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The Geisel Library
The brutalist architecture of William Pereira

Cristiana Bartolomei[1], Falko Kuester[2], Eric Lo[3],
Caterina Morganti[4], Dominique Rissolo[5]

[1] Department of Architecture, Alma Mater Studiorum University of Bologna, Italy
cristiana.bartolomei@unibo.it
[2] Cultural Heritage Engineering Initiative (CHEI) Qualcomm Institute, UCSD Division of Calit2, University of California, San Diego, USA
fkuester@ucsd.edu
[3] Cultural Heritage Engineering Initiative (CHEI) Qualcomm Institute, UCSD Division of Calit2, University of California, San Diego
eklo@eng.ucsd.edu
[4]Department of Architecture, Alma Mater Studiorum University of Bologna, Italy
caterina.morganti4@unibo.it
[5] Cultural Heritage Engineering Initiative (CHEI) Qualcomm Institute, UCSD Division of Calit2, University of California, San Diego, USA
drissolo@ucsd.edu

Abstract. Brutalism is the broader architectural phenomenon during the 1960s and 1970s of an almost sculptural Modernism rendered in raw concrete, which had manifestations the world over. From the mid-20th century, this style rose in popularity before reaching its apex in the mid-1970s, after which it fell into disfavor. But it seems that things are now changing, with a renewed interest and appreciation for this once disparaged architectural style. Known for its use of functional reinforced concrete and steel, modular elements, and utilitarian feel. Brutalist architecture was primarily used for institutional buildings, such as libraries, courts, public housing and city halls. Imposing and geometric, Brutalist buildings have a graphic quality that is part of what makes them so appealing today. The word Brutalist does not come from the architecture's fortress-like stature, but from the raw concrete it is often made from-*béton brut*. Emblematic of this architectural movement is the most iconic building within the University of California, San Diego campus: the Geisel Library. The Geisel Library was designed in the late 1960s by William Pereira.

Keywords: Geisel Library, William Pereira, Brutalism.

1 Introduction

Brutalism is an architectural movement derived from the modern movement that sought to move away from the clean lines and monotonous forms of this trend. Brutalism is an architectural tendency which developed after World War II. The first epicenter for the formulation of brutalist principles was England, despite the works of the Swiss architect Le Corbusier being considered its emblem. The British architects Alison and Peter Smithson coined the term "Brutalism" in 1953, from the French *béton brut* or "raw concrete", words used by Le Corbusier to describe the poured board-marked concrete with which he constructed many of his architecture works [6]. The use of this term has become common when the British architectural critic Reyner Banham used it in the title of his 1966 book "The New Brutalism: Ethic or Aesthetic?" to characterize a somewhat recently established cluster of architectural approaches. Brutalist buildings are defined by evocative repetitive angular geometries. Where concrete is used, the texture of the wooden forms used for the in-situ casting are revealed. Although the emblem of Brutalist architecture is the massive use of concrete, many Brutalist buildings also feature materials such as brick, steel, glass, rough-hewn stone, and gabion. Moreover, it is important to note that not all buildings characterized by the conspicuous use of concrete must necessarily be Brutalist, but could belong to architectural movements such as Constructivism, International Style, Expressionism, Postmodernism, and Deconstructivism. Most Brutalist projects are institutional or commercial buildings. The composition of these buildings is majestic and of great proportions which, when juxtaposed with simple forms, generates a dominant monumentality. The regular repetition of the modules and construction elements creates a surprising rhythm in these concrete giants. Brutalist buildings cease to refer to the harmonious aesthetic canons to which even modern art and architecture had conformed in the interwar years; rather, Brutalism is characterized by an aesthetic heedless of being pleasing. Unité d'Habitation in Marseille developed by Le Corbusier, Habitat 67 in Montréal, Boston City Hall, Trellick Tower in London, SESC Pompéia in São Paulo, Torre Velasca in Milano are just a few examples of the many majestic Brutalist buildings around the world (see Fig.1).

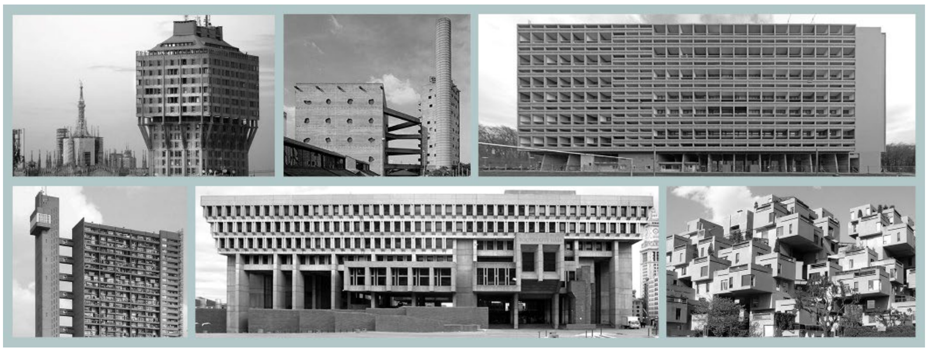

Fig. 1. From top left to bottom right: Velasca Tower in Milano, SESC Pompéia in São Paulo, Unité d'Habitation in Marseille, Trellick Tower in London, Boston City Hall, Habitat 67 in Montréal.

2 William Leonard Pereira

William Leonard Pereira (1909-1985) was an American architect from Chicago, of Portuguese descent. He graduated from the College of Architecture in the University of Illinois. In 1930, when the Great Depression was in full swing, William Pereira left school and after three months looking for work, he finally found it with the prestigious Chicago firm of Holabird and Root. Among the most important works carried out at this architectural firm was the Chicago World' s Fair, realized in 1933. A world's fair held in Chicago in 1893 to celebrate the 400th anniversary of Christopher Columbus' arrival in the New World in 1492.
At the young age of 25, William Pereira established his own firm. His first assignment, after moving to Los Angeles in 1938, was to design a new studio for Paramount. His approach to the film world also led him to win an Oscar for Best Visual Effects in 1942 for “Reap the Wild Wind” by Cecil B De Mille. He later was producer, for RKO-Radio, of the mystery-melodrama "Johnny Angel," starring George Raft, and the romance "From This Day Forward," starring Joan Fontaine.
After few years, in 1949, he returned to architecture, Pereira became a professor of architecture at the University of Southern California, and in 1950 established the architectural firm of Pereira and Luckman with Charles Luckman.
Their architectural firm quickly became famous and they were commissioned to design major building complexes, such as: the project of the Columbia Broadcasting System’s (CBS) Television City in Hollywood (1952), Santa Barbara campus of the University of California (1955), and Los Angeles International Airport (1959).
Other works outside the state of California included launching facilities at Cape Canaveral, Houston Center in Texas, and U.S. military bases in Spain.
In 1959 the working collaboration with Charles Luckman ended and he formed the third and final company of his career, the design firm "William L. Pereira & Associates” [14].
Pereira's work became a whirlwind of concrete and the architect soon became known for his for its eccentric and futuristic building designs.
Between 1960 and 1970, the firm "William L. Pereira & Associates” designed over 250 buildings, many of them characterized by austere geometric shapes such as domes, pyramids, ziggurats, cubes and parallelepipeds.
In particular Pereira operated in a variety of areas along the West Coast, some examples of buildings constructed in this area are the San Diego International Airport (1959), the Theme Building in the Los Angeles International Airport, plans and buildings for campuses of the University of Southern California, and the University of California, Irvine (1962), Dickson Art Center at UCLA (1964), Los Angeles County Museum of Art (1965), Transamerica Pyramid in San Francisco (1967), the Times Headquarters addition (1972).
If the icons of Corbusian Brutalism are the massive structures for public housing and the Miesan Brutalism a memorial to capitalism, the highest expression of William's brutalism is expressed as an imposing administration building that live in balance with nature: the Geisel Library, the most iconic building within the University of California campus in San Diego.

3 History and design of Geisel Library

Central Library of UC San Diego was the original name of the *Geisel library*, which changed its name in 1995. The building took its current name to honor both Theodor Seuss Geisel and his wife Audrey for the generous contributions they have made to the library. After his death, Audrey donated a large collection of Theodor's work which is housed in the Special Collections & Archives. She later donated more than $10 million to the campus library's renovation and a collection of Theodor's original material, including books, notebooks, drawings, sketches, tapes, records and memorabilia from of his career (valued at $2.3 million) [8].
The eight-story library, built in 1970 and expanded in 1992, serves as the architectural and intellectual focal point of the La Jolla campus in San Diego. It is located in the center of the campus with Library Walk to its south, Thurgood Marshall College to its West and Earl Warren College to its East (see Fig.2).

Fig. 2. Siting of Geisel Library (elaboration by Caterina Morganti).

The Geisel Library is the most recognizable building on campus. This futuristic looking structure consists of eight floors and the two lower floors serve as a pedestal for the upper stories of glass and concrete (see Fig. 3, Fig.4, Fig.5). Precisely this futuristic façade inspired the building protagonist of the Christopher Nolan movie "Inception" (see Fig.6).

Fig. 3. Geisel Library (photo by Caterina Morganti, 2020).

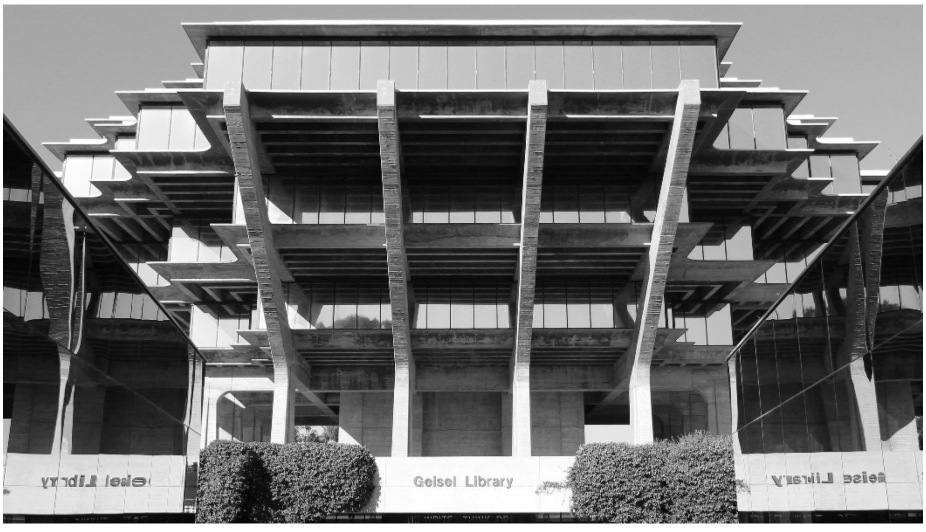

Fig. 4. Geisel Library, taken from the entrance on first floor (photo by Caterina Morganti, 2020).

Fig. 5. Full view Geisel Library (photo by Caterina Morganti, 2020).

Fig. 6. The snow fortress from the movie "*Inception" (*freeze frame by Caterina Morganti, 2021).

Pereira originally conceived a steel-framed building, but this was changed to reinforced concrete to save on construction and maintenance costs [18].
This change of material presented an opportunity for a more sculptural design.
The building is a structure with a height of 110 feet (approximately 34 meters) and at its widest point a width of 248 feet (approximately 76 meters).
The building can be imagined as hands holding a stack of books (see Fig. 7).

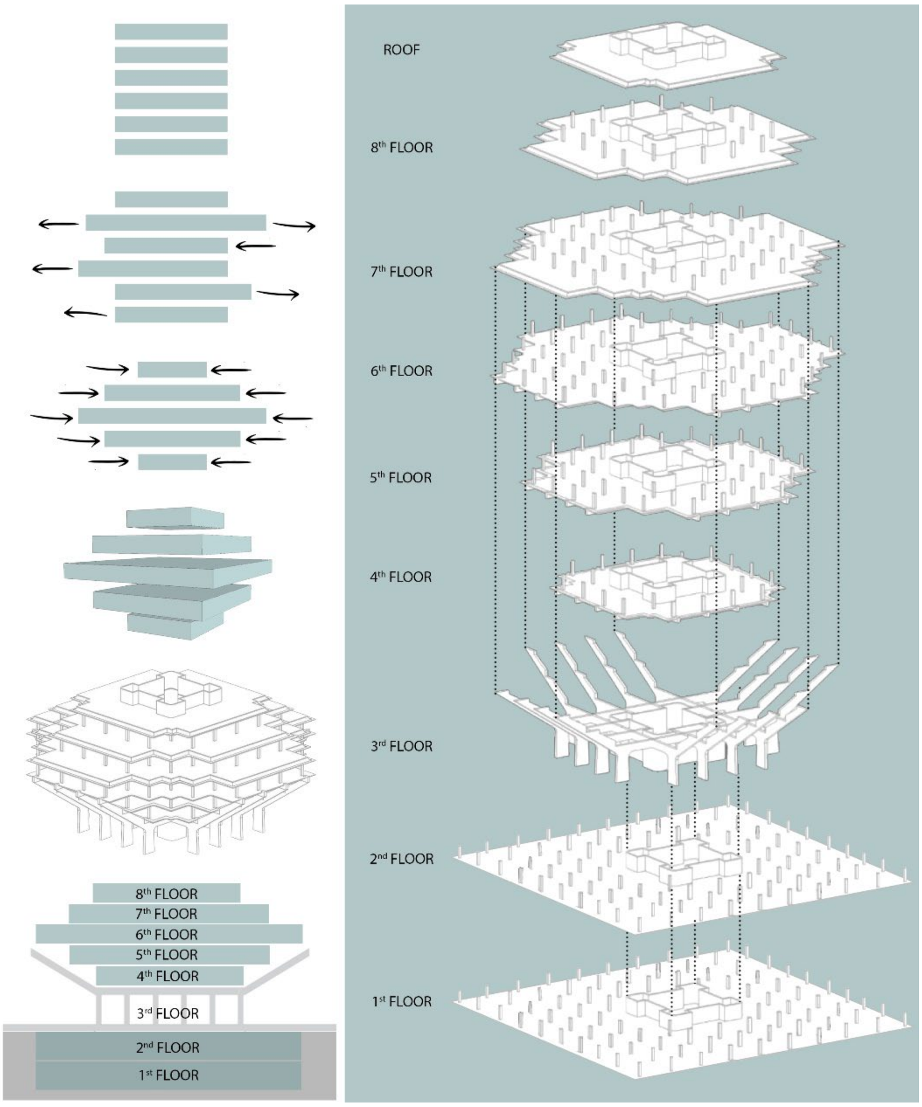

Fig.7. Concept and exploded view of Geisel Library (elaboration by Caterina Morganti, 2021).

The building structure incorporates a cast-in-place concrete frame on a square form for all floors. The overall finish is roughcast concrete with anodized aluminum window walls containing 38,000 square feet (approximately 3520 square meters) of flat glass (see Fig.8, Fig.9).

Fig. 8. Detail of glazing (photo by Caterina Morganti, 2020).

Fig. 9. Detail of glazing (photo by Caterina Morganti, 2020).

The building contains 17,000 cubic yards of concrete (approximately 13,000 cubic meters). To support the load of this cantilevered building, there are four massive, curved pillars. The curved pillars slope upwards at 45 degrees from the sixth level and are literally tied to their counterparts throughout the building on both the fifth and sixth levels (see Fig.10, Fig.11, Fig.12).

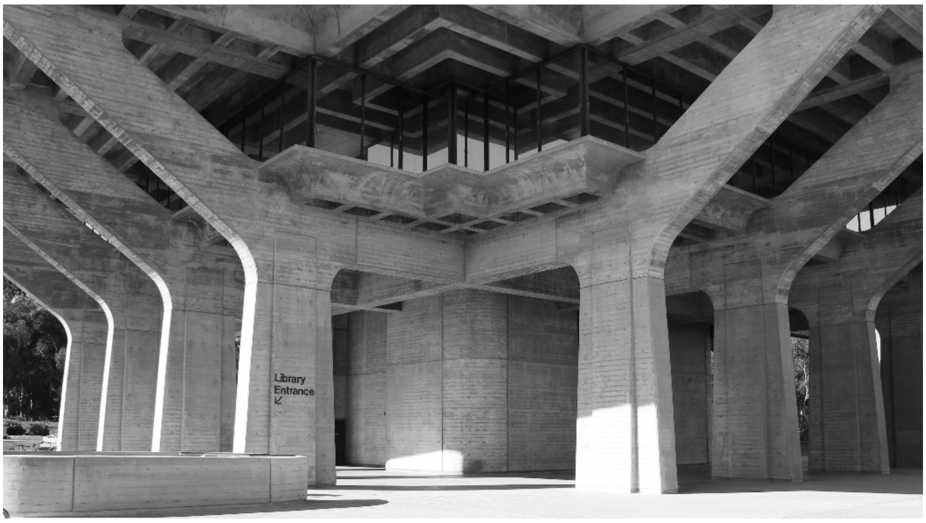

Fig. 10. Detail of massive pillars in concrete (photo by Caterina Morganti, 2020).

Fig. 11. Detail of massive pillars in concrete (photo by Caterina Morganti, 2020).

Fig. 12. Detail of the inclination of the pillars (photo by Caterina Morganti, 2020).

Buildings designed by Pereira never seem to touch the earth. The architect accomplishes this illusion beautifully by setting the ground floor of the buildings back slightly, and circling them with wide overhangs, so the ground floor is hidden in shadows. One does not really see how the buildings connect with the earth.

Meanwhile, the main parts rise into the sunshine above the floating overhangs. Geisel Library looks as if it is dancing with the landscape. Walking near the structure it is possible to appreciate the reticular grid in sight of beams realized for the support of the floors. The layered, orthogonal grid of reinforced concrete beams is certainly distinctive (see Fig.13).

Fig. 13. Detail of interlacement of beams (photo by Caterina Morganti, 2020).

4 Preserving Brutalist Cultural Heritage with H-BIM

Projects involving Cultural Heritage in general, whether for conservation, protection, or restoration, are playing an increasingly prominent role worldwide.
The construction industry has adopted Building Information Modelling (BIM) for its ability to plan and control different types of interventions in a comprehensive, coordinated and decentralized manner. These advantages have also influenced the way of relating to the existing Cultural Heritage, whose complex management activities have led to increased consideration of the concept of Heritage BIM, which pursues the modeling of architectural elements in accordance with their constructive and historical-artistic characteristics [15]. Tangible Cultural Heritage, in particular real estate, such as monuments, architectural complexes, historical buildings and archaeological sites, are the main field of application of this new approach. In this context, so vast and varied, it is clear the need for complete and exhaustive digital 3D models as reference tools for understanding, monitoring, reconstruction, and possible preparation of future interventions.

For this reason, it is imperative to have a database that includes extensive graphic, textual, technical, historical, and semantic documentation, which for many historic buildings turns out to be fragmentary, often leading to inefficient project management, affecting the time and cost of maintenance processes, retrofitting, and all interventions related to the historic Heritage [16].
In addition, over the past decade, the projects in the architecture, engineering, and construction (AEC) industry have been characterized by new project delivery methodologies and the use of new and constantly improving design tools. A project in the construction industry begins with an investigation phase, followed by a planning and design phase, an execution phase a life of the work phase, followed by an eventual demolition or restart phase of the cycle itself. Different risks may be present in each of the different phases.
In order to obtain the greatest efficiency from each phase of the process there is always a greater demand to identify methods and tools to obtain an optimal process.
The H-BIM (Heritage/Historic Building Information Modelling) methodology aims to investigate the building process through the storage of spatial information and metadata, but also provides the means to document the changes that structures undergo over time. The scope of application is very broad, ranging from use as a digital documentation repository, to being a design and preservation planning tool, to becoming a construction, renovation, and maintenance simulation tool.
H-BIM models therefore represent a real database, which can be consulted and implemented by the various actors involved in the process. In this way, it is possible to acquire information and data to make accessible and modifiable within the models.
Brutalist buildings, thanks to their morphological characteristics and thanks to the clean lines that define them, lend themselves particularly well to the application of this process.

5 Data acquisition for point cloud generation

In general, for existing buildings the first step is the survey of the building, which in almost all cases is carried out with the help of digital tools such as laser scanners or cameras combined with photo-modeling software, whether they are standard handheld cameras or integrated into a drone.
The combination of different techniques, which can be developed individually or combined into hybrid techniques, now allows the exploration of the macroscopic and microscopic world. With the clouds of points obtained with these instruments it is possible to obtain geometric and colorimetric information, thus being able to have a model that defines the state of the structure to be used as a basis for design or maintenance of the work. In this way it is possible to constantly check the updating of all the information concerning the structure and operate according to the needs.
The intervention projects on the built Heritage can be defined as continuous or discontinuous processes of knowledge and decisions that affect a building asset throughout its entire life cycle and are organized in different ways depending on the prevalence of objectives and interventions suitable to build them. The implementation of intervention

strategies planned on the Heritage requires a preliminary phase of definition of knowledge and objectives to be achieved. The activity of analysis, monitoring, and diagnosis of the conditions of the Heritage building, therefore, has a considerable importance within the process. On the built environment, whether Brutalist or of another architectural current, the cultural values that must be analyzed and documented cannot be ignored or underestimated. Decisions regarding possible interventions on buildings are influenced by the recognized (or recognizable) values placed upon them. On the built Heritage, it will therefore be necessary to carry out a whole series of analytical and diagnostic activities absolutely necessary to acquire the degree of knowledge sufficient to guide the project [3]. Analyses and diagnoses will be clearly declined according to the characteristics and conditions of the case under examination. Preliminary activities are the collection of information about the building, their orderly cataloging, any instrumental diagnostic investigations aimed at knowledge, interpretation and evaluation of the state of preservation, operating conditions and performance of the construction or its parts, and the geometric survey. The technique of photomodelling constitutes a useful and rapid solution that allows the reconstruction of real scenes from photographs and some basic measurements for scaling, it provides a solid foundation for the representative system, capturing its essence and showing its meanings [2]. Applied to architecture, it constitutes an effective solution for documenting the state of existing buildings, providing specialists with the necessary elements for their study or elaborating supports for dissemination and valorization intended for the general public. In particular, the survey campaign carried out on the Geisel Library is done via drone. The use of drones has the potential to reduce the time and costs of conventional techniques employed for field survey of cultural Heritage buildings, and enables portions of the building to be captured that would otherwise be in-accessible via ground-based imaging. [4]. Digital photogrammetry with drone is the survey technique that allows one to obtain geographic and metric information, position and shape, of three-dimensional objects, such as land and buildings by processing digital photographic images obtained by air [12]. The recognition of the homologous points in the frames, in fact, allows their alignment and subsequent processing of a "point cloud" model [10]. This model is constituted from a whole of points univocally determined by three spatial coordinates X, Y, Z and three RGB color coordinates [17]. In particular, for the survey of the Geisel Library, the brand of drone is DJI and the model is Phantom 4 RTK with the firmware version 02.01.0012, released on 22-05-2019, was used, the latest available on the market at the time of the survey.
The technical characteristics of the aircraft used are:

- Takeoff Weight: 1391 g
- Diagonal Distance: 350 mm
- Max Service Ceiling Above Sea Level: 19685 ft (6000 m)
- Max Flight Time Approx.: 30 minutes

The technical characteristics of the camera are:

- Sensor: 1" CMOS; Effective pixels: 20 M
- Lens: FOV 84°, 8.8 mm/24 mm (35 mm format equivalent: 24 mm)
- Photo Format: JPEG
- Supported SD Cards MicroSD, Max Capacity: 128 GB.

The flight plan parallel to the ground surface was planned for 25 m of AGL (Height Above Ground Level, is the height measured with respect to the underlying surface of the ground) to obtain a GSD (Ground Sample Distance), is the distance of the ground sample and the distance between the central points of each sample taken from the ground. Since these are digital photos, each sample is a pixel. The GSD is therefore the size of each pixel on the ground (0.68 cm / px at takeoff height). The gimbal was aimed downward 60 degrees from the horizon to supply oblique views. The side and the front overlap was set to 80%.
The selected flight was a manual type orbiting the building, keeping it centered on the camera body [19]. This choice was made because it was not possible to plan a flight model parallel to the vertical facades or to define 3D flight paths in GS Pro. The flight was planned to travel along semicircular arches at approximately 8 different altitudes with specific angles of the gimbal to make the best photographic coverage. In the image below the inclinations of the gimbal according to the altitude of the drone, repeated on the four facades of the building (see Fig. 14).

ALTITUDE (meter)	GIMBAL PITCH (degree)
5	13
9	5
12	0
16	-8
22	-15
30	-24
39	-30
52	-40

Fig. 14. Double lawnmower pattern flown from the top and flight from the south of Geisel Library (survey by Eric Lo, 2020).

6 Processing image and H-BIM production

The processing of the images acquired by drone was carried out through the new release of the Agisoft Photoscan software: Agisoft Metashape. Thanks to this software it was possible to obtain polygonal models and a model composed of Tie Points.
The sparse cloud was generated first then the dense cloud. Then the referencing and scaling of the model was done by means of measurements or known points recollected in the field, with mesh creation and projection of HD oriented image on the achieved mesh model [7].
The number of images that have been processed in Metashape are 1668. The steps that led to the construction of the point cloud, which was then imported into the Revit software, are as follows: importing photographs, photo alignment, camera calibration and building dense point cloud. It is necessary to export the point cloud in a format compatible with Revit import: the .rcp format model [1].
The so-called "Scan-to-BIM" phase, or in this case better to say "Drone-to-BIM", is the phase immediately following the point cloud generation phase.
To date, with regard to the mere modeling phase, i.e., the "tracing" of the point cloud within a BIM software environment, there are no standards or tools for automating this activity.
This phase is therefore substantially attributed to the sensitivity of the technician in charge of the "tracing" and to their knowledge of software, both aimed at the generation of the point cloud and its export, and to the knowledge of BIM modeling software [9].
The definition of a structured methodology to go from a numerical model to a parametric model in a BIM platform is still a terrain to be explored [5].
The Scan-to-BIM phase of the process is, to date, still the most critical.
Many scholars and researchers have tested different platforms and software, but it is still evident the deep limitation connected to the automation phase of the process and it has not yet been possible to identify a semi-automatic process that allows to pass from a numerical model, corresponding to the point cloud, to a parametric model, the H-BIM model [13].
The photomodelling by drone is limited to the recording of the architectural object at the time of data acquisition, geometric, chromatic and material characteristics.
With this information provided by Structure-from-Motion operations it is necessary to proceed with reverse engineering analysis [11].
To date, the types of reverse engineering processes applicable to the built environment can be identified in two macro-groups. 1. The first one is mainly addressed to those architectures, basically historical, characterized by shapes and morphologies difficult to standardize. In this case, the most widespread process today is a semi-automatic process that involves the generation of sections with extraction of profiles and extrusions of faces, operations performed directly on the cloud of points. 2. The second is aimed at buildings constructed since the 1920s. For these architectures it is possible to perform a sort of real recalculation of the point cloud, with the possibility of creating customized families.
The procedure performed on the Geisel Library falls within this second case (see Fig. 15).

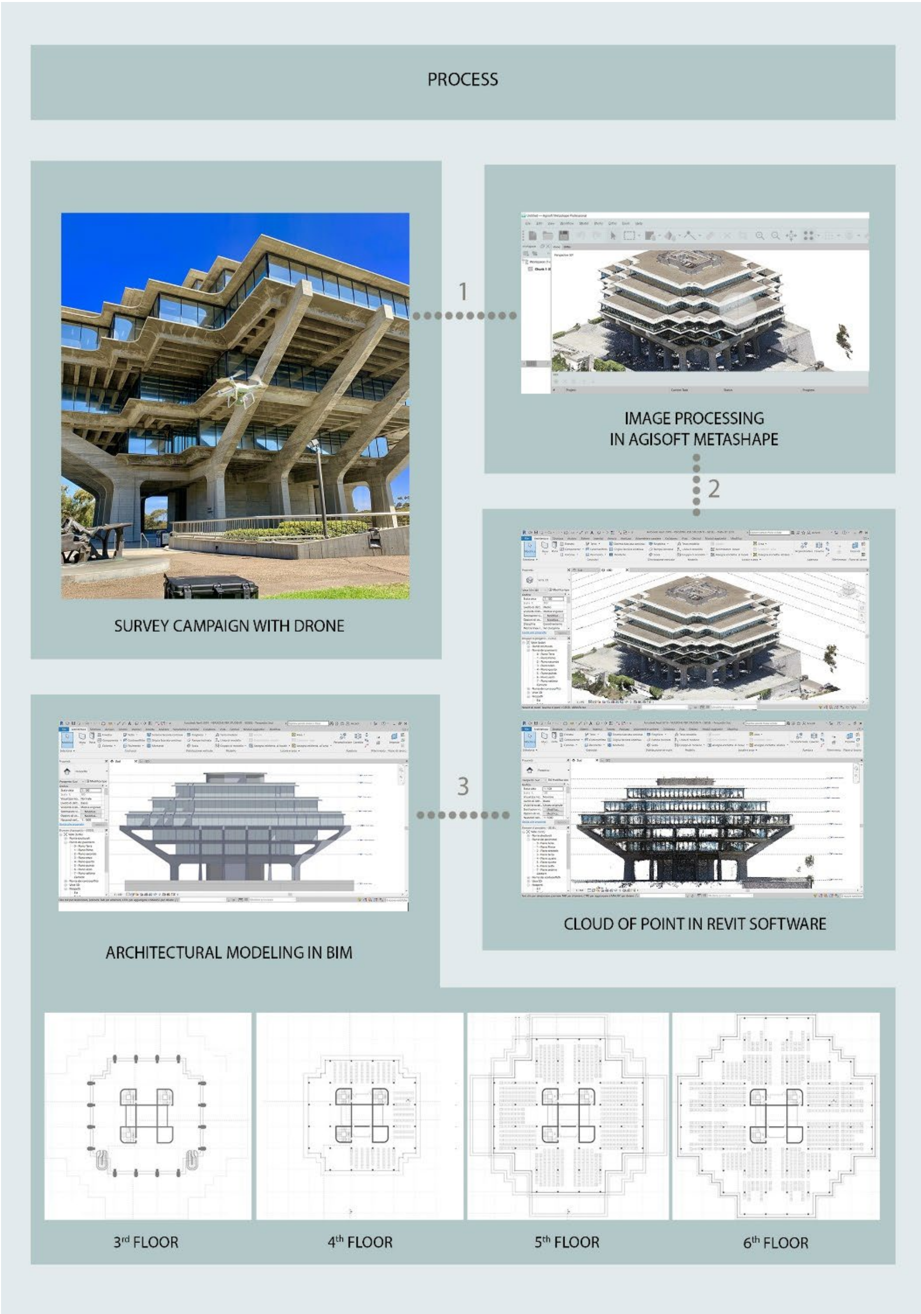

Fig. 15. From drone survey to Revit modelling (elaboration by Caterina Morganti, 2021).

6 Conclusion

Today, Geisel Library represents an icon of brutalism but also the icon of UC San Diego. This dual relevance denotes the strong evocative and cultural value of this building and, consequently, the importance of needing to preserve it over time. The H-BIM model that was built allows on the one hand to collect metric, material, photographic historical, constructive, and performance information regarding the building, and on the other hand to obtain a virtual tool that can be used to better define a restoration strategy. Having the ability to consult a navigable and measurable model is a great advantage not only for documenting and monitoring buildings, but also for the assessment procedure, intended to prevent and reduce vulnerability. Pereira's building represents a particularly intriguing object of study because of its unique morphology, and its geometric composition allows for a clear identification of the parametric families to be realized in Revit. Combining the information regarding the internal composition extracted from the plans with the information obtained thanks to the SfM procedure for UAV of the exterior it was possible to realize the H-BIM model of the library. It is necessary to fully understand how BIM tools and parametric modelling can enable conservation-related interventions and ultimately contribute to the valorization of Heritage structures. The construction of an implementable Geisel Library H-BIM model will ensure a collaborative and multidisciplinary process of design, information exchange, and consultation, which is proving to be an increasingly necessary basis in the planning of future interventions and in the entire decision-making process. While the new construction sector has already been characterized by BIM design for years, this is not entirely true for existing buildings. H-BIM application on Cultural Heritage and historic buildings is still not widespread. This study is the starting point for the creation of an integrated model of the Geisel Library on which, in the coming years, different experts and stakeholders will be able to work and merge in an interoperable way the information acquired and define future interventions (see Fig. 16).

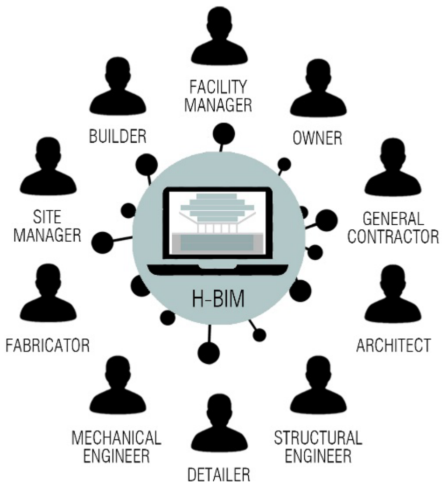

Fig. 16. Collaborative and multidisciplinary process for Geisel Library (elaboration by Caterina Morganti, 2021).

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