

Digital Tools for Heritage Preservation and Enhancement

The Integration of Processes and Technologies on 20th Century Buildings in Brazil and India

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Abstract. Currently the 20th century architectures are all over the world in danger and under attack: these buildings (in many cases designed by international renowned professionals) are facing a silent destruction. Day by day they are slowly modified in terms of materials, volumes, colours or even demolished. These architectures are still used for public purposes or as residential buildings but they are usually in bad conditions and their state of materials conservation is quite poor. This on-going research explores in depth the possibility to preserve and valorize modern heritage in Brazil and India by the integration of 3D tools, processes and technologies in order to face the future preservation challenges. Soon after the research process the main topics of the project were evaluated and studied to create the bases for a structured research path. In parallel the case study assessment was able to identify suitable buildings (both in Brazil and India) on the which the chosen topics are now being applied in order to improve the knowledge on the design process and reach a guidelines proposal for the preservation and enhancement of these architectures.

Keywords: 20th century architecture · Modern architecture · 3D tools · Technologies · Heritage enhancement

1 Subject of the Scientific Research

1.1 State of the Art

The global research on modern architecture started few decades ago but it has already involved many historians, academics, curators, writers, archivist and journalist: people who lent their knowledge and time in order to better understand a miscellaneous phenomenon. In this wide research field the global exchange of architectural ideas and forms over the 20th century is an important characteristic to be highlighted which came from the geographical movements and migrations of architects and engineers.

Modern buildings are apparently less sensitive to minor changes as those of earlier historic periods. To preserve this massive built heritage it is essential to understand their history and fundamental design principles. If we really want to cure the buildings diseases, like doctors do, we should know the anamnesis of patients, their background

and causes of illness. The design of windows, for example, often is the most interesting part of their architectural characterization. Modern buildings are, for their concepts, shapes, materials, perfect case studies to explore the integration of 3D technologies and heritage conservation (and valorization toward the transmission of knowledge to future generations).

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Despite the wide range of modernist buildings in global south countries (previously known as developing countries), architecture history books focus on the Western scenario of this style. As stated by Lu (2010, p. 1) “with the exception of the work of a very small number of acclaimed architects, little attention was devoted to modern architecture in third world which was considered merely lesser forms of Western modernism”.

1.2 Anthropological Background

The research on the strong relation between the new modernism principle influence in South America and Asia and the anthropological effect on local societies and styles could help to better understand this tangible (and also intangible) heritage toward its preservation and enhancement. A more anthropological approach is needed to identify the transcultural principles underlying the design of modern buildings in India and Brazil: as recently stated by the Italian sociologist Domenico De Masi, these are currently the last two countries bringing a sort of humanism within their deep cultures. On the one hand Brazil is the land of the corporal humanism due to its image of “country of happiness”, where things are very often related to the curves of human body (for instance Oscar Niemeyer architectures²), on the other hand India is the country of spiritual humanism, a place where souls and thoughts merge and spread out a sense of deep personal involvement in every visitor³.

Transformation/adaptation process on modernism buildings in Brazil and India could be defined as a kind of architectural transculturation phenomenon. The term transculturation has been coined by Cuban anthropologist Fernando Ortiz in 1947 to describe the transition process of merging and converging cultures. Transculturation does not consist merely of acquiring another culture (acculturation) or of losing or uprooting a previous culture (deculturation). Rather, it merges these concepts and additionally carries the idea of the consequent creation of new cultural phenomena (neoculturation)⁴.

Brazil and India have strong relations with migration influxes or outflows that influenced local art and culture. Also the architectures of this countries have always reflected

¹ Macdonald (1996).

² Philippou (2008).

³ De Masi (2014).

⁴ Ortiz (2002).

this views, especially the ones from the twentieth century buildings designed by the great masters of modernist architecture in a period of incredible flow of ideas and concepts and sharing of cultural backgrounds.

In this wide scenario the nationalist movements coincide with the modernist architectural thinking and the promotion of an international style. Architects responded to the increasing challenges in different ways, some employed technological innovations, others got inspired from vernacular solutions to design regional interpretations modern architecture principles⁵.

2 Methodology

The research is exploring by deep study 3D technologies for the heritage conservation, highlighting the current state of art, opportunities, processes and possible future challenges.

The research themes are:

- Twentieth century architecture framework in India and Brazil
- Documentation processes and technologies

The Research process is based on the evaluation of:

- Architects migration flows and related transculturation phenomenon
- Materials of modern architectures in Brazil and India
- Preservation framework on modern architectures in Brazil and India
- Digital archives and database use for heritage enhancement
- 3D modelling for documentation
- Non-invasive technologies

In selection process the main topics of the research project were evaluated and studied in order to create the bases for a structured research path. In parallel the case study assessment identified suitable buildings as possible case studies. The main selection process steps were:

- Selection of case studies (200 buildings analyzed)
- Selection of the most suitable topic to be applied on case studies

In application process the chosen topic are currently being applied to the most suitable case studies in order to reach a design proposals guidelines based on local context and environmental issues. The research main topics are:

- Data sheet and representation techniques (applied on 80 buildings out of 200)_Sect. 3.1
- BIM approach (applied on 20 buildings out of 200)_Sect. 3.2
- 3D laser scanner survey (applied on 3–4 buildings out of 200)_Sect. 3.3

⁵ Lang et al. (1997).

The innovative building materials and structural systems of these modern architectures are at the same time warts and all. On one hand modern architects were brilliant and very creative on the other they not always had enough knowledge on the nature and behavior of new materials.

This research could actually help towards the creation of local management plans that could guide long-term maintenance of buildings and the transmission of modern design principles (Fig. 1).

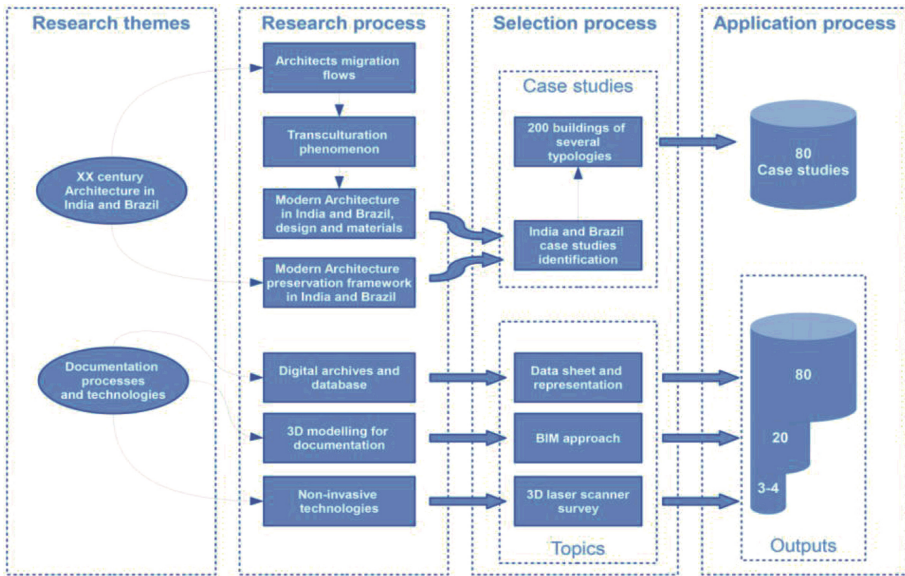


Fig. 1. The research methodology

3 An Heritage in Danger: Topics Application

3.1 Representation Techniques: The Redrawing Process of Modern Architecture in India and Brazil

If time has slowly switched off the power of the transformer dreams of modernist architects, their buildings are a legacy of extraordinary value that should be protected and enhanced as it is a collection of real lessons of architecture. For this reason, the in-charge teachers of the course of Techniques of Architectural Representation (TRA) a discipline of the second year of Architecture Curriculum at the Department of Architecture of the University of Ferrara, decided to analyze by different groups of students the heritage built in the vast and heterogeneous Indian and Brazilian contexts.

In 2016, for the third consecutive year, through the works of the greatest architects of the period it is possible to browse an important slice of history of architecture, passing by the national identity search for specific local features, an architecture that is eclectic, hybridized, which addresses the theme of living, of dwelling, with a completely new

and varied language of a different symbolism from that of the past, redesigned with poetry and sharpness.

The use of drawings in order to carry out analytical reviews of the archival heritage of 20th century architectures in India and Brazil can reveal design experiences that reflect the different territorial contexts from which they emerged and the cultural forces behind them. The so called “survey of the project” was the adopted methodology: by analyzing and redrawing the original documents using innovative graphic layouts the research can highlight the potentials of these built heritage.

The aspects taken into account in this phase describe the complexity of the study and the need of well-structured data. The process led to a very good understanding of the designer’s work by the interpretation of original drawings, scheme and pictures, that reveal the design process behind the construction.

The deep knowledge of the buildings, carefully selected and analyzed with a precise methodology and representation techniques, had as outputs an exceptional variety of ideas for further research and reinterpretations. For example the study of demolished modern buildings or the reconfiguration of different design hypothesis for the most important buildings of this period (Fig. 2).

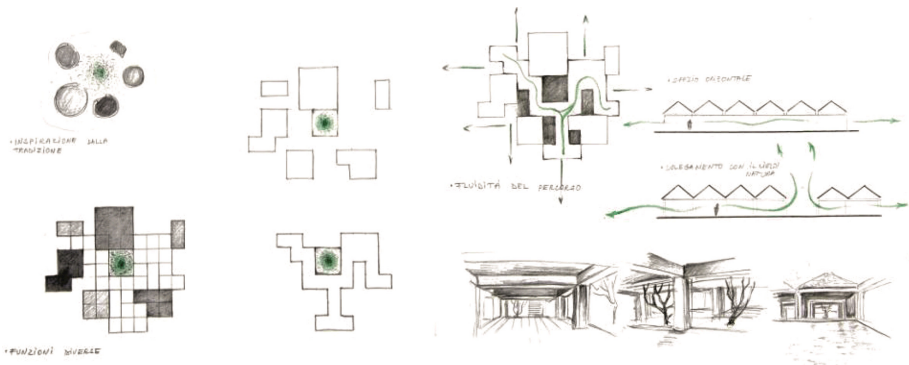


Fig. 2. Redrawing and understanding the modern architecture: Gandhi Ashram in Ahmedabad by Charles Correa. Research and drawings by A. Sousa, I. Bulgaru, M. Abdelhaj

3.2 BIM Approach: Modelling Ramkrishna House House in Ahmedabad, India, by Charles Correa

The elaboration of digital models by Ferrara University Architecture Department staffs has gone through a careful planning and guided process in the field of BIM (Building Information Modeling), a virtual three-dimensional space in which each component can be called full-scale, integrating all information related to the geometry with details concerning the materials employed, the phases of realization, costs, technical characteristics, and by linking the building with environmental factors (Fig. 3).

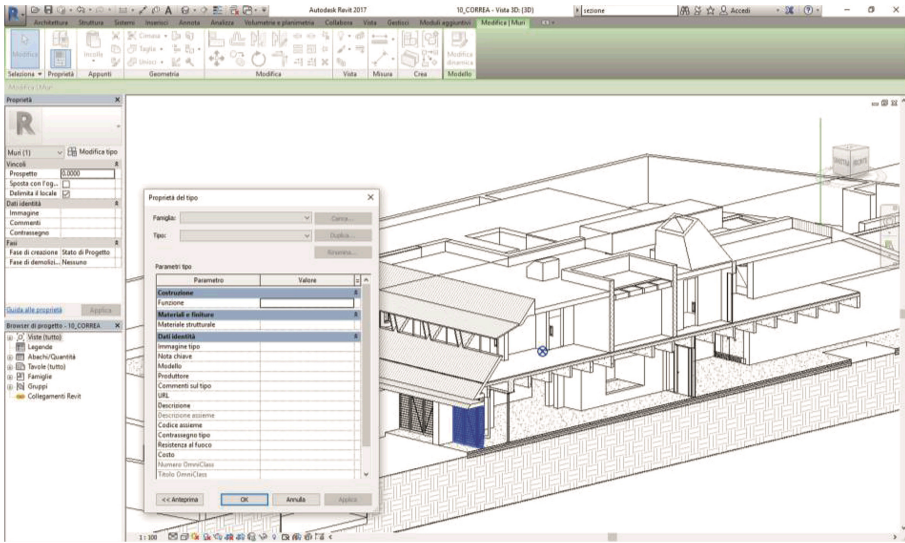


Fig. 3. Ramkrishna House in Ahmedabad, by Chalres Correa, Revit 2017[®] BIM model by E. Ranuzzini, O. Ballardini, D. Felloni.

In this framework, the Development of geometrical single-disciplinary Building Information Model (BIM) of the Ramkrishna House in Ahmedabad gave to research team basic shared knowledge of the data harvested from the documentation analysis and it will help to manage all information about the building.

The house, designed by Charles Correa, presents parallel walls which form the backbone of its plan, a structure divided into 4 main zones: living areas, guest rooms with private garden, service area and bedrooms on the upper floors.

Built between the 1960 and 1962 the house explores the ideas related to dwelling issues in India in strong relation with climate challenges⁶.

The BIM model of this architecture has been created taking advantage of the documentation research on Charles Correa drawings. The picture of the original construction were thus utilised in order to study the materials framework. Beside being a strong base spatial research and study by this model was also used in order to create a virtual reality (VR) model. Software as V-Ray use a proprietary stereoscopic rendering camera to generate a 3D environment with existing Revit cameras, lighting and materials. With this environment it was so possible to generate photo-realistic images of the Correa project to give to the public a sense of what the house look like by creating a VR “map” of a building inside and out (Fig. 4).

The key passages of the BIM creation were focused on: acquisition of building data, integration of other sources of information able to describe the built heritage, definition of reference geometries for architectural components, development/detailing of the

⁶ Scriver and Srivastava (2015).



Fig. 4. Ramkrishna House in Ahmedabad, by Chalres Correa: original pictures (left side) and photo-realistic views (right side). Rendering by E. Ranuzzini, O. Ballardini, D. Felloni.

building as 3D digital reconstruction, and implementation of instruments for the exploitation of the model between valorization and management.

The advantages associated to the approach proposed concern the flexibility of the instruments adopted, the quality of the results obtained in terms of precision and level of detail, and the possibility of communication between the product developed and other solutions oriented on the exploitation of the building through the model.

The final output of this 3 years BIM research highlighted a strong synergy between building management and valorization approaches through the workflow. Future perspectives of this scenario are related to the diffusion of accurate methods for the acquisition of building data and the development of 3D models. Building Information Modelling methodology is increasingly penetrating into building design. Currently laser scanning appears to be the ideal solution for data acquisition on existing buildings. It allows the quick and precise high definition capture of 3D data. The challenge here is to create a parametric 3D BIM model from the precise depiction of the real world, in the form of a point cloud. For instance point snapping allows the precise remodelling of the point cloud regions with 3D BIM elements.

This diffusion may bring a wide and common evolution, influencing management strategies of cultural heritage currently adopted in India and Brazil with the optimization of management strategies and improvement of knowledge on modern heritage.

3.3 3D Laser Scanner Integrated Survey of Casa das Canoas, by Oscar Niemeyer, Rio de Janeiro, Brazil (1951)

Designed by Niemeyer in 1951 as his family home, Das Canoas House is considered one of the most significant examples of modern architecture in Brazil and is well recognized by specialists in art history as a synthesis of modern architecture and authorial self-creation that flourished in Europe and in America (Fig. 5).



Fig. 5. Casa das Canoas (Rio de Janeiro) by Oscar Niemeyer

The most interesting feature is the fusion of organic architecture and minimalist architecture. As it is an obvious tribute to the Farnsworth House, Das Canoas puts geometric regularity in crisis, but does not alter the formal purity. From Mies design to Niemeyer's Das Canoas, it's possible to see the evolution of reinforced concrete into a modern building material⁷.

The house is currently facing bad problems of materials deterioration and lack of maintenance. Main degradation issues are vegetation, that is growing very fast on external walls and on horizontal surfaces due to the local climate; structural, because part of the house is slowly moving towards the hill slope and an intervention need to be urgently planned; big cracks cross the bedrooms ceiling and rain water is leaking inside the house, plaster is becoming very fast darker and weaker; swimming pool pavement shows cracks and deterioration and further analyses are required to better understand the causes of this problem; great geological instability of the slope subject to strong storms is a serious degradation factor.

The documentation of the architectural masterpiece by Niemeyer has been intended priority to analyse the current condition and the state of conservation of the building, which currently suffers from a lack of maintenance. The integrated survey was carried

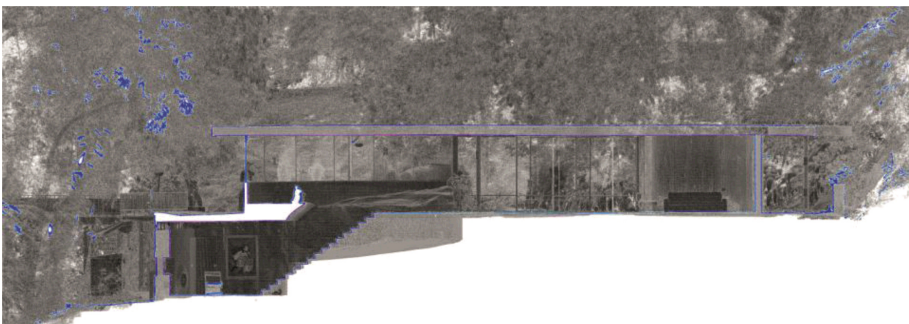


Fig. 6. Casa das Canoas: points cloud section CAD ready for architectural drawings

⁷ Weintraub and Hess (2012).

out by the DIAPReM centre at Ferrara University and started from the architectural analysis: Oscar Niemeyer's ideologies in terms of society, politics and architecture had formed a unique style, which he expressed to the full in the architecture of the house at Canoas, which in itself was a remarkable achievement of Modernist architecture (Fig. 6).

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The "reading" of the architecture composition focused three main themes of investigation: the shape of the space and its three-dimensional use, the study of the relationship between architecture and sculpture and the visual connections between interior and exterior, the relationship of architecture with the surrounded green landscape (Fig. 7).

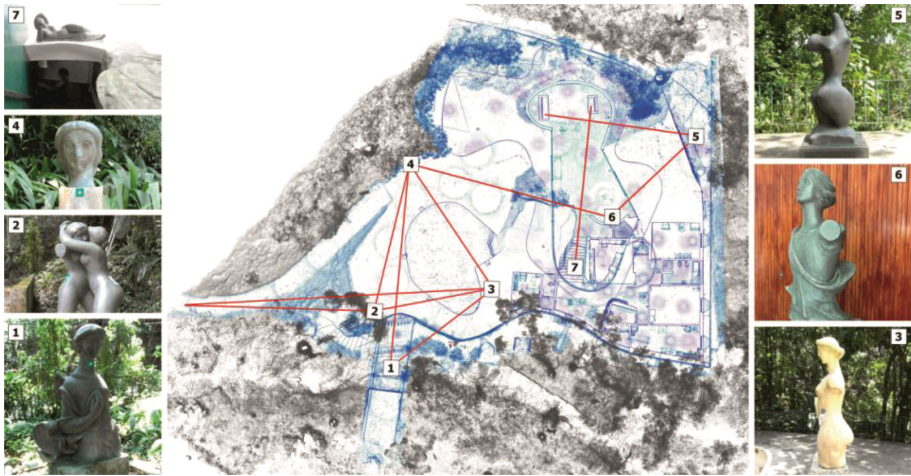


Fig. 7. Locations of main sculptures on point cloud plan and their relation with the Casa das Canoas' main openings

Niemeyer adopted this idea and throughout his career he not only designed sculptural buildings, but he also insisted for the right sculptures and paintings to go with them. In the Casa das Canoas are placed sculptures by his friend Alfredo Ceschiatti. For the first time a 3D survey with this level of detail (3 mm) allows to identify new ways of "reading" and cross interpretation, such as the triangulation perspective between the artwork placed by Oscar Niemeyer into the enclosed and not enclosed space. Thanks to the detailed data capturing it was possible to identify the axes of relationship that develop from the placement and orientation of the female bodies to encourage to share the environmental and architectural experience.

An integrated survey methodology was applied in order to obtain set of data to be critically analysed to examine in depth the research themes on the architecture by Niemeyer (Table 1).

Table 1. Main data of the instrumental survey campaign.

Total station	Leica TS06
Matched targets	53
Polygon vertexes	7
3D laser scanner	Leica C10
Number 3D scan stations	128
Acquired targets	142
Point cloud coordinates	1.717.862.695
Work schedule	10 days (about 75 h)

The integrated survey project involved 10 days on field working, about 8 h per day. The total computed area for the 3D survey campaign included the external area of the house and the garden. This is because the landscape project was an essential part of the overall design process by Oscar Niemeyer. The 3D survey has been carried out with Leica C10 Laser Scanner (Lidar technology) and topographic survey was performed by Leica Total Station TS06 plus 2". Topographical main connection to the network and framework, consisting of a polygonal closed or opened to bench marks at the ends and with polygonal rods with no longer than 80 m. The survey campaign has been documented by a detailed photographic survey.

The great opportunity to document and survey one of the most significant architectures by Oscar Niemeyer, developed in cooperation with the Oscar Niemeyer Foundation, has shown how the integrated methodology is able to reveal new aspects of the building and to analyze spaces and surfaces by means of innovative methods that have allowed to track intellectual avenues completely unexplored and unpublished.

4 Future Steps

The series of documentation developed by the masters of the modernism in India and Brazil that have been deeply analyzed during this research, have been reconfigured and utilized in order to achieve the creation process of 3D study models. These models enable greater and more effective understanding of the masterpieces of modern architecture in these countries and thus a possible stronger preservation policy. Future steps should be the creation of a digital platform by the which it will be possible for researchers and experts to have access at this database.

On the other hand it has been highlighted that three-dimensional survey has proved to be essential to represent buildings/areas that would be otherwise impossible to analyze, for example elevations deeply immersed in very green areas, and to find plans matches that are essential to understand the architectural "philosophy" of the modernism masters.

In this representative phase there is a motivational value, which makes the survey-representation a real project itself, with significant critical implications aimed at the determination not only of geometric precision but, especially in architecture, of visualization and conceptual representation of reality.

At the moment integration of 3D survey and BIM approach seems to be the strongest base for future conservation plans and valorization projects. Furthermore, in case of demolition or unexpected events (such as natural disasters, etc.) this methodology will also preserve the memory of this extraordinary heritage.

To address these challenges, the Getty Foundation in Los Angeles, USA, developed *Keeping It Modern*, a grant initiative that aims at the conservation of modern buildings. The programme is already supporting modern buildings grant projects of outstanding architectural significance that promise to advance conservation practices: the University of Ferrara is deeply involved in the preservation masterplan of three of these buildings. The cooperation between the Getty initiative and the on-going research could actually help towards the creation of conservation management plans that guide long-term maintenance policies and the testing and analysis of modern architecture materials (Fig. 8).

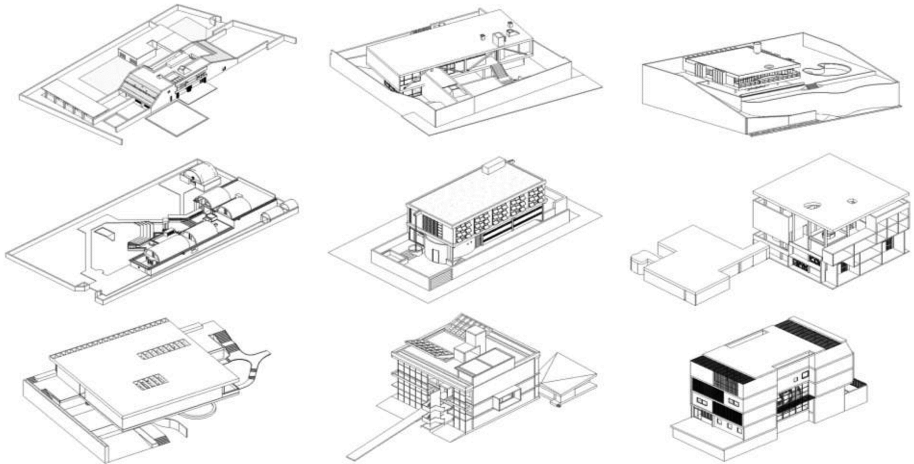


Fig. 8. Some examples of 3D database of Indian and Brazilian modern architectures developed by the research carried out at the University of Ferrara Architecture Department

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