prioritizing high-risk areas and seeking to minimize the effects of intervention while avoiding unnecessary loss of original material [9]. More appropriate repair methods began to be studied, but the COVID-19 pandemic interrupted the work.

The KIM initiative provided FAU with the opportunity to conduct systematic research and analysis for preventive conservation purposes, which, as mentioned earlier, is challenging to finance in Brazil. It allowed for an in-depth understanding of the building in terms of its real materiality and geometry, as transformed over time, rather than as an abstraction. This not only facilitates historiographical clarifications

[5] The central administration of USP did not authorize the authors of the proposal, PHD Engenharia, to oversee the works, despite FAU's appeals, which resulted in lack of proper control and measurements.

but also makes it possible to address issues on a well-founded basis so as to propose solutions and plan further studies and actions.

4 Developments of the Plan and Future Prospects

The CMP was developed also with the aim of promoting a diverse institutional awareness, as previously stated in the PMP, to go beyond the mere reacting to problems to achieve full understanding of their causes, prevent them in the future and shape future actions. This type of approach requires studies, planning, constant monitoring, and structured actions over time, which implies a renewed way of proceeding within the institution. Despite the support given by successive FAU administrations to the implementation of the plan and the continuation of the process, practical outcomes have been limited. Procedures at USP were slow and on top of that, the Covid-19 pandemic came and disrupted ongoing processes, including the laser scanning of the building (part of the cooperation between USP and DIAPReM)[6] and façade treatment tests.

Despite the limitations, specific results of interest were achieved following the plan's recommendations, such as the partial transformation of the spaces of the research laboratory of the Department of History carried out in 2019. Additionally, an accessible pedestrian ramp was built between one of the main campus streets and the Vilanova Artigas building. The project, developed by students in the interdisciplinary course, was embraced by the USP Spaces Superintendence, which developed the executive project with student participation and carried out the construction, completed in 2022 (Fig. 6). Tests for cleaning and removing graffiti from the concrete interior of the building were conducted in 2021, and in the same year a plan for contracting maintenance and preventive conservation services for the roof was approved (but the contract was never made official). As the polyurea membrane is approaching the end of its 10-year lifespan without any maintenance, based on knowledge acquired from the CMP, FAU's Board of buildings is awarding a contract for the realization of experimental modules equipped with a non-adhered Polyvinyl Chloride membrane, a waterproofing system that is more suitable to the roof's conditions and behavior [10].

The interdisciplinary course provided support for further exploring specific issues and the potential of FAU for expansion was examined, especially due to its growing collection of architectural projects. These are preliminary studies that still need to be developed into projects.

There is an evident gap between FAU's ability to conduct studies and proposals and its ability to implement these propositions; this gap is primarily due to administrative and financial issues. Nevertheless, despite these limitations, studies continue to be developed and have materialized into specific actions. While these actions have

[6] For the analysis and results of this cooperation, see Kühl et al. [7].

Fig. 6 New access to Vilanova Artigas building, 2022 (Photo Beatriz Kühl)

not achieved the desired broad scope, they are gradually transforming spaces and procedures.

Acknowledgements The author would like to thank the Getty Foundation (Keeping It Modern initiative) and the National Council for Scientific and Technological Development—CNPq (Research Productivity Scholarship).

The author prepared the English version of this text with the assistance of ChatGPT.

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Five Points for Preserving Twentieth-Century Architecture. A Conservation Management Plan for the National Art Schools of Cuba

Davide Del Curto

Abstract The National Art Schools of Cuba were designed immediately after the Castro revolution (1961–64) by Ricardo Porro, Vittorio Garatti, and Roberto Gottardi to accommodate the integrated teaching of various art forms: visual arts, theatre, music, dance, and ballet. Although the Schools are included in the WMF list of 100 most endangered sites (2000), the UNESCO Tentative List (2003), and the National Register of Monuments (2010), a scientific approach to their sustainable conservation has long been lacking. The conservation plan prepared between 2018 and 2020 includes five lines of action: documentation, architectural preservation, landscape protection, environmental sustainability, and management. The plan has developed a clear list of priorities and practical solutions to the most urgent needs, such as the conservation of concrete and the adaptive reuse of abandoned parts, also in combination with themes that are ancillary to architecture but are also essential to its survival, such as the risk of flooding. The plan also discussed the "statement of significance" of this architectural masterpiece, involving different stakeholders (designers, owners, users) and other points of view (local, national, and international). In this way, the writing of the CMP was an exceptional collaboration experience between Italy, Cuba, and the United States.

Keywords Tropical modernism · Thin-tile vaults · Reinforced concrete · Flood risk

1 Rectificaciones

In 2017 Cuban painter José Manuel Mesías painted *Rectificaciones a la obra de Armando Menocal, "La muerte de Maceo"*, where he corrected a previous work dating back to 1908, portraying the killing of a lieutenant-general of the liberation army during the War of Independence (Fig. 1a,b). Operating from a contemporary

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D. Del Curto and S. Salvo (eds.), *Planned Conservation of 20th-century Architecture*, PoliMI SpringerBriefs, https://doi.org/10.1007/978-3-031-67818-9_5

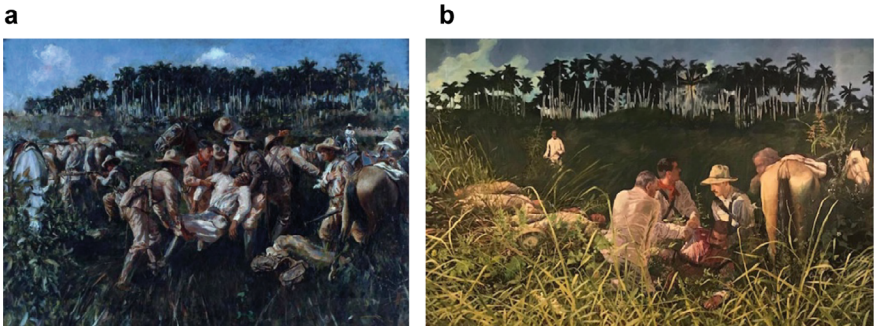

Fig. 1 **a** Armando Garcia Menocal, La muerte de Antonio Maceo, 1908 (*Source* wikipedia.org/Armando_Menocal_1.jpg, last accessed 2023/10/08), **b** José Manuel Mesias, Rectificaciones a la obra de Armando Menocal "La muerte de Maceo", 2017. Courtesy of the artist, photo by Davide Del Curto

and more detached historical perspective, Mesías liberated the early 1900s painting from any emphasis and distortions [1]. Mesías set the point of view very close to the wounded hero lying on the ground, unlike in Menocal's picture, where the companions support lieutenant-general Maceo at the center of the scene, in a classical layout. The result is a less rhetoric and more natural composition, evoking the humanity of the wounded man and calling forth the smell of the prairie. Moreover, Mesías artificially applied a grid to the surface of the canvas, thus giving the painting the immediacy and neutrality of a photographic or even photogrammetric shot. As further proof that such pictorial-historiographic revision work is based on a scientific method, Mesías surrounded the main picture with a series of secondary canvases dedicated to the taxonomic and botanical examination of the tropical prairie where the central scene of the dying hero takes place. Mesías accurately portrayed details of individual blades of grass two or three times greater than the real scale, thus simulating the zoom effect of a scientific photo-documentary and obtaining an unexpected visual result (Fig. 2a,b).

Like Mesias's work, we might affirm the Conservation Management Plan (CMP) for the National Art Schools of Cuba (NAS) has operatively continued John Loomis's historical–critical updating, and this is not just aimed at celebrating the memory of utopia. The CMP overcomes the idea of an unfinished dream of architecture and focuses on the scientific assessment of the as-built architecture. It is a basis for designing multiple sustainable development scenarios with contributions from all stakeholders (Fig. 3a,b).

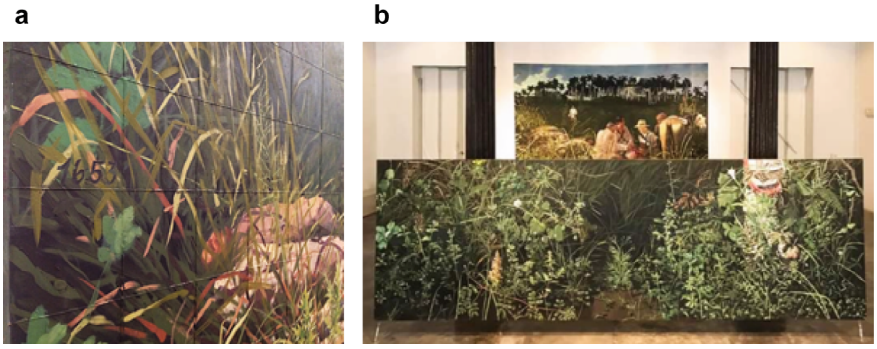

Fig. 2 **a** José Manuel Mesias, Rectificaciones a la obra de Armando Menocal "La muerte de Maceo", 2017. Detail with grid and time. Courtesy of the artist, photo by Davide Del Curto, **b** Hortus conclusus. Estudio de plantas de la mitad inferior del cuadro base, 136 × 425 cm. Courtesy of the artist, photo by Davide Del Curto

Fig. 3 **a** Looking at Vittorio Garatti's school of ballet in 1970. Photo by Lorenzo Carmellini, **b** Respecting the vision, changing the view. Looking at Vittorio Garatti's school of ballet 50 years later (1970–2020). Photo by Federica Allegretti

2 A Myth of Architecture: Modern, Heroic, and Tropical

According to the mythology that has accompanied the narrative of this architecture for seventy years, Fidel Castro and Che Guevara had a moment of relaxation at the Havana Country Club in the aftermath of the revolutionary triumph. Trying their hand at an improbable game of golf, they dreamed that Cuba would soon become a point of reference for all Latin America and lead the subcontinent in the fight against the slavery of capitalism. According to Che Guevara's Pan-American vision, Cuba would have inspired that liberation by spreading not only the socialist political-economic model but also a cultural message based on freedom, education, creative amenities, art, and music of the Caribbean.

To make that dream come true, Fidel Castro called three young architects, two of whom were under thirty years old and still little experienced. He ordered them

to transform that tropical green into a great art school open to young people from all over the Third World. He also ordered them to hurry because the Revolution could not wait. We can imagine the enthusiasm of those three young architects when the *Comandante* called them to participate in a political wave that aimed to rewrite the rules and build an equal world, their state of mind in those feverish months of work, when they had the chance of creating in total freedom, without any limits or restrictions, thus experiencing an ideal and unrepeatable condition for any architect [2].

Ricardo Porro (1925–2014), Vittorio Garatti (1927–2023), and Roberto Gottardi (1927–2017) designed five revolutionary buildings, each dedicated to teaching a form of art: music, visual arts, drama, dance, ballet. Each worked independently based on specific standard criteria such as free inspiration from the forms of nature, the absence of borders and fences, the use of bricks and Catalan vaults.

Ricardo Porro designed the Dance School, whose plan represents a sheet of glass broken by a blow, an architectural metaphor of the revolution, which disrupts the status quo and creates vital confusion. Porro also designed the School of Visual Arts, taking inspiration from the sensual shapes of the female body. Roberto Gottardi designed the Drama School, where he evoked some architectural features of Venice in a labyrinth of narrow passages and little courtyards. Vittorio Garatti created the Ballet School, taking inspiration from the foliage of tropical trees and the domes of Labrouste's library in Paris. He also designed the Music School by retracing John Wood's Royal Crescent in Bath. As a result, the building looks like a long snake following the hill's profile and should have included a gigantic concert hall which, however, was never built.

These visionary buildings arose on the edge of the 18-holes golf course in Havana, resulting from the subdivision of an agricultural property (Finca Lola) concluded in 1911 [3]. The area also included other buildings, such as the Country Club, which is now the seat of the rectorate, the library, and other minor buildings. This wonderful green area of over fifty hectares alternates the bright green of the English lawn and the dark green of the tropical ficus and carob trees. The Quibù River crosses the park before flowing into the Caribbean Sea a few hundred meters downstream, adding to the beauty of the landscape but also exposing the complex to the risk of flooding (Fig. 4).

3 Revolution of Forms

Once the post-revolutionary enthusiasm was over, the construction of these buildings was interrupted and the three architects were forgotten, if not ostracized, because of their alleged excess of individualism and narcissism that did not fit well with the new course of real socialism. The National Art Schools were forgotten by international critics and the tropical vegetation grew up to literally bury them. The first time John Loomis visited Havana, the Schools appeared to him like the remains of a pre-Columbian city hidden by the forest, or an archaeological treasure sunk in the

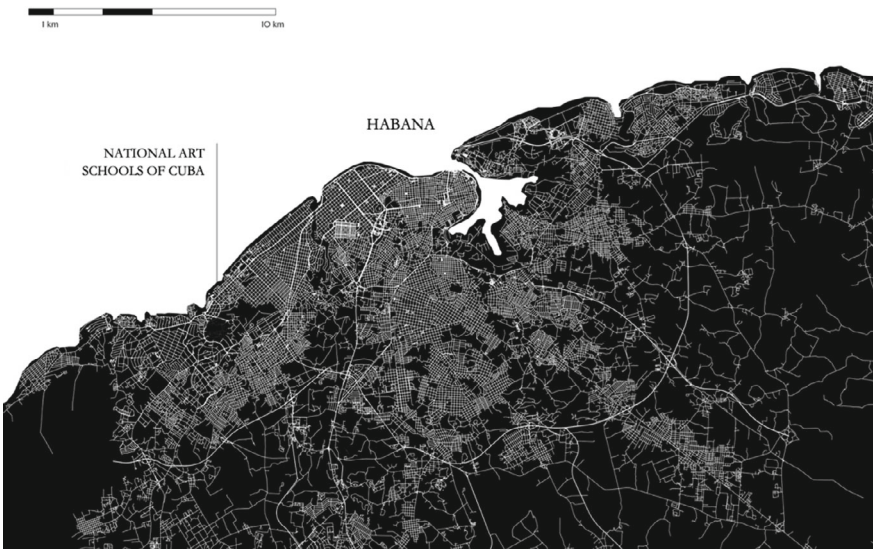

Fig. 4 Habana and the National Art Schools of Cuba

Caribbean Sea, a forgotten architectural treasure waiting to be discovered… and this is just the dream of each young researcher in architectural history! John Loomis published "Revolution of forms" in 1999 and the success of this book (translated into Spanish and Italian) literally brought the Schools out of the oblivion into which they had sunk [4]. Finally, thanks to a scientific study based on documentary and comparative research, "Revolution of forms" set the forgotten National Art Schools of Cuba in the framework of international modernism, freeing them from local disputes and interpretative distortions and giving them a place in the history of twentieth-century architecture.

Following this critical fortune, the World Monuments Fund included the NAS in the list of the "100 most endangered sites in the world" at the beginning of the 2000s. This decision consolidated the perception of the architectural and cultural value of these buildings both inside and outside the borders of Cuba and promoted an international debate over their conservation. As a result, the NAS were registered in the UNESCO Tentative List (2003) and, finally, also in the list of national monuments of Cuba (2010), thus being considered a building of historical value and worthy of protection.

Moreover, the Cuban authorities promoted the restoration of the School of Visual Arts and the School of Modern Dance, the only two buildings out of five that had been completed and regularly put into operation. However, the restoration was not supported by a proper research campaign and a scientific debate adequate to the importance of the buildings [5]. As a result, the restoration implemented poor structural solution due to interpretative mistakes and therefore worsened the stability of the buildings rather than consolidating it [6].

Almost at the same time, in 2012, Cuban dancer Carlos Acosta, star of the Royal Ballet in London, offered to recover the ruins of the unfinished Ballet School as a location for his dance academy [7]. Sir Norman Foster prepared a restoration project, but Vittorio Garatti protested violently, demanding to be involved in the project and claiming respect for his copyright as the original designer. He wrote a public letter to Fidel Castro to denounce the capitalist attempt to dismember the remains of the revolutionary dream. The political controversy that followed his words thwarted any effort, and the only result was the abortion of Acosta's initiative. He therefore found another location for his academy, and the Ballet School remained an abandoned ruin [8].

4 A 5-points CMP for Modern Architecture

Today, the National Schools of Art present both conservation and management issues. On the one hand, we have a masterpiece of modern architecture in a terrible state of conservation and a national monument that requires protection and repairs after seventy years of neglect. On the other hand, we have an arts academy with a robust teaching model based on integrating visual arts, music, dance, and theatre that continues its educational mission despite countless difficulties. To address this double challenge, as early as 2004 the Cuban authorities developed a *Plan Rector* aimed at the strategic management of the transformation of this large complex. However, the results were poor due to a lack of resources and failure to define a clear strategy and set priorities. The *Plan Rector* thus proved to be a weak management tool during the above-mentioned restoration of the Schools of Dance and Visual Arts and the attempts to repair the Ballet School.

Building on that precedent, between 2018 and 2020 the Getty Foundation's Keeping It Modern program funded the drafting of a new Conservation Management Plan. The activity was led by. Politecnico di Milano together with Fondazione Politecnico di Milano and in collaboration with the University of Parma, Princeton University, Universidad des Artes de Cuba, and Assorestauro, the Italian association of producers of materials, equipment, and companies specialized in the restoration sector. The research was carried out in Italy, Cuba, and the US involving architects, archivists, structural engineers, hydraulic engineers, students, and professors.

The Conservation Management Plan follows the methodology defined by ICOMOS Australia in 2013 based on the experience of the Sydney Opera House and the Burra Charter and provides for five operational phases. It represents an important step in the path—started fifty years ago—toward the enhancement of twentieth-century architecture as part of the built heritage and its protection. The NAS CMP covers all the five revolutionary buildings, thanks to the skills of five international partners, and is structured in five WPs (Working Packages): (1) Documentation, (2) Conservation, (3) Flood-risk assessment and landscape protection, (4) Environmental sustainability and energy efficiency, (5) Integrated information management and adaptation strategy. The result is a 1600-page report involving over

seventy specialists from three countries who explored 600,000 m^2 of green area and over 40,000 m^2 of buildings corresponding to more than 500 rooms and 40 domes.

5 CMP as Research

The CMP for the National Schools of Art of Cuba was conceived by a university with expertise in the preservation of architectural heritage and the support of two more universities specialized in structural engineering. Preparing a CMP was thus an excellent opportunity for doing applied research in the field of architectural preservation and carrying out the first systematic study of this modernist masterpiece. The research team carried out as-built analyses, technical surveys, and site tests. As-built architecture was the primary source of information instead of only archive documents or literature. Therefore, in terms of methodology, preparing a CMP is the opportunity for investigating twentieth-century architecture by applying the same, well-established method used for all historic buildings, which is culturally based on the material history of the built environment [9]. According to Fernand Braudel, the *École des Annales* and the culture wave derived from the *Nouvelle histoire*, the material history of the built environment is one of the micro-stories or "particular stories" that form the history of material civilization. The material history of the built environment differs from the history of architecture. The latter stems from the history of art and identifies and retraces a succession of periods dominated each by a certain movement, a formal style, a school, or a single master. However, this type of history is not sufficient to support those conservation activities that are the goal of any research on architectural heritage. The material history of the built environment combines the methods of historical-archival analysis with the *Baufoshung*, i.e., the post-classical archeology applied to the built environment [10] and based on the direct survey of buildings.

This is not new for historic buildings, but it is often so for twentieth-century architecture, which due to its young age, has rarely been studied with this method. Therefore, drafting a CMP has been the first opportunity to carry out such a systematic study with the primary objective of preserving the authenticity of these buildings. We know that twentieth-century buildings were constructed with innovative, highly experimental, and often unprecedented techniques and materials that had never been tested before. We are also aware that architects of the period focused most on designing highly creative forms without controlling every detail, and many construction issues were decided directly on the building site. For this reason, when investigating twentieth-century architecture with the *Bauforschung* method, researchers often encounter significant differences between the as-built work and the information contained in the original project drawings, or even between the narratives of the different architects, who sometimes show not to be completely aware of all the construction aspects of the works they designed, despite these aspects are often crucial to the final architectural outcome.

This is just the case of the NAS. Starting from previous findings from Princeton University, the drafting of the CMP redefined the structural system used in the complex [11]. By means of archival research, on-site analyses, and IR-survey, it was possible to prove that this revolutionary architecture was not created only by adopting the Catalan vaulting technique, as they have believed for the last sixty years, as instead, it was created using a mixed structure combining reinforced concrete and thin-tiles vaults [12]. The reason that Vittorio Garatti, Roberto Gottardi, and Ricardo Porro never explicitly admitted the fundamental role of reinforced concrete is still unclear, although it is evident that those iconic buildings would simply not exist without this material. Since every work of architecture results from co-authorship, even though some of the co-authors may remain hidden [13], it would be worth to further investigate the role of engineers Edoardo Esenarro, Isabelita Wittmarc, and Ilda Fernandez, who contributed to the project by conceiving and calculating this ingenious "invisible concrete" and whose co-authorship deserves to be fully recognized [14].

Such results confirm the hermeneutic potential of any conservation and restoration activity, including drafting a CMP. By (ideally) dismantling and reassembling a building, we highlight new and often unexpected details, thus supporting an innovative and research-based interpretation [15].

Historic documents remain fundamental and need to be managed by specialized archivists and not only architects or arch-lovers as it often happens with twentieth-century architecture. Historical documentation of the NAS was spread over more than six institutional archives and at least five private holders in four countries. To bring order in such a complicated framework, we settled the structure of an archival superfund [16] for collecting the results of any current or future research and thus contribute to the building of knowledge, just like the Princeton Library has recently done by ordering and making publicly accessible Roberto Gottardi's archive.

Alongside the consequences on a historical–critical level, the discovery that the NAS are mainly made of reinforced concrete has implications for their preservation; the pilot restoration site and the workshops organized in Havana in collaboration with Assorestauro focused precisely on these implications. Therefore, twenty years after John Loomis' "Revolution of forms" had brought the NAS into the scientific debate on international modernism and had given them a place in the history of twentieth-century architecture, the CMP brought the NAS into the global discussion on how to practically preserve modernist architecture, where preserving concrete is one of the core issues (Fig. 5).

6 Alongside Preservation

Besides documentation, on-site analysis, and material preservation, the CMP tackled some lateral issues of architectural conservation, such as the hydraulic risk in the climate change scenario. The whole area is exposed to the risk of frequent floods from the Quibu River, due to its proximity of the Ocean and the changes occurred

Fig. 5 Pilot site for reinforced concrete's restoration. Courtesy of Assorestauro, photo by Davide Del Curto

in the riverbed in the early 1900s, when it was artificially modified and adapted to the layout of the golf course. Subsequently, this artificial landscape offered Vittorio Garatti a perfect river meander to set up the Ballet School. However, he did not realize the building would have been exposed to flood risk and that this would have become ever more frequent due to climate change. Mitigating the flood risk is clearly a priority for preserving the NAS, even more than repairing concrete or thin-tile vaults. A team of hydraulic engineers joined the preparation of the CMP by developing a digital model that predicts the risk of flooding for each building and sets solutions to mitigate this risk in both short and long-term scenarios [17].

The CMP also analyzed the entire complex, room by room, and assessed its state of conservation, current use (200 rooms out of 500 are today completely unused), level of authenticity, and tolerance for change, that is how much each part of the complex could withstand new restoration works or transformation. Based on this investigation, we have locally assessed the level of significance, both at the scale of the single building and at the scale of the entire complex. These data were organized and managed based on a GIS [18] (Fig. 6 and Fig. 7).

Finally, the Plan defined some guidelines for planning spaces' restoration and adaptive reuse and addressing future transformations. Ricardo Porro, Roberto Gottardi, and mostly Vittorio Garatti based the architectural design of the NAS on a tight functional analysis of each single school, where they assessed the number, dimension, and position of each room, depending on its specific function. That

Fig. 6 Ballet School flooding, January 2019, photo by Davide Del Curto

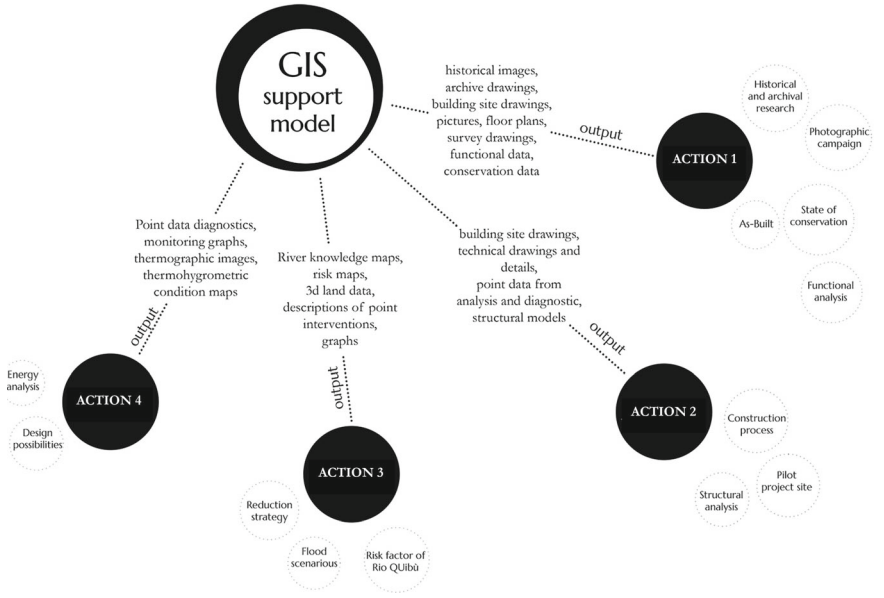

Fig. 7 The conservation management plan's structure for the National Art Schools of Cuba

organicist-modernist architecture was thus grounded on entirely rational architectural thinking, and the idea, typical of the twentieth-century idea, that form follows function. However, the educational programs have changed a lot over time, and today, after two national reforms of education, the NAS are now very different compared to the Sixties. The teaching manifesto does include ballet, and therefore, one might ask what the purpose is of restoring Garatti's unfinished School and what form of adaptive reuse best suits it. Roberto Gottardi developed four projects to complete the Theater School between 2001 and 2011 in response to four different educational-functional programs of the Ministry of Education, but none of them was realized. In the meantime, the new departments of "Conservation of Cultural Heritage" and "New Media and Communication" are attracting more and more students due to the training and job opportunities they offer. However, these two departments are outside the iconic but unfinished buildings from the 1960s. We may therefore ask: to what extent the iconic architecture of the 1960s, firmly designed for a functional program that no longer exists, is today capable of accommodating the current educational manifesto of the ISA, the University of the Arts of Cuba? How much can those revolutionary forms follow the contemporary function and today's will of modernization? It is a crucial issue because if the answer was yes, architectural preservation and school management could collaborate, while on the contrary, if the answer was no, they could have different or even antithetical targets.

7 CMP as a Tool for Discussion and Inclusion

In drafting the CMP, we asked various stakeholders the above-mentioned question on the antinomy between architectural preservation and school management, we collected their answers and promoted dialogue among each other:

- Vittorio Garatti, who joined the research since the very beginning: the NAS have been an unfinished dream for over sixty years and claims to be completed.
- Most international scholars and architecture enthusiasts: the NAS are an icon of the post-revolutionary wave and represent a hypostatized image of that period.
- The Monuments Office of Cuba: the NAS are architectural monuments to be protected by controlling risk factors.
- The Cooperation Agency of Cuba: the NAS are an opportunity to implement international cooperation projects in a sector attractive to foreign financiers, such as music and the arts.
- The users (teachers, students, rector): the NAS are simply a modern university of the arts asking for a comfortable place to teach and learn, with a certain degree of indifference to the fate of the architectural ruins from the 1960s.

Such debate has occurred perhaps for the first time since the 1960s. It proves that the CMP process is effective in promoting cooperation and boosting the decision-making process, more than (or before) any architectural design as the ones aborted in 2012 (Ballet School), 2001–11 (Drama School), and 2016 (Music School). These

Fig. 8 Dancing over the ruined roof of Vittorio Garatti's school of ballet. Photo by Federica Allegretti

projects were designed by great architects but were not adequately supported by an open discussion and the sharing of objectives and expected results. Moreover, each stakeholder has specific requests, priorities, and needs for economic resources which nowadays in Cuba can only come from abroad through international collaboration or cooperation projects. Therefore, the CMP has clarified the complex's priorities, promoted dialogue among the stakeholders, and made the NAS a more reliable entity for global investors (Fig. 8).

[…] architecture must no longer be that of the great utopian projects of the 60s, the years of megastructures, or the dreams of Superstudio. Today, only what is interesting is possible; Yona [Friedman] and others then developed an essential criticism of traditional architecture and indicated that the model of the architect, fundamental for us, is no longer understood as a great author of visionary designs but is rather seen as a mediator, a figure capable of relating both to those below and those above. The time of charismatic architects as the Renaissance was, is truly over; today, we need the role of the architect to be recognized greater social legitimacy if we want to change things [19].

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The Halls of Torino Esposizioni: From Conservation Management Planning to Future Use

Rosario Ceravolo, Paolo Faccio, Greta Bruschi, Cristiana Chiorino, Erica Lenticchia, Irene Matteini, Francesca Pasqual, and Antonia Spanò

Abstract Pier Luigi Nervi described reinforced concrete as the most beautiful construction system that mankind has discovered to date. Intervening today in a respectful way without altering the balance of Nervi's architecture between form, structure and function is a challenge that requires an in-depth and multidisciplinary approach. In this context, a Conservation Management Plan is an indispensable tool for outlining key guidelines for the conservation and maintenance of this architectural heritage. In 2019, the Getty Foundation awarded the Keeping It Modern initiative grant to develop a Conservation Plan for the exhibition center Torino Esposizioni, designed and built by Pier Luigi Nervi in Turin. Thanks also to an unprecedented campaign of experimental investigations, a multidisciplinary team led by the Politecnico di Torino produced a conservation plan that played a key role in the recent implementation of the plan to renovate and reuse this complex. The project is currently taking shape in the new civic library and new university spaces.

Keywords Conservation management plan · Torino Esposizioni · Exhibition center · Pier Luigi Nervi · Experimental test campaign · Reuse

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D. Del Curto and S. Salvo (eds.), *Planned Conservation of 20th-century Architecture*, PoliMI SpringerBriefs, https://doi.org/10.1007/978-3-031-67818-9_6

1 Introduction

In the vision of Pier Luigi Nervi, creating cast stones of any shape and capable of resisting tension better than natural ones has something magical in itself.[1] Engineer, pioneer, and entrepreneur, in his long-lived activity Nervi demonstrated his ability to exploit the full potential of this construction technique [14–16, 26]. Intervening today in a respectful way without altering the balance of Nervi's architecture between form, structure and function is a challenge that requires an in-depth and multidisciplinary approach. In this context, a Conservation Management Plan (CMP) becomes an indispensable tool for outlining key guidelines for the conservation and maintenance of this architectural heritage.

In 2019, the Getty Foundation awarded the Keeping It Modern (KIM) initiative grant to develop a CMP for the exhibition center Torino Esposizioni (Fig. 1), designed and built by Pier Luigi Nervi in Turin. A multidisciplinary team was then created lead by Prof. Rosario Ceravolo from Politecnico di Torino, involving various research institutions and industrial companies, including Iuav of Venice, the Foundation Pier Luigi Nervi Project (PLN), Buzzi Unicem, and many others. They conducted an in-depth assessment, also on the basis of an unprecedented experimental investigations campaign, to produce a CMP for this complex.

The KIM Getty grant project (2019–2022), together with the constant support of S.C.R. (Piedmont region commissioning company) and the City of Turin, played a key role in the recent implementation of the rehabilitation and reuse project (funded by the European Recovery and Resilience Plan—RPP), which includes the creation of the new civic library (Hall B) and an expansion for the School of Architecture of Politecnico di Torino (Hall C).

2 Case Study

The exhibition center Torino Esposizioni was commissioned by FIAT [11, 12], and was designed and built by Pier Luigi Nervi and his company "Ingg. Nervi & Bartoli – Anonima per costruzioni" [1, 22–24] between 1947 and 1953. This large complex, designed as an exhibition space for FIAT annual car show (Figs. 2, 3), sits along the Po River within the Valentino Park area.

Torino Esposizioni is composed of many pavilions; the two main ones are referred to as Hall B and Hall C. This complex is the first large scale implementation of Nervi's ferrocement systems, which are the distinguishing feature of this architecture [9, 10]. In addition to his best-known ferrocement patent, Nervi also registered other patents in the field of building construction [13, 15, 17] (Fig. 4).

[1] See [25, p. 77]: «il più bel sistema costruttivo che l'umanità abbia saputo trovare fino ad oggi. Il fatto di poter creare pietre fuse, di qualunque forma, superiori alle naturali poiché capaci di resistere a tensione, ha in sé qualche cosa di magico».

Fig. 1 Aerial view of the exhibition center Torino Esposizioni in 1954 (Archivio Storico Fiat)

Fig. 2 Hall C, International Car Show, 1950 (Archivio Storico Fiat)

Fig. 3 Hall B, The first motor show in 1948 (Archivio Storico Fiat)

Fig. 4 This photo of the construction site shows the mobile scaffolding system used to build the vault (Archivio Privato Ravelli)

Only limited interventions and minimal maintenance have been carried out since the complex was completed. The largest intervention was the renovation of Hall B for temporary use as an ice-skating arena during the 2006 Olympic Winter Games (a limited structural assessment was performed for this purpose). The intervention included the addition of mechanical equipment on the roof, a sprinkler system across the structure, and the installation of partition walls under the lateral balconies. Since the change in ownership that occurred in the 1980s, when the complex became the property of the City of Turin, Torino Esposizioni has been in disuse and abandoned for most of the time [8]. After and despite the many years of neglect, in 2020 the complex was finally declared of Cultural Interest (as per Art. 10, para. 1, and Art. 12 of Legislative Decree 42/2004), and thus became a National Historic Landmark.

3 The Path of Knowledge

The CMP was drafted based on an interdisciplinary approach, as is appropriate when working on a heritage structure. In particular, a specific knowledge path was developed that intertwined information from different sources: archival documents, original project documents, photographic documentations, the building code at the time of construction, and oral history [27].

A large survey campaign was carried out using multiple approaches, due to the complex and differentiated morphology of the halls. The first phase of in-depth research and study of the original documents made it possible to understand Nervi's design intentions, to identify each construction element (coding system), and to develop the best strategy for the test campaign. A complex 3D metric survey campaign was undertaken based on laser scanner and photogrammetric technologies (terrestrial and from UAV—Unmanned Aerial Vehicle) to obtain an accurate description of the entire complex, both externally and internally [28]. In addition to innovative solutions in the field of mobile mapping system technologies [2], numerous results were obtained from the study and processing of multiscale and multisensor 3D models. The geomatics team also provided original contributions to the assessment of the structural arches, with their parabolic curves designed by Nervi, and above all to the general digital twinning approach pushed up to defining an HBIM cognitive model [29].

After the 3D survey, an extensive testing program was conceived and executed in both halls [20, 21], which included a wide range of destructive and non-destructive mechanical tests to study and understand the condition of the structural elements, including the reinforced concrete elements and the ferrocement roofing system (Fig. 5). Direct investigations were also carried out on selected areas of the surface of both halls based on historical information and the changes made to the structure over time. This study thus revealed a forgotten feature, that is the polychromies of the halls [3], which were conceived by Nervi himself as an integral and distinctive part of this architecture. The structural analysis and the seismic assessment revealed limited construction deficiencies that are to be primarily attributed to the lack of

Fig. 5 Hall B, after the clearing and cleaning operations for the execution of the tests within the Keeping It Modern project (courtesy of Fabio Oggero, 2022)

seismic provisions at the time of construction [5]. Furthermore, deterioration of the materials was observed on some elements and areas. This could be attributed to the lack of maintenance and the long period of abandonment, which accelerated the deterioration mechanisms of the steel reinforcement.

For the ferrocement system, an experimental campaign was designed and conducted in the laboratory to study the performance and durability of this unique material [7, 18, 19]. Due to limited accessibility during the fieldwork and the fragile nature of this system, various types of mock-ups were created in the laboratory following Nervi's original recipe. Different surface treatment methods were applied to evaluate their effectiveness in minimizing the need for replacement of the original material.

4 The Conservation Management Plan

The CMP consisted of a report accompanied by tables with views of 3D models, orthophotos, graphic schemes, and drawings that summarized all the work carried out during the study phase, based on which the intervention hypotheses had been developed [6]. Each table briefly illustrates the path of knowledge developed during the research phase, based on the deconstruction and coding processes. The deconstruction process, aimed at identifying each construction element, was designed specifically for this case study: it is based on the peculiarities of the "Sistema Nervi" and identifies the elements that were cast on-site, the prefabricated elements, and the ferrocement elements, without neglecting the connection castings needed to guarantee the monolithic nature of the system.

For each construction element, the CMP reports:

(1) A general table for each macro-element (e.g., slab) containing the following fields: *History* (consisting of some historical notes relating to the particular macro-element); *Construction phases* (considered as the constructive and transformative phases in the 1947–1953 period); and subsequent *Transformations* (understood as the most recent transformations, mainly related to the use of the complex); *Coding* (i.e., identification of the sub-elements); *Geometric survey* (containing the information relating to the peculiarities); *Structural Analysis* and *Monitoring*; up to *Possible indirect and direct interventions* (the general tables present extensive interventions which are then detailed in other tables); *Critical Issues* (related to all the analyses considered); and finally, the *Maintenance* schedule.

(2) A detailed table relating to each deconstructed and coded sub-element (e.g., north balcony) and containing additional fields: *Material characterization* (containing specific information derived from historical and bibliographical research); *Analyses* (including results of specific laboratory tests on individual elements or materials); *State of conservation* (related to the specific element considered); *Possible punctual conservation techniques* (including the techniques most suited to the specific element); and *Critical issues* (intended here as interferences between the different analyses, in particular concerning safety and conservation).

Closing, a summary table summarizes the most significant issues of each hall. The aim of these tables is to bring back attention to unitary nature of the architectural complex, after having split it into parts for detailed analysis and accurate design of interventions.

5 Critical Issues

The overall analysis highlighted, as is natural in these cases, some problems of coexistence between conservation and safety, mainly collected within the *Critical issues* section of the general tables of the CMP. The discussion concerns above all the choice of acceptable safety levels for the protection of human lives, especially with respect to seismic action, and the consequent structural improvement interventions that can lead to losing the historical fabric (Figs. 6, 7). In this sense, the case of Torino Esposizioni is particularly complex because it highlights the need to preserve Pier Luigi Nervi's structural concept while also having the building comply with standards on and resist to horizontal actions that could not be taken into account when the exhibition center was originally designed and built.

The actions reported in the general tables of the CMP aim to improve the performance of the construction element, but at the same time highlight the possible conflicts that may arise in case of direct intervention.

Fig. 6 The bichrome area between the beige wall and the brown plinth, visible in the lower areas of the walls of Hall C and the pillars of Hall B

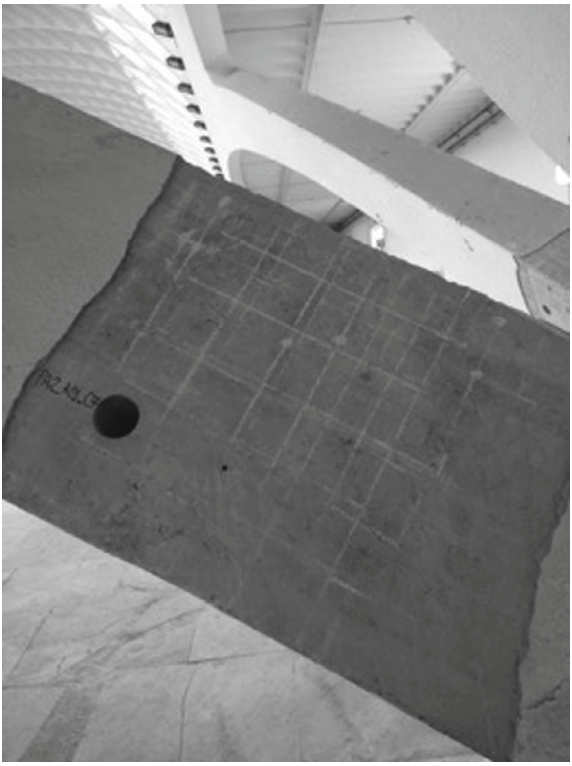

Fig. 7 Grid for non-destructive testing (ultrasonic, rebound hammer, half-cell potential) on one of the inclined arches of Hall C. The grid was also useful for locating the positions of the reinforcing bars and allowed for coring in the most suitable position

6 Present and Future Developments

Interest in the reuse and conservation of this iconic architectural complex started brewing in 2014. At that time, the City of Turin and Politecnico di Torino signed a Memorandum of Understanding for the reuse and conservation of Torino Esposizioni and envisaged a project for re-developing Hall B and transforming it into the new Civic Library of the city. Following this MoU, an international competition was launched for awarding the feasibility study on the proposed location of the new Civic Library; in 2015 it was won by a consortium of professionals formed by ICIS Srl, Rafael Moneo, Isolarchitetti et al. However, despite the interest of the city in it, the project was not realized, due to poor funding.

In 2019 the Getty Foundation of Los Angeles awarded the Keeping It Modern grant to the team led by Politecnico di Torino, as fully discussed in this article. Thanks to the media campaign triggered by this important international recognition,[2] local and regional authorities proposed using part of the residual funds from the 2006 Turin Winter Olympics (Law 65/2012). Also, in the wake of this renewed interest,

[2] E.g. https://torino.repubblica.it/cronaca/2019/07/18/news/la_getty_foundation_di_los_angeles_il_padiglione_nervi_di_torino_esposizioni_tra_i_capolavori_dell_architettura_900_-231469818/.

and before the CMP was completed, in April 2021 the City of Turin, owner of Hall B, received funds from the European Recovery and Resilience Plan (RPP) to be allocated for the rehabilitation of Hall B. In addition, the RPP plan also covered the creation of the new Civic Library in Hall B, together with the rehabilitation of Teatro Nuovo and the redevelopment of the surrounding urban area of Valentino Park. At the same time, S.C.R., the contracting purchasing body of Piedmont Regional Authority, was appointed to monitor and guide the implementation of the project, including its technical and economical feasibility.

As regards the adjacent Hall C, after years of total neglect, in 2011 it was selected by the Foundation PLN Project as a venue for the international exhibition "*Pier Luigi Nervi: Architecture as Challenge*". In March 2022, the City of Turin and Politecnico di Torino signed a Memorandum of Understanding for Pavilion 3a (former Hall C), giving Politecnico di Torino the permission to reuse the pavilion and create additional classrooms and teaching spaces for the School of Architecture.

The final report of the Getty Keeping It Modern project was completed in August 2022. The resulting CMP, released in its final form in spring 2023,[3] aimed to provide detailed information concerning the chronological changes occurred to the building, according to the results obtained from diagnostic evaluations and structural and seismic analyses, as well as a series of guidelines for interventions and maintenance for future preservation work. Thus, the City of Turin has recognized the CMP as the main tool to support and guide the current rehabilitation project of this complex.

The coordination between S.C.R. and the CMP Team led by Prof. Rosario Ceravolo played a fundamental role in the progress of the project plans and activities. The CMP analysis provided a basis for the new Technical and Economical Feasibility Project led by ICIS and for the advancement of the project, within the constraints imposed by the RPP plan, up to the tender phase (Executive Phase) of the work. The project for the new Civic Library was awarded in March 2023 and is currently in the execution phase, led by the construction company Cobar with Abdr Architects, Manens Tifs, and Mjw Structures Massimo Majowiecki. Use of European funds has imposed the project a tight schedule, and therefore the Getty Keeping It Modern Team and the Foundation PLN Project are committed to help the CMP in the implementation and execution of the work for protecting and enhancing Torino Esposizioni as part of Nervi's legacy and an iconic piece of Modern Architectural Heritage belonging to both Italy and the world.

[3] The CMP has been published in the Getty depository (Keeping It Modern report library) (https://www.getty.edu/foundation/initiatives/current/keeping_it_modern/report_library/).

7 Conclusions

In the light of the interdisciplinary path of analysis undertaken, the iconic architecture of Torino Esposizioni and the new function it has been assigned a priori (and Hall B as the Civic Library in particular), it is important to highlight and reflect on some issues.

The complex relationship between form, structure, and function that characterizes Nervi's architecture is crucial when intervening on this architecture. Conservation and safety must coexist in a non-conflicting way, without one prevailing over the other, and fully respecting the original fabric. The issues of safety and conservation should go hand in hand, and this is precisely the approach followed in the preparation of the CMP for Torino Esposizioni.

From the analysis of Nervi's halls, it emerges that identifying for them a new function that is compatible with the existing building can resolve the above-mentioned conflict. Defining an architectural project in relation to a suitable function will make it possible for all (or most) issues to be held together, according to the idea of "integrated conservation".[4]

It is essential that the vulnerabilities and peculiarities highlighted in this study as well as all possible indirect and direct actions and the critical issues they may entail are taken into consideration for developing the architectural project.

Finally, as highlighted in the CMP, the issue of structural safety should not overshadow other conservation issues, i.e., the respect for the original features and fabric of Torino Esposizioni and its polychromy [4].

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[4] See 30.

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Critical Notes on Practical Fallouts of the Stadio Flaminio Conservation Plan

Francesco Romeo

Abstract The current outcome of the Conservation Plan of the Stadio Flaminio in Rome by Pier Luigi and Antonio Nervi are reported. The Plan was carried by Sapienza University of Rome, the Pier Luigi Nervi Project Association and DO.CO.MO.MO Italy within the 2017 Keeping It Modern funding initiative by Getty Foundation. The Stadium, built for the 1960 Rome Olympics, is considered one of the most iconic buildings by Pier Luigi Nervi; notwithstanding this, it was decommissioned in 2012 and is currently in an abandoned state. The developed Conservation Plan was conceived with the primary goal to provide the Municipality of Rome with a tool to promote, support and guide the recovery of the Flaminio. The Plan contributed to the declaration of cultural interest for the Stadio Flaminio, issued on September 27, 2018. The guidelines provided by the multidisciplinary Conservation Plan were implemented in an ad-hoc HBIM to allow their direct use by professionals, researchers, and technicians involved in requalification and recovery interventions. After the Conservation plan completion, in agreement with the Department for Sports and Youth Policies of Rome Municipality, an experimental dynamic testing campaign has been carried out in 2020. In the spring of 2021, significant maintenance works were carried on the grandstand roof. Recently, in a design competition notice launched by CDP Immobiliare and Istituto per il Credito Sportivo, design guidance and graphic documentation related to the Flaminio were based on the Conservation Plan. The critical issues that are currently limiting the effective use of Plan are eventually discussed.

Keywords Conservation plan · Conservation policy · Modern built heritage

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D. Del Curto and S. Salvo (eds.), *Planned Conservation of 20th-century Architecture*, PoliMI SpringerBriefs, https://doi.org/10.1007/978-3-031-67818-9_7

1 The Stadio Flaminio Conservation Plan

1.1 Objectives

> "What makes everything connected with static truth durable? The answer is that what is serious, what relates to nature, i.e. inspired by statics, what has a substantial reason for being built, never tires. It may be more or less expressive, but it has a validity within itself that is absolute. It is a rule to which I have not yet seen any exception. Everything in the construction field that is in accordance with materials, static truth and also with functionality, when this is clear and simple, it is always right; it always has something in itself that withstands the test of time, which is the toughest testing ground for architecture."
>
> *Pier Luigi Nervi*

Established in 2014, the Keeping it Modern programme is an annual grant initiative of the Getty Foundation focused on supporting model projects for the conservation of Modern architecture. In 2017, it included the Stadio Flaminio in Rome by Pier Luigi and Antonio Nervi among the year's awarded grantees [1].

The grant was requested by the Department of Structural and Geotechnical Engineering of the Sapienza University of Rome, the Pier Luigi Nervi Project Association and DO.CO.MO.MO Italy, in agreement with the City of Rome, owner of the building. Scope of requested funding was to finance a research programme needed to develop a Conservation Plan for the Stadio Flaminio, based on analytical investigations of its architecture, structures, materials and construction techniques supported by historic and archival documents and onsite testing. Aim of the Conservation Plan was to provide clear indications and recommendations for the conservation and restoration of the building's original characteristics, with the prospect of restoring its original multifunctional purpose, as a stadium and sports facility.

The Stadium, built for the 1960 Rome Olympics (Fig. 1, 2), is considered one of the most iconic buildings by Pier Luigi Nervi. It is located in a central part of the city, characterized by an exceptional urban context history rooted back to third century BC; an area which today includes other Modern and Contemporary relevant architectures, like the Palazzetto dello Sport, by Pier Luigi Nervi and Annibale Vitellozzi, the Corso Francia viaduct also by Pier Luigi Nervi, the Auditorium by Renzo Piano, the MAXXI Museum by Zaha Hadid and the "Ponte della Musica" bridge by Buro Happold. After having hosted the last official rugby match on March 12, 2011 (Italy—France for the Six Nations Tournament) the Stadio Flaminio was decommissioned in 2012 and it is currently in an abandoned state.

In compliance with overall aim of the Keeping It Modern initiative the Stadio Flaminio Conservation Plan has focused on three main objectives.

The primary objective was to provide the Municipality of Rome with a tool to promote, support and guide the recovery of the building. According to the conservation planning methodology, the plan aims at setting out how to secure the future of the Stadio Flaminio while retaining its cultural significance.

A second objective of the Conservation Plan was to serve as a model for the development of best practices. One of the reasons, if not the main one of the current

Fig. 1 The Stadio Flaminio in 1959 (CONI Archive)

Fig. 2 The Stadio Flaminio gym under the west grandstand (ICCD Archive)

degraded state of the Stadio Flaminio, as well as of other Italian buildings by Pier Luigi Nervi (e.g., Palazzo del Lavoro in Turin), is the lack of exemplary procedures to guide restoration and reuse projects of the Modern Architectural Heritage in Italy.

A third objective has been to back and motivate the listing process of the Stadio Flaminio. The listing is to be considered of crucial importance for sports facilities reuse and conservation practices. While preventing inappropriate alterations, it enables the respect of "ad hoc", usually less stringent, regulations and compliance requirements. The Stadio Flaminio has been listed on September 27, 2018.

1.2 Approach and Methodology

The Stadio Flaminio perfectly matches Nervi's definition of structural architecture: an architecture in which the load-bearing and enclosing functions are carried out by different, clearly identifiable elements; so, the structural system, playing merely a load-resisting role, is visible from the interior and the exterior characterizing the overall appearance. If design excellence is achieved in stadia when structure, enclosure and finishes express at all scales—from overall form right down to the smallest detail—a single concept which functions well, is rich and expressive [2], the Stadio Flaminio has certainly achieved it.

However, when it comes to specialized sports architecture like a stadium, additional multifaceted aspects contribute to make their definition no simple matter. Despite its evident function, a venue for watching sport, an inner-city stadium is an intertwined system of social, urban, and architectural spheres. This is particularly true for the Flaminio, for the uniqueness of its historical role for both the city and the nation, its valuable urban context, and its inspired architectural quality. Aware of such complexity, the Conservation Plan hinges on a multidisciplinary approach aimed to address all attributes and values of the Flaminio's cultural significance.

This significance is put in danger by several vulnerabilities: The achieved usable service life, to be extended by means of proper rehabilitation and cautious seismic retrofitting; lengthy period of abandonment, causing a widespread deterioration of the architectural and structural elements and exposing it to vandalism; lack of listing which, until 2018, exposed the building to major modifications to its original fabric and even to partial demolitions; physiological aging of materials and MEP systems; the stadium medium size capacity, i.e. around 25,000 spectators, often considered either too small for high-category sport events or too large for minor ones.

On one hand, these weaknesses and the significant investments required for recovering the Flaminio Stadium from its current state of decay and bringing it back to life, pose unquestionable challenges. On the other hand, a number of opportunities make these challenges worth to be faced: The Stadio Flaminio is an iconic sport facility, internationally renowned since the 1960 Olympic Games; it is ideally situated in the centre of Rome and it would naturally represent a key point of interest for the Flaminio neighbourhood; according to most recent trends in stadium architecture [3], standing in a central urban area, rather than on the outskirt of cities, it may

become catalysts for regeneration, fueling further developments in terms of cultural, sport and musical events. Moreover, besides the inflexible stadium's seating bowl, the Stadio Flaminio boasts high quality spaces located under the stands, such as an indoor swimming pool and five gymnasia potentially suitable for multiuse design.

1.3 Tools and Guidelines

The conservation planning methodology focuses on the development of a tool for guiding and managing the future of twentieth century architectural heritage by identifying an adequate balance between the preservation of their tangible and intangible values and the need for change, mostly imposed by the evolution of uses. Accordingly, the content of the current plan is organized following a sort of ideal timeline along which the past, present and future of the Stadio Flaminio are sequentially addressed. Moreover, within each temporal frame, the topics are presented in an order that goes from the outside to the inside of the building.

Together with the traditional, paper format of the conservation plan, which is based on texts, tables, drawings and images, a digital BIM implementation of the sport facility was carried out in parallel.

The implementation strategy entails the conservation guidelines covering the outdoor areas surrounding the Stadium, the architectural, structural and MEP systems aspects. The recommendation pertaining intrusive elements and deteriorated building materials also are reported. To organize the indications and ease the access to the guidelines, besides detailed redrawing of the stadium typical portions that exemplify its architectural and constructive specificities, 20 tables pertaining to the main areas have been defined. A second set of 20 tables is also presented to describe the tolerance for change of the principal building components. The digital implementation of the conservation guidelines is embedded in the HBIM platform. The conservation plan is equipped with 42 annexes reporting the supplemental details of the performed structural investigations.

2 The Main Fallouts Conservation Plan

2.1 HBIM for Conservation Plan

The use of BIM for heritage conservation has been extensively investigated in the past decade and several methodological approaches were proposed [4, 5]. The main goal of the HBIM implemented for the Stadio Flaminio was to provide the administration with an information management system that could improve the knowledge of the facility and support an effective management of the conservation plan. Thus, the HBIM developed for the Flaminio had a dual goal: on the one hand to produce

a BIM model in a proprietary format, addressed to professionals, researchers, and technicians for the planning, design and implementation of all future requalification and recovery interventions; on the other, to provide an open format BIM model, used even by "non-experts" as tool for the dissemination of historical and architectural work information.

In this cultural, professional and research context, the digitization work developed for Flaminio was not directly aiming at the production of a recovery/restoration project, as usually happens in most cases of HBIM, but rather to provide a digital tool enabling to implement the multidisciplinary conservation plan guidelines.

Developing an HBIM model for a conservation plan implied to: (i) narrate the historical evolution of the work, from its design stage and realization to its present state; (ii) connect the digital database to all documents in the available physical files; (iii) represent the state of degradation of materials and the cracking pattern of structural elements; and (iv) contain the restrictions, recommendations, and guidelines of conservation policies.

Such an approach, which requires a significant level of innovation in terms of operational methodologies and process organization, enables management and owners of assets of historical and architectural value to operate consciously, in a planned and controlled manner, using an informative and cognitive model of the building, useful for evaluating future investments and optimizing all available resources for the improvement of the work.

The Stadio Flaminio digitalization process, organized according to a data segmentation, structuring and representation procedure, has treated three macrophases, characterized by as many BIM models.

The first macro-phase concerns the modeling of the original project of Studio Nervi, because of the digital translation of the reading and interpretation of the tables of the executive project, found during the archival investigation phase. From the tables found in the various archives consulted, it was not possible to completely reconstruct the stadium. The undocumented elements have been subjected to deduction operations and estimations of the possible geometric conformations. To ensure an accurate philological reconstruction for each element, a parameter that identifies the presence or absence of a reference document and the relative hypertext link that refers directly to the document in question has been assigned.

The model of the original project was followed by the modeling of the current conditions. The reality-based 3D model is the result of the massive survey of the building carried out by laser scanning. From the point clouds it was possible to model the entire building in its current status. The geometric model was implemented with information related to the state of surface degradation, which is possible through the improvement of coded parameters based on the classification and the type of degradation detected.

The digitization process was concluded with the implementation of the guidelines provided by the multidisciplinary conservation plan (Fig. 3). The application of this information took place in two distinct ways, depending on the entity within the model to which reference was made. Therefore, two groups of parameters were set: the first relating to the building areas (playground, terraces, indoor environments, etc.) and

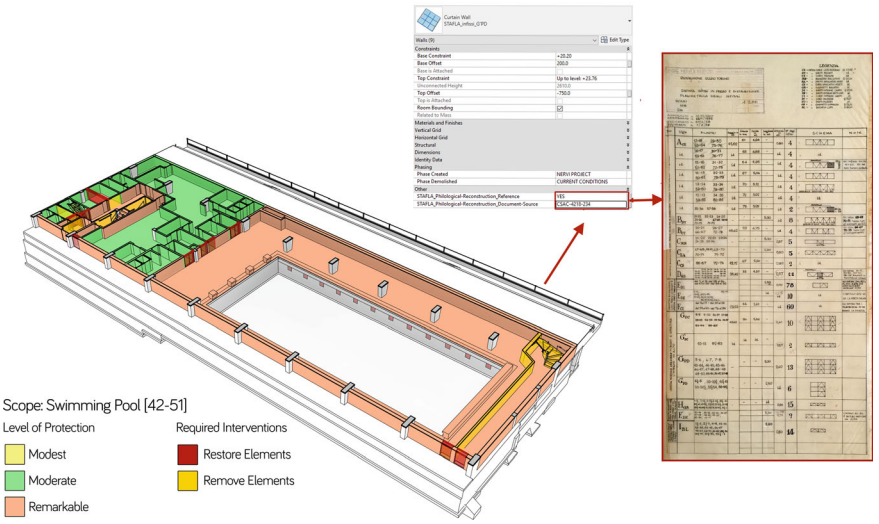

Fig. 3 HBIM including references to source documents and Conservation Plan guidelines

the second to the main categories of elements (frames, fixtures, coverings, etc.). This procedure assigns the levels of importance of the areas and the levels of tolerance for change that are proposed for the main elements.

By resorting to HBIM, the process of protecting and enhancing the architectural heritage becomes collaborative and interactive, optimizing all the resources available to the administrations and supporting the development of a new widespread cultural sensitivity.

2.2 Legal Framework: Protection and Listing Aspects

The creation of a conservation plan for a building or a built context designed and constructed during the twentieth century must consider the evolution of the concepts of protection and monument. This evolution of meaning varying over time and in different social and cultural contexts also involves the concepts of maintenance, reuse, and restoration. All this must take into consideration the conservation of a heritage as a sum of actions that goes from knowledge to recovery, to re-invention. In the contemporary practice of modern architecture protection, the conservation plan is confronted with ensuring the permanence of the heritage work with its original characteristics in a city or territory that is constantly evolving. This implies not only the mere conservation, but also the adaptiveness and resilience of the asset.

Throughout the development of the Stadio Flaminio conservation plan, the Special Superintendence for the Archaeological Heritage of Rome was involved to share the proposed conservation strategies. As a matter of fact, the report based on which the

declaration of cultural interest for the Stadio Flaminio was issued on September 27, 2018, was part of the conservation plan activities. In particular, the listing subjected the Flaminio to the regulations of the Code of Cultural and Landscape Heritage (Italian Legislative Decree No. 42/2004) by leveraging on the significance of the cultural asset to which it belongs as well as on its own historical, technological, architectural, and structural characteristics.

Once completed, the Stadio Flaminio Conservation Plan was submitted to the Special Superintendence of Rome which declared it an "indispensable tool for any future intervention on the stadium" with an official communication dated 29 January 2021.

For the Flaminio, in which reinforced concrete plays a structurally leading role, the implementation of conservation plans' guidelines must deal with the current structural codes in which culturally significant heritage does not receive the attention it deserves. Hence, ideal conservation processes providing a framework that combines concrete repair standards and shared conservation principles may be jeopardized by myopic structural examination. The existing mismatch between conservation and safety instances in reinforced concrete modern heritage buildings and structures can be found in the Italian context. As a matter of fact, the provisions of the current regulations—NTC 2018 standards (Ministerial Decree of 17 January 2018) and subsequent Circular No. 7 of 21 January 2019—ignore reinforced concrete heritage. Thus, the safety assessment of any existing buildings must be carried out in relation to that required for new buildings, allowing practitioners to use simplified procedures leading too often to unacceptable underestimation of structural capacity.

It is worth emphasizing that the stadia conservation in Italy is threatened by the recent article 55 bis, enacted into law in Italy on September 11, 2020, establishing that other public interests take precedence over that relating to the protection of cultural heritage, notwithstanding the constitutional prominence of the latter.

2.3 The Interaction with the Property and the Stakeholders

In December 2016 the Rome Municipality contacted the Pier Luigi Nervi Project Association expressing the wish to initiate a feasible reuse process of the stadium and asking for scientific support to enable it. The conditions were set for a successful candidacy to the Keeping it Modern grant, which was only possible thanks to the full endorsement from the City of Rome and the commitment of the city's officials, who shared from the beginning the wish to preserve and revive the masterpiece by Pier Luigi and Antonio Nervi to its original beauty. The project team was able since the beginning to apply the shared methodology essential for the successful preparation of a conservation plan: the Municipality was informed of every single phase of the research and analysis and proactively participated in the collection of the necessary data, being aware of the criticalities but also of the restoration and reuse potential of the Stadium.

The steady commitment of the municipal administration until the completion of the Conservation Plan led initially to foresee a successful implementation of the conservation plan, laying the conditions for an effective involvement of the different city stakeholders in appropriate interventions and respectful management. However, to date, no initiative has been taken by the municipality of Rome, which continues to take a passive attitude towards this iconic yet fragile piece of architecture.

2.4 Maintenance and Monitoring Interventions

After the completion of the Conservation Plan, further supplemental initiatives devoted to the Flaminio have followed thanks to the support of the Department for Sports and Youth Policies of Rome Municipality. These activities were mostly focused on the roof of the west grandstand that, given its crucial role in the stadium structural organism, appeared to be deserving more investigations.

An experimental dynamic testing campaign has been carried out in 2020. The experimental results were used to calibrate the material properties adopted in the finite element model used to simulate the structural performance of the stadium. Moreover, it was shown how the interpretation of the canopy peculiar dynamics can be used to design a structural health monitoring (SHM) system enabling the assessment of the structural health, the control of the structural degradation, the planning of maintenance works, and the evaluation of the increased structural performance achieved by compatible retrofitting interventions. Apart from the numerical and in-situ characterization of the Flaminio, this activity allowed to delineate a SHM strategy concerning with dynamic response rather different from the more usual frame-like and beam-like behaviour of common buildings and bridges, respectively. The management of the whole SHM process in a heritage building information modelling (HBIM) framework was also planned [6].

In the spring of 2021 maintenance works were carried on the grandstand roof to remove a series of improperly positioned lighting devices and loudspeakers added on the sides of the cantilever and on the thin edge facing the field (Fig. 4). Moreover, some interventions were devoted to limit the widespread biological growth and degradation affecting the rear of the roof caused by rainwater gathering due to the lack of maintenance of the discharge pipes (Fig. 5).

2.5 Stadio Flaminio Redevelopment Proposals

In 2020 a relevant initiative design competition was launched by CDP Immobiliare, a major Italian publicly controlled joint-stock company whose core mission is to foster real estate sustainable development in Italy, and Istituto per il Credito Sportivo. The project area was located between the Villaggio Olimpico, Flaminio and Parioli neighbourhoods, within the Municipality II of the Municipality of Rome. It included

Fig. 4 Ferrocement cantilevered roof after improper lighting and loudspeakers devices removal

Fig. 5 Maintenance works on the grandstand roof. Stagnant rainwater and biological growth before the intervention (left); new gutter waterproofing layer (right)

two major sports facilities, the Flaminio Stadium and the Palazzetto dello Sport, both accessible from Viale Tiziano, and the buildings currently used as horse track on the slopes of Villa Glori, with access from Viale Pilsudski.

The competitors would have to propose an architectural and urban enhancement concept involving in a single organic complex both the two main sports facilities, which together with the viaduct of Corso Francia constitute the system of Olympic facilities built by P.L. Nervi at the Flaminio, and the neighbouring area, to operate in a logic of complex urban regeneration and enhancement. For the area, a transformation and valorisation project should have been proposed, considering the area's evident sporting and cultural vocation, redeveloping, and enriching the existing infrastructures with new sporting functions, putting the entire asset into a system and returning to Rome a regenerated and renewed portion of the city.

In this design competition notice, the design guidance document and graphic documentation related to the Flaminio were exported from the Conservation Plan. Moreover, it was explicitly required for the Nervi's architectures and adjacent open spaces to provide proposals "compatible with the guidelines and recommendations formulated in the Conservation Plan for Rome's Flaminio Stadium, in which the approach outlined by ICOMOS for the conservation of 20th-century heritage of historical and artistic interest has been implemented".

3 Concluding Remarks

The planning of the Stadium's conservation has been developed according to three macro-phases: the recognition of the value of the work and its urban context, the analysis of the current state and the transformations that have occurred over time, and the definition and implementation of conservation policies. The organic development of these phases required multidisciplinary synergies capable of analyzing the material and immaterial aspects that contribute to defining the Flaminio's specificity.

The difficulties encountered so far by the application of the Stadio Flaminio Conservation Plan are related to the cultural inertia affecting the modern heritage. The conservation plan does not set out to make design proposals, it rather provides the criteria, expressed in terms of hierarchies of values and tolerances to change, respecting which the redevelopment project can be said to be correct. In essence, it is a matter of becoming aware that the Flaminio, like every monument of modern architecture, is a vector of material and immaterial values that must be recognised, respected and, hopefully, enhanced for the benefit of the community. It would therefore be crucial for the Rome municipality to acknowledge the opportunities that the Flaminio's cultural value offers and that redevelopment proposals should be able to seize. Initiatives without such prerogatives, driven by local interests, are not acceptable; they would undermine a unique architectural heritage and compromise the proper future use of the facility and the adjacent public space.

The stadium, a specialised building, cannot lose its primary function and, restored to a configuration that does not betray its original conception, must continue to host sporting events for which the regulatory requirements are compatible with its layout. The identity of the original structure to which you refer cannot disregard the urban context in which the stadium is located. A context, that of the Flaminio, of value, in which the initial sporting vocation has been joined in recent decades by a cultural one. The urban poles that characterise it, the Auditorium, the Maxxi and Nervi's other Olympic works, i.e., the Palazzetto and the viaduct of Corso Francia, should therefore be put into a system for the creation of an urban park worthy of a European capital. In addition, the Flaminio has a total area of approximately 9,000 square metres of covered spaces, the largest of which, initially used as a gymnasium of approximately 400 square metres, are of recognised spatial quality. Maintaining the morphological characteristics that characterise them, these spaces have all the potential to host different and new functions.

The critical issues that emerged from the Conservation Plan can naturally be traced back to the different scales on which the redevelopment of the Flaminio is confronted. From the complexity of the reorganisation of the urban space and the landscape, to the urgency of the consolidation and calibration of the structural improvement interventions, up to the choices related to the preservation of the constructive and architectural elements. These articulated critical issues, extensively analysed in the plan, although challenging from a design and management point of view, in no way preclude the concrete possibility of carrying out a sustainable redevelopment and enhancement intervention.

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Spoken into the Void: Conservation Management Planning for the School of Mathematics at Rome's University Campus (Gio Ponti, 1935)

Simona Salvo

Abstract The School of Mathematics built within Rome's university campus in 1935 is one of Gio Ponti's masterpieces. Research and conservation planning for this building have made available a precise understanding of how to preserve the material authenticity of this piece of architecture. Yet, Sapienza's governance appears more engaged with the constant discrepancy between available spaces and ever-growing functional demands required by academic activities rather than with the conservation of this valuable architecture. The Getty Foundation has offered an unrepeatable opportunity to develop research and to concentrate on the development of a strategic approach in order to continue using the building albeit yielding its cultural values and its conservation. But after the publication of the Conservation Management Plan, which could have been adopted as the starting point of a new approach to the preservation of the building, this has been subject to renovation and refurbishment, with replacement of finishes and of architectural elements that are affecting the overall material integrity. Conservation planning efforts and achievements appear to have been spoken into the void.

Keywords Gio Ponti · Sapienza University · Mathematics · Planned conservation · Heritage community

1 Background and Context of the Research

The School of Mathematics, designed by Gio Ponti between 1932 and 1934 and built within Rome's university campus by 1936, is one of Sapienza's most significant historical buildings and is today acknowledged as a true 'architectural gem' by the Italian and the international public.

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D. Del Curto and S. Salvo (eds.), *Planned Conservation of 20th-century Architecture*, PoliMI SpringerBriefs, https://doi.org/10.1007/978-3-031-67818-9_8

Fig. 1 The School of Mathematics at Rome's university campus, front building (photo N. Sardo)

In order to evaluate if and how the Conservation Management Plan drafted for this building between 2019 and 2022 has impacted on its present reality and future conservation, it is essential to consider the broader context of the academic institution within which the building is framed, starting from the relationship between the campus and the city of Rome, and also considering the present-day Italian socio-cultural scenario (Fig. 1).

To this end, it is important to recall that Sapienza is the largest university in Europe—with over 120,000 students, 3,500 professors, 2,100 administrative staff, and a stock of 41 buildings, totaling over 2 million cubic meters—and therefore requires a rather articulated administrative apparatus and a complicated management.

Sapienza is undoubtedly also a very rich and multifaceted cultural environment, with a long-lasting academic tradition. Within this context, the "Roman School" of architectural conservation has found its origins at the beginning of the twentieth century, offering a fertile theoretical setting for the development of conservation planning. This was initially defined in the 1940s by Cesare Brandi, and then further developed by Giovanni Urbani, triggering an elaboration process that is far from concluded. Moreover, scientific research carried out by scholars within Sapienza is largely responsible for the historical knowledge about the specificities of campus, especially (but not only) in the fields of architecture and engineering [12]. The experience discussed here thus represents a point of arrival of an investigation process that has sedimented over the years.

Nevertheless, appreciation and attention granted by Sapienza to the university campus as architectural heritage have not been constant over time, and scholars have not always shared equal admiration for this architectural complex, first and foremost due to the evident political-ideological implications of the achievement of the campus with the Fascist dictatorship. The survival of this and other buildings of the "Ventennio" should be attributed to the Italian inclination to preserve existing artifacts rather than to demolish them, which relies on a somewhat "uneven" consciousness.

Despite the rapid growth of research and critical literature, conservation (and unfortunately also essential maintenance) of Sapienza's architectural heritage has often remained a statement of principle. This for at least two fundamental reasons: on the one hand Italian culture seems more likely to invest in the "restoration of monuments" understood as a decisive and ingenious act, rather than in a long-lasting care and safeguard of cultural heritage. On the other hand, Rome's university campus has been steadily subject to strong processes of transformation and development, in a constant struggle to settle the unbalance between available spaces and ever-growing functional requirements enforced by academic activities [16], which has been a priority in the management of the campus' transformations since ever.

Even though functional needs are entirely legitimate, they should be reconciled with the recognition of historical and architectural values that have been assessed by legal protection restrictions almost forty years ago. This is especially true in the case of the School of Mathematics.

Instead, design, planning, and transformation of this architectural heritage has rarely leveraged upon scientific knowledge collected within Sapienza itself, except in rare cases [10]. Nor has the Ministry of Culture opposed preservation issues against functional needs expressed by the academic institution, limiting its supervision to the uncritical fulfilment of ritual administrative acts, and thereby confirming the priority of use over historical and architectural values of the campus's buildings.

The above-mentioned situation has been increasingly impacting on Sapienza's architectural heritage, especially lately as the university campus has become an open-air construction site, fueled by massive funding provided by post-pandemic recovery financial plans. Almost every building in the campus is—or will be—subject to works to improve energy performance, to adapt technical installations, to consolidate structures, to review the functional organization, and to comply with anti-seismic and fire safety regulations, all without much reference to scientific knowledge (Fig. 2).

Unfortunately, the School of Mathematics again is no exception in this scenario. Over the decades, the building has been subject to repeated interventions aimed at adapting spaces to the ever-changing needs of teaching and research. Fortunately, extensions, partitions, fire escapes and a good deal of technical installations have entailed additions more than removals until now, so much so that the overall material authenticity of the building has remained almost intact, at least so far [8]. Therefore, the building still retains a substantial "authentic material content", apart from the loss of the original glazing and of the large stained-glass window designed by Ponti and made by the firm Fontana Arte in 1935, which were shattered during the allied bombing of Rome in July 1943. Today, additions are likely to be taken over by more irreversible demolitions, which are already happening with the campaign of

Fig. 2 The huge construction site recently installed at the heart of Sapienza's university campus (photo Salvo, February 2024)

widespread destructive essays implemented to retrieve information about structures and construction details, despite most data has already been made available with recent research. This is the counterproductive result of the scarce consideration for scientific research that Sapienza's technical offices are practicing, again at the cost of the building's material authenticity.

2 Preliminary Research for Conservation Planning

In such context, funding for interdisciplinary research and conservation planning obtained in 2018 from the Getty Foundation appeared to be a very favorable opportunity. The availability of generous financial resources and the attention granted by such a prestigious international philanthropic institution sparked enthusiasm and encouraged to develop an unprecedented holistic study of the building, intended as a potential instrument for its conservation. It seemed therefore credible that a "Copernican revolution" in the conservation of this architectural piece—perhaps also of the university campus—could be started.

However, it was clear that scientific knowledge of the School of Mathematics was indispensable not only to initiate its conservation, but also to spark a truthful and critically grounded interpretation of Gio Ponti's cultural profile, who's latest revival and critical reconsideration after a long-lasting oblivion, had paved the way to the Getty Foundation's interest. Indeed, funding allowed to deepen knowledge far beyond previous research [3, 4] that had been well founded on archival and bibliographical investigation but less on the direct analysis of the architectural and material complexity of the building. As in other projects of the "Keeping It

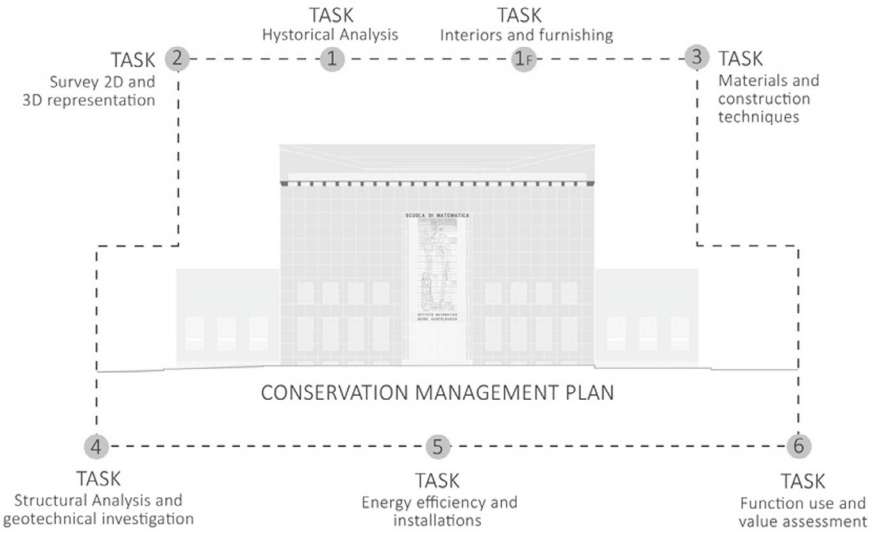

Fig. 3 Organization of interdisciplinary research methodology (© Salvo, 2018)

Modern" program, the aim consisted in acquiring fundamental data to implement a conservation management plan.

Research activity, later completed in 2021 due to the SARS-Cov2 pandemic, branched into six main tasks including the philological reading of the history of the building based on archival and bibliographical sources, on a complete survey with rendering of measured drawings, on the analysis of construction materials and techniques, on the identification of the structural system with static and dynamic verification, on the study of the original and current technical equipment, on investigation around its use over time, and on a philological reconstruction of the interior fittings (Fig. 3).

The research work, described in detail in the final report, outlined three fundamental achievements [13]. Firstly, the detailed retracing of the construction phases based on the comparison between archival documentation and the built fabric allowed a systematic assessment of the historical and architectural value of each part of the building. The original parts designed by Ponti between 1932 and 1934, and completed in 1936, were finally recognized from later transformations and modifications. While the former are imbued with historical value and are therefore untouchable, the latter are to be considered significant only for their sedimentation within the building's daily use, non-reversible for functional reasons, and useful for mere material issues, therefore open to transformation. Such detailed philological reconstruction represents an essential critical tool to design any future intervention.

Secondly, the story of the building's use yielded to particularly useful data to understand the original functional organization of its architecture, today undecipherable due to transformations and additions. Although the building's intended use as

"school of mathematics" has never changed, academic research and teaching have instead radically transformed, both in terms of quality and quantity. This has become especially true since the 1960s, when the Italian higher education was finally "opened to masses".

The gap between past and present use emerges clearly from the fact that Ponti designed spaces calibrated on the presence of only eight professors and for an incomparably smaller number of students than today. The way of "inhabiting" those same spaces—halls, offices, corridors, library etc.—has inevitably changed to adapt to new conditions, but also to the different behavior of students and professors. All in all, only one single functional invariant has been kept beyond so many changes since the 1930s, consisting in the presence of large slate blackboards, which are still an unfailing prerogative for the work of mathematicians (Fig. 4).

Thirdly, a synthetic yet crucial fact emerges from the overall result of the research, which is related to Ponti's original architectural conception of the building. In antithesis to other buildings of the campus, Ponti did not design the School of Mathematics as a "single block", but as the composition of three geometrically and formally diverse volumes, functionally independent and isolated from the surrounding buildings. These three consisted of a prismatic front building, two curvilinear symmetric wings and a three-stories-high tower placed as keystone to the latter, with a large courtyard in the center, an apparently empty space intended as the juncture of the composition.

Although the building still retains a high level of material authenticity, the architecture is visibly compromised by an exponential increase of use and by the persistence

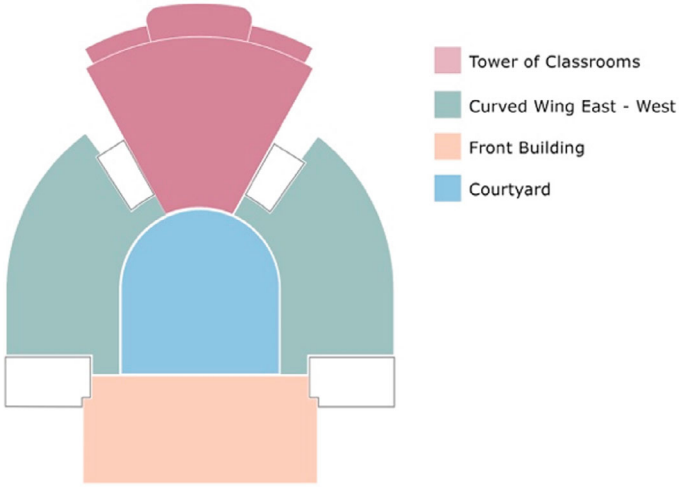

Fig. 4 Composition of architectural volumes corresponding to the original concept of the building (© Salvo, 2022)

Fig. 5 The fire-escape staircases placed in the courtyard in the eighties (photo Salvo, 2021)

of a function that is proving to be a source of danger rather than a value to be preserved. Even more worrying is the enduring lack of maintenance that threatens the survival of finishes and construction elements, especially the various top cornices in concrete and in "faux travertine" stucco crowning the three bodies of the building, which are exposed to aggressive atmospheric agents. To assess the state of conservation and the causes of the building's current state of deterioration, it is therefore necessary to distinguish between manifestations of "physiological deterioration" due to ageing and normal wear-and-tear, and "pathological decay", to be ascribed to excessive and improper use and to a persistent lack of maintenance.

The imminent transformations aimed at complying to fire and to seismic regulations, fueled by exuberant funding in respect to the possibility of providing a careful value assessment, represent an additional major uncertainty to the preservation of the building. The excessive crowding of the building, which is taken as an irreversible fact, will in fact lead either to the installation of further fire prevention facilities in addition to the three bulky metal safety staircases placed in the courtyard in the mid-1980s, or to the replacement of the latter, again to the cost of material integrity (Fig. 5).

3 Conservation Planning: Premises, Contents, Users

The conservation plan proposed for the School of Mathematics is referred to the Italian idea of "Conservazione programmata" [2]. This approach conceives restoration as a critical and conservative process based on scientific knowledge of the building's physical substance and on the assessment of the values at stake, according to a systemic vision rather than to the more pragmatic approach proposed by the Getty Foundation. Although the analysis of the differences between Italian and American approaches to conservation planning is here unappropriated, it may be said in nuce that this lies in the perspective from which the process of conservation is considered.

In the former, the process starts far before and beyond the artifact, in a systemic view that considers all the possible variables in a single coordination; in the latter, it consists of a pragmatic and tolerant approach seeking a sustainable development and adequate balance between values and change.

Although conservation is by now a widely shared principle commendably promoted by the international community and by philanthropic institutions, premises and aims cannot be standardized or understood univocally, especially if considered in different cultural settings. In the Italian meaning, conservation planning is the "methodological" consequence of a "theory" rather than the application of principles as elsewhere in the world [6], which represents a crucial difference in this and other matters concerning heritage conservation.

According to the theoretical premises of "preventive restoration" conceived by Cesare Brandi [7, 9], then elaborated as "planned conservation" and further developed in terms of complex "co-evolutionary dynamics", the degradation of artefacts should be investigated considering the many relations that these establish with their environment. For this reason, the approach to conservation planning in Italy is also closely related to the "Map of Risk" project, a digital information system that frames conservation within strategic planning on a territorial scale [1]. In the case of the School of Mathematics, the physical conditions of the building are also to be considered in the broader context, first and foremost within Rome's urban environment and in the current Italian political, socio-economic, and legal framework.

Planned conservation therefore transfers the principle of maintenance to legal terms, as a complex of conscious actions based on scientific knowledge, and primarily referred to the act of preventing the loss of authentic material. Thus, conservation and maintenance are not a question of enhancing the performance of the artefact to meet the needs dictated by contemporary use: instead, they are a set of initiatives that privilege cultural values, entailing that the artefact may eventually offer sub-par performance levels. For this reason, conservation planning envisages a complex of direct and indirect measures to prevent and control its degradation on large or small scales, and not uncritical "repetitive" actions aimed at keeping the artefact in good working order.

The conservation plan is therefore bound to elaborate research data into predictive terms: in the case of the School of Mathematics, the aim is to respect and reveal the building's original conception as a composition of architectural bodies with different shape, surfaces, uses and accessibility, enhancing the true conception and nature of this piece of architecture. This proves to be an effective key to engage conservation in an integrated manner, regaining harmony and balance in the relationship between conservation issues and use, which ultimately represents the main strategy to keep architecture alive and in good order.

Users are therefore irreplaceable actors of conservation, responsible for spreading awareness of the values at stake and for shaping a participatory and informed approach based on the growth of a sense of appropriation of the place. Indeed, scientific knowledge should be able to permeate into day-to-day management and

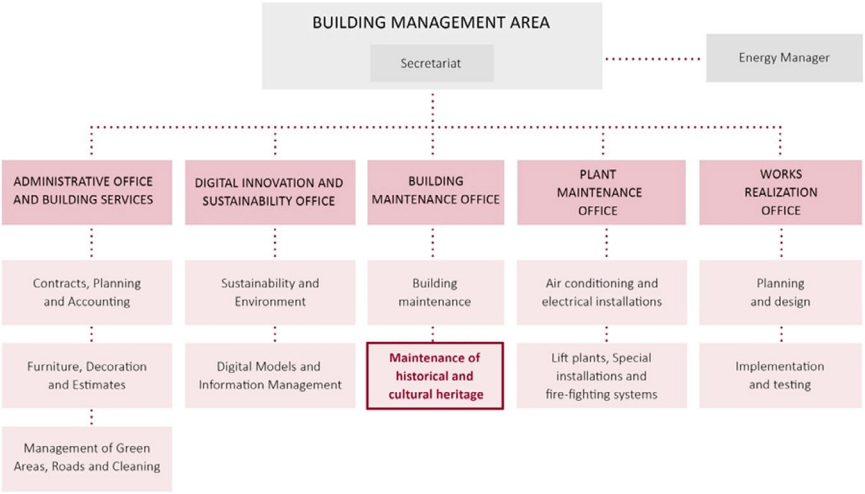

Fig. 6 Organization of Sapienza's technical office in charge for the maintenance of the university's historical and cultural heritage (© Salvo, 2021)

enhance awareness of the values at stake in the inhabitants of the building, such as teachers, students, administrative staff, and especially in those who manage and plan its transformations (Fig. 6).

One current and urgent issue concerns the compliance of the campus buildings to fire regulations, which in the case of the School of Mathematics should be reconsidered in light of the acquisitions outlined by research, and approached adopting an integrated strategy.

Compared to the current horizontal reading of the building, by which escape routes are arranged according to each floor, a general rethinking should reorient planning in order to address the outflow of people according to the same logic established by the original conception of the building. Escape routes could/should be understood according to each volume of the architectural composition and arranged independently. Similarly, the choice to move or resize the fire escape staircases that currently clutter the courtyard should first take into consideration spaces of lesser historical-architectural value, contemplating the different "level of authenticity" of its various parts. On the other hand, a reduction of the crowding in the building by approximately 10% would enable to avoid the addition of new fire prevention facilities, such as fire doors, panic bars, etc., which would entail substantial demolitions (Fig. 7).

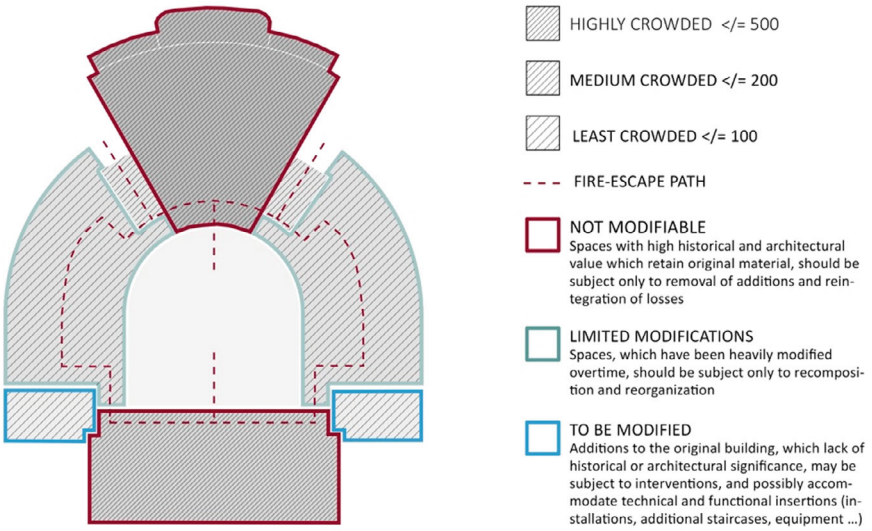

Fig. 7 Plan of fire escape paths, crowded areas, and level of applicable modifications according to historical and architectural values (© Salvo, 2021)

A first set of measures to guarantee the conservation of the School of Mathematics consists in daily actions that should follow the building, *i.e.* monitoring and repairing elements and vulnerable parts. These are then subject to a variety of interventions: most urgent ones are necessary to recover the chronic lack of maintenance, but also preliminary operations, proper conservation, one-time restoration works, and initiatives aimed at enhancing architectural and historic values of the building in order to keep a virtuous circularity between value assessment and protection of the artefact [11] (Figs. 8, 9).

	INTERVENTION		YEAR 1												YEAR 2				YEAR 3		YEARS 4-5	YEARS 6-10	YEARS 10-20
			MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12	MONTHS 13-15	MONTHS 16-18	MONTHS 19-21	MONTHS 22-24	MONTHS 25-30	MONTHS 31-36	MONTHS 37-60	MONTHS 61-120	MONTHS 121-242
BUILDING IN GENERAL	ROOFS	monitoring, and cleaning						*						*				*		*	*	*	*
	WINDOW FIXTURES	inspection, fixing, replacement of broken parts												*				*		*	*	*	*
	SEWAGE SYSTEM AND MANHOLES	periodical unblocking and cleaning						*						*				*		*	*	*	*
	HYDRAULIC SANITARY SYSTEM	Periodical maintenance												*				*		*	*	*	*
	ELECTRIC SYSTEM	Periodical maintenance (elevators and lifts)												*				*		*	*	*	*
FRONT BLOCK	LIBRARY AND BOOKDEPOSIT SKYLIGHT	monitoring of glass cement blocks and window fixture												*				*		*	*	*	*
	LIBRARY SKYLIGHT WINDOWS	monitoring and inspection												*				*		*	*	*	*
	CONCRETE CROWNING	Monitoring and Protection			*			*			*			*		*		*	*	*	*	*	*
	TRAVERTINE SLAB CLADDING	monitoring and cleaning												*				*		*	*	*	*
	LITOCERAMIC CLADDING	Monitoring												*				*		*	*	*	*
	DOWNPIPES	Monitoring and cleaning						*						*				*		*	*	*	*
	WOODEN WINDOW FIXTURES	Monitoring, replacement of broken parts, protection of surface with oil												*				*		*	*	*	*
	METAL WINDOW FIXTURES	Monitoring, minor replacements, cleaning with special products, coating												*				*		*	*	*	*
	FINISHES - MARBLE PAVING	Cleaning, monitoring of slabs and protective treatment												*							*	*	*
	FINISHES - LINOLEUM PAVING	Cleaning and monitoring												*							*	*	*
CURVED WINGS	FAIDE TRAVERTINE CORNICES	Monitoring , cleaning from vegetation, mapping of degradation processes			*			*			*			*		*		*	*	*	*	*	*
	DOWNPIPES	Monitoring and cleaning						*						*				*		*	*	*	*
	WOODEN WINDOW FIXTURES	Monitoring, replacement of broken parts, protection of surface with oil												*				*		*	*	*	*
	METAL WINDOW FIXTURES	Monitoring, minor replacements, cleaning with special products, coating												*				*		*	*	*	*
	FINISHES - PAINTED PLASTER	Cleaning, monitoring																*			*	*	*
	FINISHES - MARBLE PAVING	Cleaning, monitoring of slabs and protective treatment												*							*	*	*
	FINISHES - LINOLEUM PAVING	Cleaning and monitoring												*							*	*	*
TOWER OF CLASSROOMS	DOWNPIPES	Monitoring and cleaning						*						*				*		*	*	*	*
	METAL WINDOW FIXTURES	Monitoring, minor replacements, cleaning with special products, coating												*				*		*	*	*	*
	FINISHES - PAINTED PLASTER	Cleaning, monitoring																*			*	*	*
	FINISHES - MARBLE PAVING	Cleaning, monitoring of slabs and protective treatment												*							*	*	*
	FINISHES - LINOLEUM PAVING	Cleaning and monitoring												*							*	*	*
COURTYARD	PAVING	Monitoring and cleaning of grass joints; check stability of travertine slabs						*						*				*		*	*	*	*
	BASEMENT SKYLIGHTS	Monitoring, minor reparations												*				*		*	*	*	*
FURNITURE	METAL JOINTS AND HINGES	Monitoring, cleaning, lubrification with handy oil						*						*				*		*	*	*	*
	TAPESTRY	Monitoring and control, treatment						*						*				*		*	*	*	*
	WOODEN SURFACES	Monitoring, cleaning, surface treatment						*						*				*		*	*	*	*
ANCIENT BOOK COLLECTION	BOOKSHELVES	Cleaning, removal of dust						*										*		*	*	*	*
	BOOKS AND DOCUMENTS	Monitoring, cleaning, removal of dust, xylophagous insects check			*			*			*					*		*	*	*	*	*	*

Fig. 8 Timetable of maintenance works for the complex of the building; specific indications are also given for each part of the building (© Salvo, 2021)

	URGENT	PRELIMINARY	CONSERVATION TO BE PROGRAMMED	MAINTENANCE TO BE REPEATED *SEE CHRONOPROGRAMME	RESTORATION "ONCE ONLY"	VALORIZATION & ENHANCEMENT "HAULING INTERVENTIONS"
BUILDING	**REGULATORY COMPLIANCE to FIRE ESCAPE LEGISLATION** - installation of firewater ring main in the basement. **REORGANIZATION of FUNCTIONS AND USES** **REORGANIZATION of ACCESSIBILITY** – pairs with compliance to fire safety rules. **ROOFS -** cleaning, removal of dirt, rubble and waste, vegetation. **BASEMENT FLOOR** - cleaning, retrieve of furniture, removal of debris, garbage and dirt. **PLANNING OF INSTALLATIONS REORGANIZATION -** removal of improper interaction of wiring, ducts and cabling of all kinds, with reinforced concrete structures (basement level); reorganization of wiring, ducts and cabling in corridors, aisles and lobbies behind false ceilings. **DOWNPIPES** - Inspection, cleaning, reintegration, and reinstatement of finishes.	**REORGANIZATION of TEACHING ACTIVITY -** decrease of number of users (students and teacher). The scope is to reduce crowding of classrooms, especially tiered lecture hall III, IV, V **NON-DESTRUCTIVE SAMPLING AND ESSAYS** - Planning and execution of further specific preliminary investigations **REDESIGN of FIRE SIGNAGE** – replacement of current system with new design **TRAINING of CLEANING STAFF** - about products to be used, specific accuracy towards furniture, window frames, stone paving, and cladding **WINDOW FIXTURES -** inspection, fixing, replacement of broken parts **HEATING SYSTEM –** Installation of thermostatic valves on all radiators **ENERGY EFFICIENCY -** Improvement of building envelope with addition of double glazing, where possible **REPLACEMENT** of lighting with LED bulbs and lamps **INSERTION** of timer s for automatic switching-off of lighting system according to time/use/area	**FIRESCAPE STAIRCASES** - removal and re-establishment of corresponding finishes: door and window fixtures of the Tower of classrooms, courtyard paving plastering of facades. **SEWAGE SYSTEM AND MANHOLES** - unblocking and cleaning **REINFORCED CONCRETE STRUCTURE -** repair elements damaged by oxidation / spalling / blemishes	**ROOFS** – monitoring, removal of dirt, rubble and waste and cleaning every 1 year **WINDOW FIXTURES –** inspection, fixing, replacement of broken parts **SEWAGE SYSTEM AND MANHOLES** - periodical unblocking and cleaning **DOWNPIPES** – Inspection and cleaning		**REDEFINE THE PROTECTION DECREE –** revised value assessment and inclusion of furniture CONTINUE **ARCHIVAL RESEARCH** (see box 1) COMPLETE INVESTIGATION ON **MATERIALS AND CONSRUCTION TECHNIQUES** with minimal destructive sampling with support of scaffolding and /or movable arms (see box 3) COMPLETE INVESTIGATION ON **LOAD-BEARING STRUCTURES AND TESTS ON CONCRETE** (see box 4) COMPLETE SURVEY OF **ENERGY EVALUATION AND DEFINE COMFORT VARIABLES** (see box 5) **CONTINUE SCIENTIFIC DISSEMINATION** **INSTALLATION OF NIGHT LIGHTING SYSTEM** **REORGANIZATION OF ENTRANCE AND SURROUNDING PUBLIC SPACES** **REORGANIZATION OF INDAM -** delocalization to other prestigious seat or reorganization within the building
	URGENT	PRELIMINARY	CONSERVATION	MAINTENANCE TO BE REPEATED *SEE CHRONOPROGRAMME	RESTORATION "ONCE ONLY"	VALORIZATION & ENHANCEMENT

Fig. 9 Conservation Management Plan for the complex of the building; specific indications are also given for each part of the building (© Salvo, 2021)

	URGENT	PRELIMINARY	CONSERVATION	MAINTENANCE TO BE REPEATED *SEE CHRONOPROGRAMME	RESTORATION "ONCE ONLY"	VALORIZATION & ENHANCEMENT
CURVED WING EAST	**REVISION OF COOLING TOWERS**	**REPLACEMENT** of individual heating and cooling system with centralized system	**FACADES** - investigation of detached patches of plaster, removal of last layer of paint, consolidation, painting with lime-based paint with apt color. **STONE INSCRIPTION** - inspection of anchoring system and cleaning		**CLASSROOMS at I LEVEL** – reinstatement of distribution aisle on courtyard side and remodulation of single classrooms. **OFFICES at II LEVEL** – reinstatement of distribution aisle on courtyard side and remodulation of single classrooms **TREATMENT OF SURFACES** – removal of red paint, reintegration and consolidation of plaster and reestablishment of clear color (white-travertine).	
CURVED WING WEST	**REVISION OF PHOTOVOLTAIC SYSTEM**	**REPLACEMENT** of individual heating and cooling system with centralized system	**FACADES** - investigation of detached patches of plaster, removal of last layer of paint, consolidation, painting with lime- based paint with apt color. **STONE INSCRIPTION** - inspection of anchoring system and cleaning	**DOWNPIPES** - monitoring **METAL WINDOW FIXTURES –** Monitoring, minor replacements, cleaning with special products, coating **WOODEN WINDOW FIXTURES –** Monitoring, replacement of broken parts, protection of surface with oil **FINISHES - PAINTED PLASTER -** Cleaning, monitoring **FINISHES - MARBLE PAVING -** Cleaning, monitoring of slabs and protective treatment **FINISHES - LINOLEUM PAVING -** Cleaning and monitoring	**OFFICES at I LEVEL** – reinstatement of distribution aisle on courtyard side and remodulation of single classrooms **INDAM -** Redistribution and reorganization **TREATMENT OF SURFACES** – removal of red paint, reintegration and consolidation of plaster and reestablishment of clear color (white-travertine)	
TOWER of CLASSROOMS	**FAKE TRAVERTINE FLASHINGS** - consolidation, cleaning, reintegration, protection. **PREVENTION FROM DAMAGES TO FIXED FURNITURE IN THE TEARED LECTURE HALLS** (students' and teachers' desks) -	**REQUALIFICATION** of the original thermo-ventilation system	**ELEVATOR** – revision of electrical system, minor replacements, cleaning and protection of surfaces **FALSE CEILINGS in TIERED LECTURE HALLS** – removal and restoration of original ones	**DOWNPIPES** - monitoring **METAL WINDOW FIXTURES –** Monitoring, minor replacements, cleaning with special products, coating **FINISHES - PAINTED PLASTER -** Cleaning, monitoring **FINISHES - MARBLE PAVING -** Cleaning, monitoring of slabs and protective treatment **FINISHES - LINOLEUM PAVING -** Cleaning and monitoring **CURTAINS** - Replacement in the tiered lecture halls	**TIERED LECTURE HALL II LEVEL** - removal of partition wall and reinstatement of one hall. **OUTER SURFACES** – removal of red paint, reintegration and consolidation of plaster, layer of new paint color on philological basis (white-travertine?)	
	URGENT	PRELIMINARY	CONSERVATION	MAINTENANCE TO BE REPEATED *SEE CHRONOPROGRAMME	RESTORATION "ONCE ONLY"	VALORIZATION & ENHANCEMENT

Fig. 9 (continued)

	URGENT	PRELIMINARY	- CONSERVATION	MAINTENANCE TO BE REPEATED *SEE CHRONOPROGRAMME	RESTORATION "ONCE ONLY"	VALORIZATION & ENHANCEMENT
COURTYARD	**MAINTENANCE OF CURRENT FIRE SAFETY STAIRCASES -** in wait of changes to the general safety plan	**PAVING** – readjustment of travertine irregular slabs and reestablishment of grass joints	-	**PAVING** - maintenance of grass joints; check stability of travertine slabs. **BASEMENT SKYLIGHTS** - Monitoring, minor reparations	**REMOVAL OF FIRE SAFETY STAIRCASES**	**PERIODICAL STAGING of THEATRICAL PERFORMANCES** – in agreement with the department of Ancient Studies, Sapienza University
FURNITURE	**REMOVE PIECES FROM BASEMENT** - select furniture pieces that are subject to excessive usury, damaged or in bad conditions. **PRELIMINARY INVENTORY** - labeling and cataloguing of each peace, collection and recovery of furniture pieces in the basement and in other building of the campus.	**INVENTORY** – Coding of furniture – fix or movable – with number corresponding to catalogue.	**CLEANING CONSERVATION AND PROTECTION OF PIECES** **MINOR REPLACEMENTS IN FIXED AND MOVABLE FURNITURE**	**METAL JOINTS AND HINGES** - Monitoring, cleaning, lubrification with handy oil. **TAPESTRY** - Monitoring and control, treatment. **WOODEN SURFACES** - Monitoring, cleaning, surface treatment	**MAJOR REPARATIONS AND REPLACEMENTS** **REPLACEMENT OF DAMAGED PIECES**	**PHILOLOGICAL RECOMPOSITION OF ONE INTERIOR WITH ORIGINAL PIECES** **REVISION OF PROTECTION DECREE –** Inclusion of furniture within specificities. CONTINUE **SURVEY AND INVENTORY OF FURNITURE** (see box 1f)
ANCIENT BOOKS COLLECTION	**EVALUATION OF RISKS (fire, humidity, insects, ...)**	**REORGANIZATION AND SHIFT OF COLLECTION TO APPROPRIATE ROOM** **PROFESSIONAL CLEANING and DUSTING** of the books, especially on open shelves **INSTALLATION OF SPECIAL MICROCLIMATE SYSTEM** for ancient books collection storage room	**INSTALLATION OF SPECIAL FIRE SAFETY SYSTEM IN THE ROOM FOR ANCIENT BOOKS COLLECTION** **INSTALLATION OF THERMO-HYGROMETRIC REGULATED SYSTEM AND MONITORING**	**PERIODICAL REMOVAL OF DIRT FROM BOOKSHELVES AND SPECIALIZED CLEANING OF ANCIENT BOOKS COLLECTION**		**ORGANIZATION OF DIDACTIC VISITS AND EXHIBITIONS**
	URGENT	PRELIMINARY	CONSERVATION	MAINTENANCE TO BE REPEATED *SEE CHRONOPROGRAMME	RESTORATION "ONCE ONLY"	VALORIZATION & ENHANCEMENT

Fig. 9 (continued)

4 "Overturning the Pyramid": Conservation and the Academic Community

It is difficult to identify and measure the impact of the Conservation Plan drafted for the School of Mathematics on the true reality of the building, only shortly after its publication in 2022; moreover, the academy, and the Country as a whole, are currently experiencing a condition of uncertainty and exceptionality. Consider, for example, that the propensity of young people to enroll at university courses has unexpectedly grown after the pre-pandemic stagnation, upsetting the forecasts that were predicting its deflation, at least in some scientific field. However, some observations may contextualize the plan's (unlikely) future effectiveness on the conservation of the monument, or its (predictable) lack of influence. Above all, those who have been involved in this experience are urged by the feeling that time, resources, efforts, and enthusiasm invested in this project have fallen into the void.

In any case, it is also well known that systematic and predictive planning tools—as conservation plans—are hard to combine with the Italian way of managing public assets, typically based on responding to emergencies rather than preventing them, which is a logic that is opposite to prevention.

In the context of a huge, complicated, and dispersive organization such as Sapienza, the adoption of a planning tool encounters even greater difficulties. It should also be considered that design and planning regarding its assets are entirely entrusted to professionals that are external to the Technical Office, due to the absence of a broad and integrated vision that coordinates changes on a large scale and over time.

Additionally, the impact of conservation planning should be also reconsidered within the Italian legal framework, and certainly within the new regulations for public procurement [14], which explicitly pursue a pragmatic "principle of good performance and related principles of efficiency, effectiveness and economy", but make no reference to conservation instances to be respected in case of urban and architectural heritage. More specifically, the new code obliges recourse to digitalization at every stage of the design and contracting process, and encourages the implementation of digital models, such as the so-called BIM. This is a positive tool, as it can be extended and modified over time as required by conservation planning; but obviously the uncritical use of digital technology runs the risk of overriding information content.

Despite being a worthy initiative, the recently promoted survey campaign for the development of digital models of Sapienza's building stock—including the campus' buildings, and the School of Mathematics—cannot replace the understanding of such articulated heritage, nor can this be an instrument to control and orient conservation and transformation planning itself. Although it represents a salient step in the process of building analysis, surveying does not provide scientific knowledge per se even if massive in data, nor does it allow an automatic recognition of features and values of an architectural object. It is unthinkable to expect that digital surveying activity can

detect immaterial data, such as the complexity of historical layering, the relationship with the context, the state of conservation of materials, and other fundamental information in view of the conservation and enhancement, if not duly integrated by critical interpretation. On the other hand, to "typify" the characteristic of any architectural artefact through survey is another example of wishful thinking, as it implies the flattening of the complexity of reality, which is anything but homogeneous. Grids, structural meshes and axes of symmetry, overlapped to point cloud survey as geometrical references to achieve a "digital twin" of the artifact with a correct level of global coherence (the so-called LOR), are superstructures that blur reality, which instead proves to be irregular, asymmetrical, and reluctant to parametric reduction. Conceived as such, a digital information model at best allows the reproduction of the shape of elements according to the principles of serial production, envisaging repetition and standardization. It is therefore evident that there cannot be an "algorithmic correspondence" between architectural artefact, numerical model, and parametric model, because this represents a "transfer" that, at best, can support data already acquired, not a system revealing reality (Fig. 10).

Rather than on economic resources, and instead of widespread surveying and digital modeling, it would be desirable to count on a shared planning activity, based on dialogue and collaboration among the constituent parts of the academic body—the technical, the administrative and the scientific—or at least transferring the flow of knowledge produced by research into decision processes regarding Sapienza's architectural heritage, more and foremost in the case of the School of Mathematics.

In a more collaborative scenario, the evident discrepancy between the content of the protection decree of 1989, and the knowledge developed around the building could be easily bridged by updating the document with specific addenda. In the case of the School of Mathematics, specific attention should be borrowed for the protection of

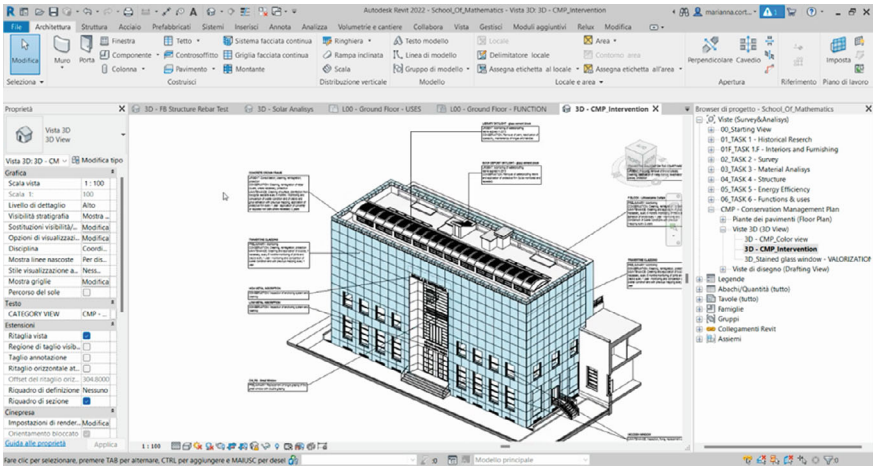

Fig. 10 The H-BIM model produced for the School of Mathematics to support data achieved through scientific research and corresponding conservation means (© M. Cortesi, 2021)

the interiors than feature valuable fixed and movable furnishings, which could refer to the accurate documentation of the pieces, today made available by the Conservation Plan [13].

A hopeful "overturning" of the decision-making pyramid, which currently branches out from the top of the university to single departments and technical-administrative bodies, could reinforce the sense of responsibility towards architectural heritage in those who daily inhabit university buildings. These are in fact imbued not only with historical values but also with important personal and affective memories that develop a sense of appropriation in the academic body, giving shape to a "heritage community". This even more true in the case of university buildings where the sense of scientific and specialized contribution is structural, as stated in the Convention on the value of cultural heritage for society, so-called Faro Convention, of 2005 [5].

On the academic side, a greater awareness of the responsibility that the management of such a rich but controversial heritage implies is probably necessary, and also the development of a major ability to impact reality. These are two limits that challenge the academic world, underlining—albeit indirectly—the urgent need to preserve built heritage. Probably only a generational change will guarantee a future to its conservation, if qualified by a renewed sensitivity.

Acknowledgements Research activity, coordinated by Simona Salvo, has seen the participation of researchers from Sapienza University, more specifically Carlo Bianchini (project manager), Simona Salvo (Conservation Management Planning and research manager and coordinator), Antonella Greco, Marzia Marandola, Annarosa Cerutti, Alberto Coppo (historical investigation, bibliographical and archival research), Flaminia Bardati, Chiara Turco (interiors and furniture), Alfonso Ippolito, Martina Attenni (Survey and Representation), Marianna Cortesi, Simone Castellan (uses and value assessment); Elisabetta Giorgi, Luisa Pandolfi, Maria Laura Santarelli and Maria Carla Ciacchella (materials, construction techniques and state of conservation); Laura Liberatore †, Luigi Sorrentino, Ilaria Martella (structural analysis) and Giuseppe Lanzo (geotechnical investigation); Francesco Mancini, Giada Romano, Maria Rosso (technical equipment and energy efficiency). Nicolò Sardo has curated the photographic documentation.

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