3D web-sharing for a new vision of the cities

Alessio Cardaci, University of Bergamo - Faculty of Engineering
Antonella Versaci, University Kore of Enna - Faculty of Engineering and Architecture

1. Introduction
The Italian island of Sicily takes origin from the tension that divided it from the European continent: a tough and fierce tear that torn it from the rest of the world, making Sicily an "island" in the heart of the Mediterranean Sea. The birth of that Fretum, named "terrible" by Seneca, granted independence to the island, leaving it alone but at the same time, giving Sicily the opportunity of having a "center". Its heart beats exactly where this center is located: it seats in the town of Enna, where the Normans built an octagonal tower to indicate the midpoint of the island, naming the town: Ombelicus Siciliae. In the immediate surroundings, areas rich in history, as little known, are hidden: urban villages looking ideally at the Tower of Frederick II, as their main point of reference.

The main purpose of this paper is to narrate a journey through the historical towns of Central Sicily, along an imaginary itinerary that spreads concentrically from the heart of the island and has its points of departure and arrival in the town of Enna. Walking through the ancient streets, pausing in the squares and living among the inhabitants, we have tried to capture the soul of such places, both by the traditional sketches and the photos (rectified and referenced), or through colored point clouds acquired by a digital sensor. Like the old architectural painters searched the most beautiful patches to represent their "ideal city", as technicians of the new era, we wandered around, looking for the most secret and seductive corners: those architectural sites or elements able to communicate the true essence of the old island centers.

We wanted this to be a journey of discovery, having, however, also objectives of critical understanding and effective cataloging. Therefore, on this trip, we used the classic, unchanging and always useful sketchbooks, although being, in addition, supported by innovative detection techniques. The traditional pencil, was in fact, combined with the electronic "eye" of the camera and the more advanced (lightest and fastest) 3D laser scanning instrument, able to permeate the material and grasp the true nature of the architectural artifacts and of their urban contexts. Our tour was then a critical travel among the architectural monuments of the most fascinating cities of Central Sicily, carried out by using several surveying techniques, both classic and modern. This, in order to allow a revival of these areas, in which their main "actors" are unfortunately, affected by urban pollution, congestion, and degradation phenomena.

2. Walking along the streets of Central Sicily, looking at its monuments
Central Sicily is, by now, relatively little known and studied in relation to the width of its historical and artistic treasures. Contemporary tourist, like as the 18th-19th centuries travelers, continues to prefer classical or littoral areas of Sicily.
However, moving away from the coast, a more secret Sicily (quite an island in the island), not less interesting from cultural and/or natural point of view, exists and needs to be valorised.

The founding of Enna goes back before the Greek period, dating from the 14th century BC. Following the Roman domination, Enna was an important fortress for the Byzantines. Taken by the Saracens in 859, it was elected as the new capital of the island and named Qasr Yānnah until 1087, when the Normans captured the town. The city’s name was then converted in the form of Castrogiovanni and so will remain until 1927 when it resumed the name of Enna. During the Norman conquest, Castrogiovanni became an important cultural and political center of the kingdom. In 1130 Roger II restored the ancient Sicanian fortress, now known as Castle of Lombardy, one of the most important and well maintained medieval castles in Sicily. After the brief Angevin parenthesis, Enna rose again. In this period, several monuments were restored and, at the behest of Queen Eleanor, wife of Frederick III of Sicily, the Duomo was founded in 1307. This magnificent monument, based on a medieval structure, has over the centuries, undergone numerous renovation and adaptation works. The main one dates from the 17th–18th centuries [1] when, an imposing façade, surmounted by a massive campanile (a prototype of the towers-facades, realized in the south-east of Sicily at that time) was added [2].

Other rich expression of medieval architecture are the towers, originally elements of the imposing fortified sighting system of Enna, then often integrated into ecclesiastic complexes. This is, for instance, the case of the Torre del Carmine, marked by a strange semi-cylindrical lateral protrusion but containing also elements of a Renaissance character; or that of San Tommaso, adjacent to the homonym Church and characterized by Catalan Gothic windows. Last but not least, majestic, the already mentioned Torre di Federico II stands: a former military stronghold built in the 13th century, nowadays considered as one of the major symbols of the city.
On the heights facing Enna, it is located Calascibetta, whose territory has been inhabited since ancient times, as evidenced by the necropolis from the 9th to 5th century AC. The town was later built by the Arabs and named Kalathos-Scibeth and then expanded by Count Roger in 1062. In the southeast, there is Aidone, Arab-Norman city nicknamed “the balcony of Sicily” for its views and marked by the 16th century’s Church and former convent of San Domenico presenting an ashlar façade; while on the southwest, we can find the city of Pietraperzia where, according to some, the ancient Caulonia rose. Its current town center was established in medieval times around an Arab fortress then restored by the Normans. It hosts the Cathedral Church, built in 1308 and rebuilt almost completely around 1500, in a larger and lavish form. Leonforte lies north of Enna. Founded in 1610 by Branciforte family, it is dominated by their outstanding Palazzo and by Granfonte, the monumental fountain built in 1652.

Historical documentation and researches about these monuments are very poor: both in terms of graphics and as regards the critical analysis, except for the work produced by Walter Leopold, a young Italian-German engineer which came to Sicily in 1910-11 to study the medieval architecture of the inner Sicily [3]. Although impressed by the accuracy of this study and even if inspired by the interesting representation work of contemporaneous drawers, we have decided not to re-walk the footsteps of our predecessors. Conscious of the fundamental importance of survey in the preparation of restoration and conservation projects, we then based our work on a close integration between tools and methodologies, both traditional and innovative. This, according to a mode of thought, not only based on a logical process of historic and aesthetic nature, but supported by those intuitive and perceptive values that are stimulated only by the on-site observation.
3. Survey for the Restoration project: between visual perception and analysis, among tradition and innovation

In the past times, the representation of the city was mainly carried out by paintings and engravings. Those works of art are today precious archives, both for architectural historians and for architect restorers. The lithographic prints of the Grand Tour, the guides and albums of images designed to improve the aesthetic and cultural values of private reading rooms, tell in iconographic way (at the same time, cataloging) monuments, landscapes and urban sites, now often no more recognizable. The "life drawing" was, once, the means to recreate and tell the spatial feeling of the observed city, the sketch was (and actually still is) a plausible restitution of the reality aimed at capturing the essence of the space seen by the traveler (even if always mediated by his own personal interpretation). That of survey has historically been the phase immediately subsequent in the approach of places: the eidotype added, in fact, to the space feeling, metric details as well as material properties and formal aspects of the observed sites. Preliminary design, aimed at providing a scientific and detailed knowledge of the studied sites, the eidotype was, essentially, a basic document, a kind of canvas on which to set up and then develop further ideas [4]. The traditional technique required, actually, the elaboration of an imposing mass of drawings aimed at documenting plans, elevations and architectural details of buildings, focusing on their geometrical, linguistic and technical aspects. The advent of photography has partially modified this approach to the city, enriching it with new contents and faces. Images obtained by cameras, seen as "fast sketchbooks" [5], have supported the traditional drawing techniques, putting at our disposal new important documentary tools. The photograph, in fact, permits to render by images the city’s fervor. Its capability of freezing the “moment” and blocking the action can reveal moments so brief as to be normally imperceptible to the human eye. The camera offers the opportunity to create
(through the pictures) a linear and temporal chronicle, of great value for all those work in the field of protection and valorisation of cultural heritage.

Nowadays, the laser scanning technology has completely revolutionized the surveying field. It ensures the possibility of digitally capture three-dimensional objects, even very complex, and returns them as point clouds, in a very short time. On the contrary to a drawing, they are not, however, a planar projection of a real object, as they represent a virtual version of reality that can be investigated. If a drawing can be observed only from the center of projection from which the designer has chosen to represent the scene, the point cloud can instead be questioned by several projective centers. It is indeed possible to get more representation by changing from time to time the observation point of the architectural work and of the city as a whole. Not less important, it is also the chance to investigate the 3D model, obtained by laser scanning technology, in its morphological and/or compositional components.

As already mentioned, from a procedural point of view, the use of 3D laser scanning technology has dramatically reduced execution time, because it unifies the initial phase of data acquisition and that of subsequent analysis. The digital sketch, actually, provides metric survey and characterization of building materials of the city, at the same time, observed and measured, both in its forms and in its structural components. Through this technique, the preparation of the object’s eidotype is less important than the survey planning, even if not required. It is, in fact, possible to fully detect the geometry of an architectural object and then postpone to the phase of data processing (in the office), the extraction of characteristic elements of the buildings and their representation through CAD [5].

In the framework of our tour, the digital acquirement of the monuments has been carried out through the Laser Scanner Focus3D produced by CAM2-Faro Technologies, innovative instrument based on the phase shift technology, much faster and more accurate than the traditional time-of-flight instruments. The survey projects have been developed by
executing “environmental 360°” scans so reducing in situ measurement time. The speed of data acquisition and measurement given by this instrument is so higher to make it more affordable (in terms of reduction of working time) the acquisition of whole information and then the cleaning of unnecessary point clouds, rather than to adjust the scanning angle and the resolution in any single scan. One of the key parameters of the laser scanner is the scanning step: in other words, the step between two points measured by the instrument. The first scanning systems only allowed very high mesh step (of the order of centimeters) or required to work with higher resolution-levels, with subsequent increase of scanning time. However, the Focus 3D permits to obtain colored and high-resolution point clouds, (10 dpi to 10 meters), with very short acquisition times.

For this research, to the traditional target now obsolete, it was initially planned an eventual replacement by calibrated spheres, because they do not need to be arranged orthogonally to the station: a simplification that in any case would not result in a significant decrease in measuring time, due to the need of always placing the spheres near the buildings and in places visible to more stations. The idea of “telling the cities” needed to cross them quickly (as quickly as a traveler-designer who draws a landscape in half an hour) and to make several acquisitions in many different places. It has been therefore preferred a much simpler survey methodology, which does not need any target or calibrated spheres, but benefits of the combined and integrated utilization of different software (the FARO® Scene 4.8 and the GEXCEL JRC 3D-Reconstructor). It should be noted that this instrument is not only extraordinarily light (5 kg), but it also integrates a coaxial high resolution camera. This has allowed coloring point clouds in automatic way, considerably reducing post-processing time. Measurements were then followed by processing of data measured in situ: the clouds were first filtered and then aligned in order to obtain virtual models of the monuments and of significant fragments of the cities.
4. From the graphic representation for the Restoration project to the Web-sharing cataloguing

At the end of the phase of data acquisition, drawings, scans and photographs taken during the tour, were used to represent and communicate information obtained. Pictures, sketches and colors were used to dress up, not only chromatically, scans metric data. The restitution phase has allowed mapping the point clouds with images processed and filtered in order to highlight the degradation state of materials and the most interesting architectural elements. The point clouds have been mapped with a kind of “tailor made dresses”: images of the architectural monuments, taken at different times of the day (including night images). That’s because the colorimetric information obtained by laser scanner is no longer a simple representation of the reality, but it may be precious both in the diagnostic and monitoring phases. The usual practice is to represent in “false” colours the reflectance values resulting from the scans (famous is the change from green to red, performed by Leica scanners depending to temperature and reflectance variations); it is rather less usual to process images using software that can alter the RGB channels, the hue, the saturation and brightness [6, 7].

The mapping of several images properly treated with the filters available in the most common image editing applications, allows representing situations barely visible or completely hidden from a visual examination. A filter providing the edge contrast may highlight the masonry wall textures, the noise & grain reduction filter can hide the dark areas due to the unevenness of the plaster, allowing an easier reading of the geometry, or even the render lighting effect filter permits to detect –lighting them- only the areas of interest.

Finally, attempting to implement new forms of representation of the degradation and deterioration of material surfaces, our scans have also been dressed by drawings showing the mapping of stone deterioration of buildings, elaborated by the students of the course of Architectural Restoration (a.a. 2009-2010) of the Faculty of Engineering and Architecture of Enna (Italy).

5. Conclusions

By the integration of all these techniques, we obtained a rich database, to make universally accessible through Web platforms, whose value is inestimable, not only to ensure today a proper restoration and valorisation of the monuments, but also in the future, in order to understand their evolution in the frame of an urban environment, always in movement. With the aim of realizing a web-shared catalogue of the monuments of Central Sicily, acquired data have been converted into 3D models which are being progressively published on the Net. The scan processing software used for this research incorporates a specific one-click WebShare function. This application makes it possible to publish scanned data on the Internet, thus enabling everyone to share scanned images, including metric, technical and material property information. Unlike photographs, which deliver only the image of the monument, the 3D model can be sliced in order to obtain cross-sections and plans; it can be processed to create orthophotos; finally it can provide useful data about chemical and physical properties of the artifacts, as well as of their states of health. Then scans can, in addition, be geo-referenced (by Google Street View for example). Unlike the images, however, the model obtained from a point cloud is an incredible database, a kind of “solid” photograph which allows to “penetrate” the material state of an architectural object.

The new frontier of laser scanning methodology offers then new important opportunities for cataloging and storing cultural goods ensuring, over time, the transmission of valuable information about their state of conservation and restoration work carried-out, in order to safeguard their authenticity.
References