SURVEY OF MODERN ARCHITECTURE

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ABSTRACT

Modern architecture or contemporary architecture can be quite difficult to survey. Most of the time, a survey is done as support to an analytical view that is constructed as support for a conservation or restoration project. Due to the fact that by and large, contemporary or modern architecture does not call for these types of interventions, the case history of surveys of modern buildings is extremely limited. However, the architectures of the modern movement are beginning show the effects of the passing of time, since reinforced concrete, which many buildings are made up, is not as durable as originally believed. One curious factor makes it superfluous to conduct a survey, even in the case of restoration interventions, quite in the same way as in the case of interventions on historic buildings. This is because the original project designs are used in the restoration project as basic documents, since many are still accessible. This approach is based as much on economic expedience as on a feeling of possession of the building, which is due to its recent construction and its continuity in the use of the building that are confirmed in the ability to access the original project designs.
This approach is deeply flawed since it is based on an initial consideration without motivation: the one-to-one relationship between design and construction.
Even though the categories with which the design takes shape, such as the geometry, can be found in the survey, the design plan and the survey plans are still different. Even if both are designs that represent the same architecture, they are quite different: the design plan is a drawing that pre-figures; the survey design post-figures. One looks to the future, the other looks to the past. In the middle between these two drawings is the construction, the site, the matter, and the skilled labourers; all elements that introduce new geometries. But there's more. There is a important phase of design (decision-making) on site. Not everything which is finally constructed is object of the preliminary drawing.
The paper develops these concepts by illustrating them through the examples of surveys of the work of Carlo Scarpa, pre-eminent Venetian architect, active in the 1960s. In Scarpa's work, the distance between the design and the completed work is so clearly evident that it makes an exceptional example of the problem described.

1. SURVEYS IN MODERN ARCHITECTURE RESTORATION

Modern architecture or contemporary architecture can be quite difficult to survey. Most of the time, a survey is done as support to an analytical view that is put together to support a conservation or restoration project. Due to the fact contemporary or modern architecture does not call for these types of interventions, the case history of surveys of modern buildings is extremely limited. However, the architectures of the modern movement are beginning to show the effects of the passing of time, since reinforced concrete, which many buildings are made up, is not as durable as originally believed. One curious factor makes it superfluous to conduct a survey, even in the case of restoration interventions, in exactly the same way as in interventions on historic buildings. This is because the original project designs are used in the restoration project as basic documents, since many are still accessible. Frequently, we find autographic documents, site sketches, photographs, video documentation, direct evidence left by the labourers and collaborators. Taking this approach has a largely economic motivation since instrumental survey of complex works can be quite expensive. But this "monetary" approach is based on a feeling of possession of the building, which is due to its recent construction and its continuity in the use of the building that are confirmed in the ability to access the original project designs. This approach is deeply flawed since it is based on an initial consideration without basis, namely the one-to-one relationship between design and construction.

2. SURVEY DESIGN AND PROJECT DESIGN

Surveying contemporary architecture implies several important considerations. Despite the fact that the categories with which the design takes shape, such as the geometry, can be found in the survey, the project design and the survey design are still different. It is clear that they can never coincide: the project design is a drawing that pre-figures since it is projected into the future. The term "project" derives from the Latin *pro-iacere* that means “push forward” and has a strong meaning that suggests intention as well as time. Quite the opposite, survey design looks back: it represents, studies, and makes note of a present configuration that is determined by events that happened in the past. It is a design that post-figures. Survey design has no future-looking objectives; it doesn't look forward but describes a current condition and "freezes" the present. Project design and survey design have the completed work in common; between the two designs is the construction, the site, the matter, and the skilled labourers; all elements that introduce new geometries. But there's more. There is an important phase of design (and decision-making) on site. Not everything that is finally constructed was necessarily included in the preliminary drawing. The temptation to overlap the two designs can be irresistible since the proximity in time of the works allows us to follow all the events of the construction project and reconstruct the transformations that led to differences between the two designs.

Figure 1. The effects of the passing of time in reinforced concrete elements of Giardino delle Scultire in Biennale Italian Pavillon

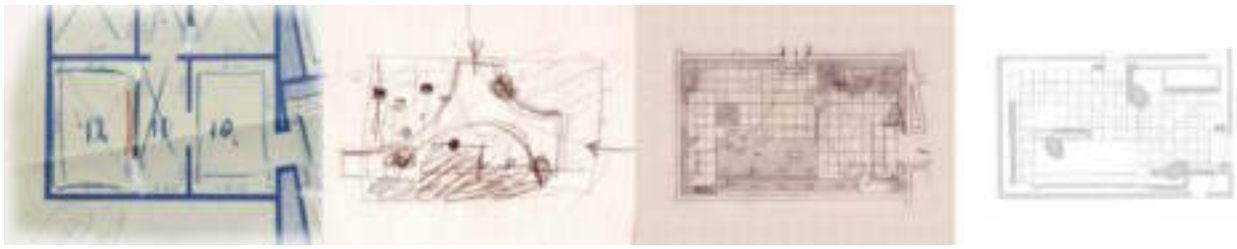

Figure 2. Comparison of sketches, project and survey design of Giardino delle Scultire

But the problem is less related to the closeness or remoteness of construction or assessing the differences based on history: these are two different designs in terms of their origin, nature and scope.
An understanding of the design process and the events that have affected the work can and must guide the apparatus of the investigations toward pin-pointing the questions that the survey must answer. But the survey design remains a document that does not cover every aspect of the work but the aspects considered necessary and appropriate in the context in which we work.

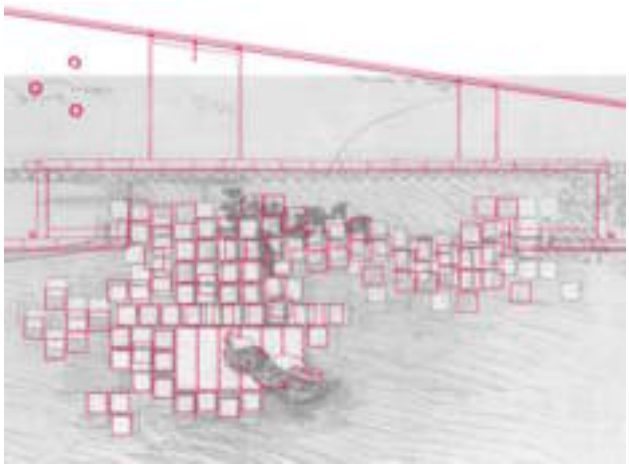

Figure 3. Overlapping of the project and survey design of the partigiana Monument at the entrance of Biennale exposition area

3. THE GEOMETRY

Geometry is one of the instruments that engineers use to conceive the building and through the technique of designed geometry, translates his or her idea for the builder. The builder also uses geometry: tracking and sizing are actions that require confirmed and recognized geometric categories that represent a bridge between the engineer and the builder. Even those who approach the building with the desire to understand more, look to make an interpretation with geometric logic: surveys supply data and information for this interpretation.
Measurement, form and figure[1] are categories used to analyze several of Carlo Scarpa's works which he designed and constructed in Venice between 1950 and 1970: *measurement* perceived as size (geometries, relationships and proportions) and quality control, *figure* perceived as references, sources of inspiration, and *form* as the result of elaborations, as a combination of technique and matter.
The choice of these three concepts depends on a preliminary general consideration regarding Scarpa's work: his work can be interpreted as a continuing process in the attempt to identify an order in things.
Measurement, figure and form are defined through the projects: the comparison of objects on the whole and parts of the works, in a transition from the general to the particular, and vice versa: study of the geometric construction of the figures and the relationship between them, verification of the precise measures of the details and the whole, quantity, repetition, and variation control in a single figure.
As mentioned, it is clear that the geometries of the design and the construction cannot be reconstructed in the survey process: there are insurmountable break points represented by the transition between the continuous and the discretion: from the continuum of the ideas of the designer to the discretion of the lines that he or she puts onto paper; from the project design to the constructed matter; from the building to the representation of the survey.
Add to this the fact that the building holds "accidental" geometries unlike the "intentional" geometries sought by engineers, caused by voluntary or involuntary causes taking place over time (partial interventions, additions, subsidence, conversions,...).
These accidental geometries can be analyzed and understood using instruments of geometry but lead us inevitably to build models (interpretations from a geometric perspective) which

may not be what contributed to the original conception and construction.
The path that leads from the project to the factory at the time we approach cannot be retraced in reversed.

4. SURVEYS

The survey studies the form of the architecture through the geometries of the building. This is clear pursuant to what we've discussed to this point. But a definition of survey of architecture is difficult to achieve: on the one hand, we have to cope with numerous unique cases while on the other, we have to cope with them with a discipline that still seems confused. We can discuss the issue by illustrating a large variety of cases so that the various forms of the objects to survey and the specific objectives of every survey gives the reason for using one method over another. The hope is to create a sort of illustrated catalogue of survey as a response to the question "how to do it" both of objects already present and aspects to be read.
Another way is to analyze the survey as a discipline and identify its bases, methods and goals. This procedure is complex right from definition of what the survey is and what it does, let alone discussing how it does it. Many people recognize the existence of a survey discipline because they work with architecture and may need to produce and use surveys, but few are able to define it.
A common approach is to view the survey from two positions, remembering that survey has very particular importance in the field of architectural analysis since it holds a dual purpose: it is a possible analytical method (analysis of the form through geometry) while at the same time, it is a correlation and support instrument for the other analyses. As analysis, the survey studies the form of the architecture through the geometries of the building, geometries that play an essential role in the processes of conception, construction and comprehension which have involved the building over its lifetime.
But survey isn't only an analysis of the geometries that define the form of the building: it is instrumental to the other analyses since it provides a metric and topological basis on which to spatially locate the phenomena being studied. Frequently, very different phenomena are correlated by the fact that they have the same position or are reciprocally located according to their own logic. The service that survey provides to other disciplines extends from creation of thematic maps with minimal support in their graphic expression, where the final printed product of survey is used (the design in orthogonal projection), to the more complex maps based on numerical cartography of information systems for geo-referencing phenomena.

5. SURVEY OF SCARPA'S WORKS

Therefore, if we lend survey this essentially documentary value, it is worthwhile to think about the possibilities offered by the current techniques for realization of surveys and representations that allow us to document the work of Scarpa in accordance with our knowledge and conservation.
In this context, it is worthwhile to remember the promotion of protection projects conducted by the Municipality of Venice, by the Central Offices of "Works Engineering and Execution" and "Cultural Heritage and Activity" and financing by the Fondazione Querini Stampalia of a research programme[2] finalized at defining and realizing an experimental survey whose data bank for understanding the work and subsequently as a fundamental managerial and decision-making instrument of the work.
The debate concerning conservation of the works by Scarpa brought to the surface the intention to begin a systematic collection of data on Scarpa's works in terms of their geometry, material and documentation to gradually formulate a methodologically correct approach for this type of intervention.

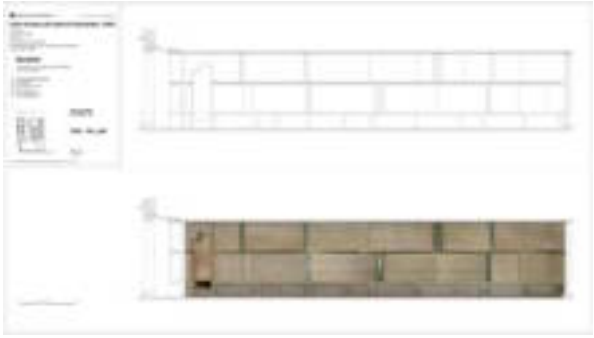

Figure 4. Section of Aula Luzzatto In Fondazione Querini

Figure 5. Plan of Querini garden (nominal scale 1:20) integrated by pavement photoplans

Figure 6. Rendered view of Aula Luzzatto
The main objective of the investigations and analysis that were

identified and proposed was to supply elements useful to the engineer in charge of the conservation project and also to build up documents on the work of Carlo Scarpa.
The survey of the works by Carlo Scarpa at the Querini represents the opportunity to experiment on the most recent tools in the field of documentation of the form and colour and to study the forms of alternative or complementary representation. Survey elaborations, due to the characteristics of the object, must use various methods of representation. Faced with the complex plastic development of Scarpa's works, while essential components are orthogonal projections (especially for plans and elevations) through line drawings, augmented in recent years by ortho-rectified images inserted into the design, 3D elaborations have become the body of the design. Today, these can be done by processing 3D figures.
Recently, we've seen a few exploratory attempts to realize numeric models at the computer – albeit always perceived as a complement to Monge representations. The need for documentation, together with the possibility of computer management of the infographic models, seems to be shifting the discipline towards a co-existence of the traditional static representations and the dynamic models. This conflicts with the needs of designers to have two-dimensional supports that, as we know, represent a spatial and functional model of the architecture. The solution would seem to be to bring together innovative concepts with the traditional methods, in other words, bringing together 3D digital models and orthogonal projections. In fact, by preferring the use of models, one risks becoming enamoured of technology; by preferring traditional projects, new fields of knowledge would be sacrificed.
Among the newest techniques that provide a deeper understanding of the works, the scientific management of colour is surely important and closely related to modelling. It's widely recognized the importance of photography in documentation: consider the desire to document materials (stone, metal, glass, concrete and wood components) and their current conditions. Today, we can quantify colour in a strict and exacting way: this quantification would add to the quality evaluation that we usually make on photography, the precise measure of the subtle changes in colour that are caused by chemical or physical changes in the material.
Survey activities have foreseen the use of integrated topographic, photogrammetric and direct techniques in addition to the use of laser scanner instruments.
The objective is to realize survey campaigns in which every metric procedure is scientifically controlled based on rigorous statistical tests founded on error theory. This has meant working with overabundant measures in order to extract the 3D coordinates (XYZ) for every architectonic survey point and an exacting indication of the uncertainty of these coordinates, through the average quadratic error of each one (σ_x, σ_y, σ_z).
Knowing the degree of precision makes it possible to use survey data correctly and respect the characteristics of the nominal scale of the final documents. The nominal scale is concurrently an indication of the metric precision of the documents (0.2 mm for the denominator of the scale of the drawing) and the quantity of information of the design (the density of markings and the quantity of details).
The survey campaigns are designed in order to optimize the procedures according to the nominal scale, 1:20, with additional information at appropriate scales for some details.
Every survey was topographically centred through the local networks (surveyed with Total Station TCA 2003 by Leica) georeferenced in the national Gauss-Boaga cartographic system: survey might be viewed as one tile on an enormous scale of a system of knowledge that is considered homogeneous as regards the system of coordinates.

Figure 7. Scheme of topografic network

There are two levels of precision: a global level where the precision is the same as the reference cartography (nominal scale 1:500) and a local scale much higher respect to the work done (nominal scale 1:20).
The local planimetric reference system is assumed to be a cartographic system (east) less than a translation into x and y (translation into x: - 2310000m; translation into y: -503000m) without rotation.
For a correct altimetric positioning, the survey stations of the network were connected to the survey stations of levelling, essentially important in the relationship between the works by Scarpa and the flooding phenomena.
Integrating topographic survey, some spaces were surveyed with laser scanner instruments (LMS-Z420i and LMS-Z320 with incorporated digital calibrated Nikon D100 camera). This method has proven to be more adapted to certain situations - for example, in the survey of the sculpture garden at the Biennale and in the monument to "La Partigiana". Essentially, this is due to the accuracy of the surveyed points: when faced with a large quantity of data surveyed in a very short period of time, the laser-scanner affords more uncertainty in the measurements and considerable interference with respect to the other survey techniques. Add to this that the laser scanner is not adapted to some objects, such as in the case of fine details. These considerations lead us to conclude that laser scanning is best viewed as a survey technique that does not replace the others, but incorporates them. It achieves preliminary geometric picture that can be correctly inserted into a multi-scale survey.

Figure 8. Comparison of well survey (Monge projections, 3d model) and Scarpa sketches

Figure 9. Details of the scans in Querini Stampalia garden. On right, triangulation and orthophoto from laser scanner survey

6. 3D MODELLING FOR REPRESENTATION

Survey data were used in realizing 3D models of Scarpa's works, including the same information of the standard documentation.
Solid models were constructed by means of Boolean operations on primitive solids obtained from geometric primitives directly derived from topographic, photogrammetric, and direct survey and laser-scanning of the surface of the object.
To ensure correct modelling and subsequent texturizing of the architectonic objects, they must be broken down into basic elements. This has led to an identification of the following operating macro-categories: walls, columns, trays, wall panels, ceilings, metal elements, stone components, wood elements, etc. This division strongly reflects the work of classification for every element that comprises the composition of each space and facilitates placement of subsequent intervention analyses.
Considering that the model provides a geometric basis of support for the historic, physical and chemical investigations that are usually carried out, every geometrically modelled element is then texturized with rectified images. In the specific case of survey of Scarpa's architecture, we have to specifically talk about *picture mapping*, namely, application of rectified images calibrated radio-metrically (to ensure a certain degree of chromatic faithfulness to the metric mapping) on the respective surfaces using an appropriate set of mapping coordinates (UVW). These coordinates are responsible for the correct "positioning" of the image on the surface.
Despite the fact that generally, *picture mapping* does not require high resolution images, it is better to use the same rectified images without needing to sample them downward. This makes it possible to obtain views with an extremely elevated definition where not exactly equal to the original, considering that modelling software reprocesses the image when the rendering is created. The quality of the images obtained can be compared with the original files.
From the final model, complete with mapping coordinates and the images used by *picture mapping*, we can obtain all the views necessary. These may be perspective views or orthogonal views (axonometric or Monge), static or dynamic, unusual and impossible to realise with traditional means; this is possible because it is a virtual camera, released from the real world and defined in digital format.
The precision of the model is on the nominal scale of the survey that generates it or the 1:20 scale equal to ±4mm. This is the global precision, extended to the entire model in every part. Locally, more information is often present that enable correct representation up to 1:10 scale.

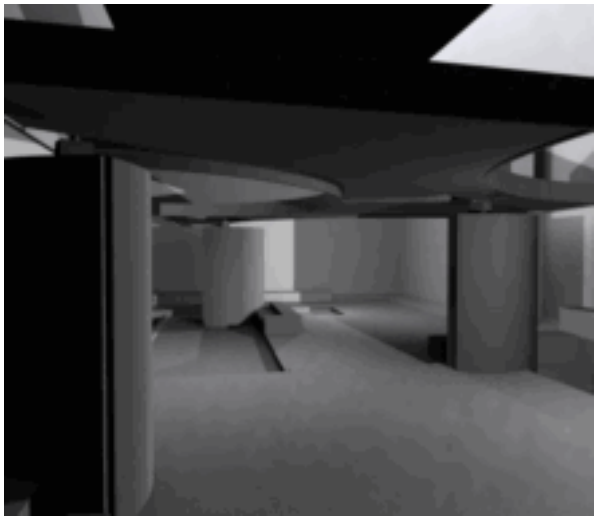

Figure 10. Renderings of the solid model.

Figure 11. Rendering of the mapped 3d model by using rectified images

The distinction between global precision (or absolute precision) and local precision (or relative precision) is related to the use that must be made of the two-dimensional extracts of the model: for interventions or studies that occupy vast areas, the precision to take into consideration will be global while for smaller areas, specific areas consider local precision.

7. CONCLUSIONS

The issues discussed above are the objective of both research and concrete applications. This is the significance of the experimental survey of Scarpa's works. This situation shouldn't seem unusual since research cannot be applied in areas such as survey: the work of survey takes shape only through experience. We see the need for constant dialogue and exchange between researchers and experimenters in a process of gradually refining the techniques that generate a definition of theoretical concepts. The rule is defined through the applications and at the same time, the applications are implemented while respecting the rules.

Notes

[1] Maria Manzin, *Measurement, form and figure*, graduate thesis held at the IUAV of Venice, adviser M. Manzelle, co-adviser, F. Guerra, academic year 2003-2004

[2] Survey of Carlo Scarpa's work at the Querini Stampalia was conducted as part of a agreement between the Fondazione and CIRCE of the IUAV University of Venice, by assigning two research bursaries. This activity is financed by the Region of Veneto based on Art. 41 Regional Law 2 of 17.01.02 and was performed between September 2003 and October 2004.

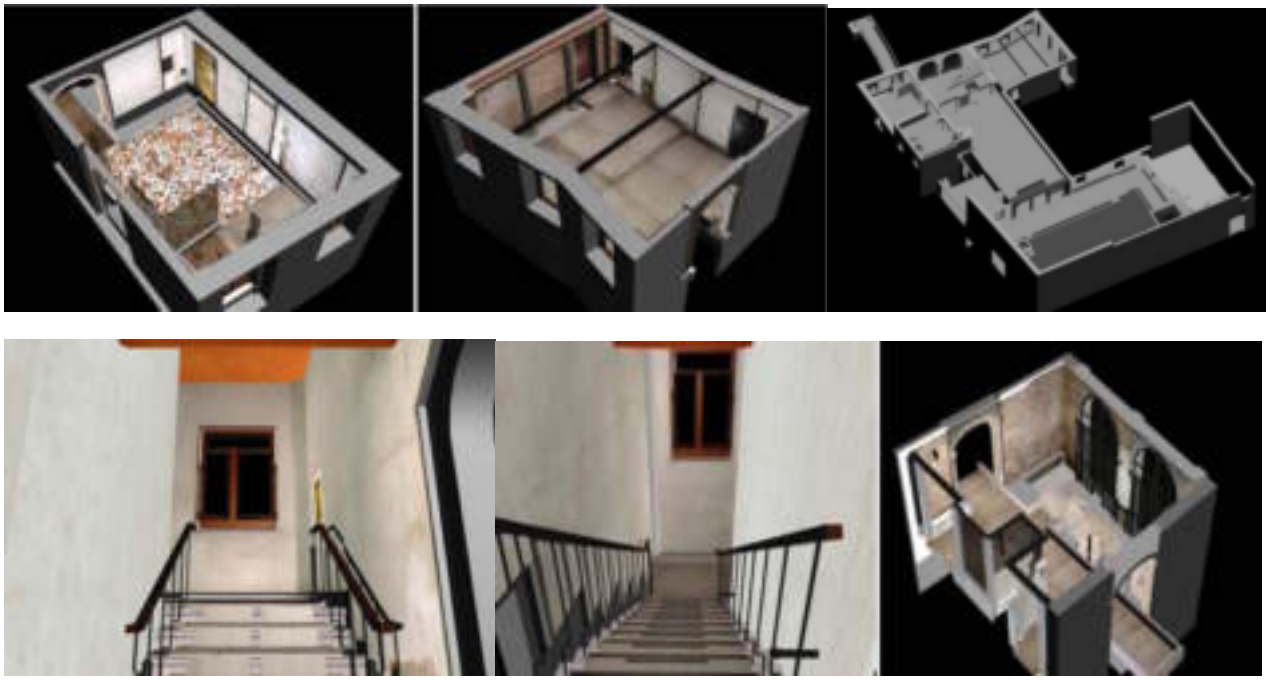

Figure 12. Views of Querini Stampalia multiresolution model

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