GEOMATICS: NEW TECHNOLOGIES FOR AN INNOVATIVE PLANNING APPROACH

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ABSTRACT

The paper discusses the technical and cultural evolution of the approach to environment, landscape and cultural heritage, providing a short review of the international charters, recommendations and conventions focused on those themes. It presents some innovative ways for collecting 3D metric documentation, such as digital photogrammetry from UAV systems and mobile mapping, since 3D models are widely used in cultural heritage to create accurate records of individual monuments and buildings as well as complete sites, and they are of great interest both for research and for dissemination purposes.
The topic of the re-use and promotion of digital cultural resources is proposed as a challenge for the near future.

Key words : Geomatics, New Technologies, Digital Heritage, Drones, Mobile Mapping

1. INTRODUCTION

Traditionally, the architect's work is strictly related to the environment, meant as a place of changes and historical processes, as well as a spatially defined territory.
With time, there has been an increase in the sensitivity shown towards the context where the engineer works, as can be seen by the progressively broader and more complex meaning attributed to terms such as *environment*, *landscape* and *cultural heritage*. Indeed, the contemporary meaning attributed to *environment* has systemic connotations that highlight the relations between geographical area, populations, resources, physico-climatic conditions, etc..
Over the last century, an interesting cultural debate has also expanded and structured the term *landscape*: "in Europe the concept of landscape and the words for it in both Romance and Germanic languages emerged around the turn of the sixteenth century to denote a painting whose primary subject matter was natural scenery" (Cosgrove 1993).

For long time the idea of landscape was close to "a cultural image, a pictorial way of representing, structuring or symbolising surroundings" (D. Cosgrove, S. Daniels, 1988) following a so-called structural approach (K. Benediktsson, K. A. Lund,

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2012); the European Landscape Convention, signed in Florence in 2000, moved to a phenomenological approach, bringing attention to the mutuality of human-landscape encounters, to consider landscape as "an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors" (Chapter I, Art. 1)
Lastly, the term *cultural heritage* appeared for the first time in the international field in 1954, with the Hague Convention. It has extended in time, as illustrated in figure X (from Vecco, 2010) and summed up in the extracts from the International Charters, Recommendations, and Conventions in the next paragraph.

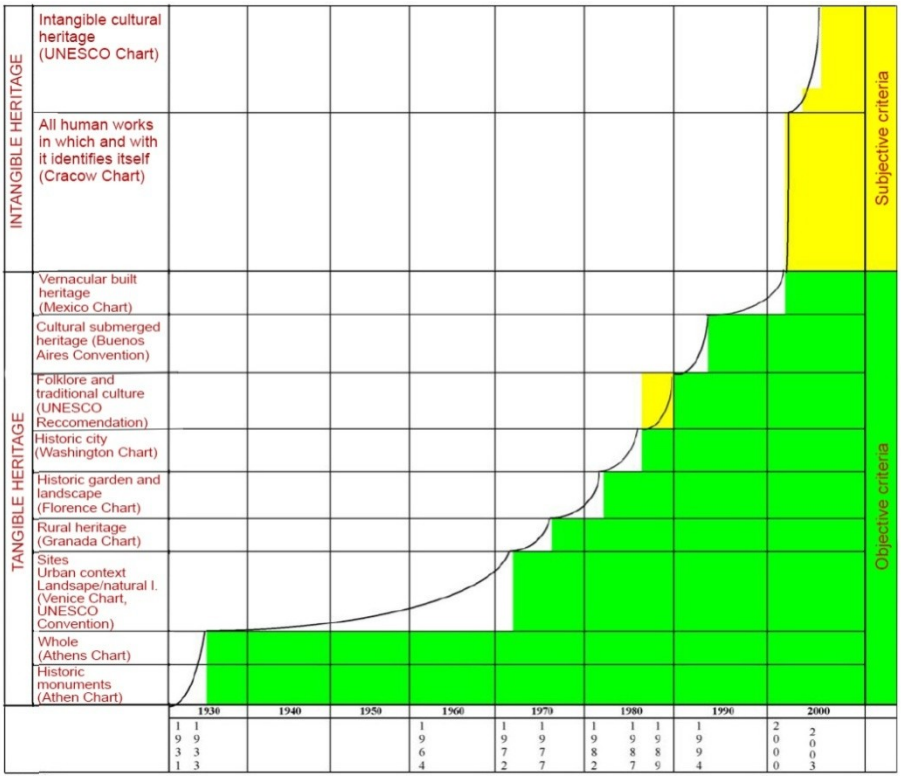

Figure 1 - The evolution of the concept of "heritage" following the International Charts, Recommendations and Conventions (from Vecco, 2010).

2. RECCOMMENDATIONS AND CONVENTIONS

2.1. Le Corbusier, commented version of the CIAM Athens Charter (Athens, 1933), published in 1942/43 (La Charte d'Athènes)

"The life of a city is a continuous event, expressed through the centuries by hardware works, drawn or built, which provide its own personality and which comes little by little his soul. These are precious witnesses of the past to be respected for their historical or sentimental value first; then because some carry with them in a plastic virtue under which the highest degree of intensity of human genius was incorporated."

2.2. 1964, Venice Charter

"The concept of an historic monument embraces not only the single architectural work but also the urban or rural setting in which is found the evidence of a particular civilization, a significant development or an historic event. This applies not only to great works of art but also to more modest works of the past which have acquired cultural significance with the passing of time."

2.3. 1972 UNESCO World Heritage Convention

"With respect to cultural landscapes, the Committee has furthermore adopted the following guidelines: Cultural landscapes represent the 'combined works of nature and of man'; they are illustrative of the evolution of human society and settlement over time, under the influence of the physical constraints and/or opportunities presented by their natural environment and of successive social, economic and cultural forces, both external and internal. The term 'cultural landscape' embraces a diversity of manifestations of the interaction between humankind and its natural environment."

2.4. Recommendation concerning the safeguarding and contemporary role of historic areas, adopted by UNESCO in Nairobi, 26 November 1976

"'Historic and architectural (including vernacular) areas' shall be taken to mean any groups of buildings, structures and open spaces including archaeological and palaeontological sites, constituting human settlements in an urban or rural environment, the cohesion and value of which, from the archaeological, architectural, prehistoric, historic, aesthetic or socio-cultural point of view are recognized.

The 'environment' shall be taken to mean the natural or man-made setting which influences the static or dynamic way these areas are perceived or which is directly linked to them in space or by social, economic or cultural ties."

3. GEOMATICS: NEW TOOLS FOR HERITAGE DOCUMENTATION

In recent times, those disciplines that have always been involved in the creation of documentation projects have had to deal with revolutions brought about by the advent of electronics first of all, and then digital technology. Now, in the latest

development, they are summed up under the newly diffused neologism of '*geomatics*'. Geomatics includes the techniques traditionally used to document the territory and the artefacts that persist there, such as topography, photogrammetry, cartography, plus more recent systems such as GNSS, scanning systems, remotely sensed imagery from satellites and GIS. With the technological evolution comes an expansion in the discipline's fields of interest. No longer is it only finalised towards the morphometric description of the object under investigation, but also the management of various kinds of phenomena in which spatial referencing is important: traffic flows, climate changes, structural deformation, etc.. Many of the studies conducted in numerous disciplines make use of geographic or, more generally, spatial data, and geomatics often finds itself in an area of overlap between various competences. Nowadays, surveys no longer need to be "static", defining documents with a metric value, located in time, valid for an instant in the history of the object under survey, an instant later already recounting a past story, albeit in many cases these approximations may be tolerable for even long periods of time. Time is now a variable taken into consideration both in the data acquisition and elaboration phases. On the tiniest scale, for example, the form of the Earth is described in relation to systems of reference with a collocation in time, which must be progressively updated owing to the movements of the tectonic plates. On a much more enormous scale of analysis, it is possible to monitor the micro-movements of structures of particular interest with sensors connected in real time to alarm systems that can be triggered when safety thresholds are exceeded.

Albeit with the inevitable approximations produced through the reduction to diagram form, today we can distinguish both range-based measurement techniques and image-based techniques.

The former include total stations, an evolution of the optical-mechanical theodolites, as well as the more modern satellite systems (initially GPS, now integrated with other satellite constellations), radar systems and land and air laser scanners.

The second group consists of digital photogrammetry, with the same principles as traditional analogical photogrammetry, but with a work flow completely innovated by the introduction of algorithms that permit both the automatic orientation of the photograms, and automatic graphical plotting, as well as the possibility to use drones for the filming that can fly at a low altitude even in urban areas or in environmental contexts that are risky for operators to access directly.

While without doubt advantageous in terms of productivity, these changes at times risk overshadowing the need for a rigorous measurement approach, namely an accurate design with the necessary resolution. Careful post-checking is also required so that the appeal of the graphical products obtained – generally they are 3D models – does not make one forget that they are nevertheless representations of the real world and that, despite being uniform and certified, their correspondence with the real world is inevitably approximate.

Figure 2 - Optocopter AeroMax 800 tested by Lab. GeCo for a digital photogrammetric project

Figure 3 -Different vehicles for Mobile Mapping Systems (from: http://www.fgi.fi/fgi/research/mobile-mapping-platforms)

Today the techniques quoted above work alongside so-called "mobile mapping" systems in which different sensors are placed in a single vehicle moving along the city streets. 2D laser scanners are used (profilometers) in order to document shape and sizes; cameras and video cameras for textures; and GNSS systems, inertial platforms and odometers are used to position all the data collected instant by instant. Further sensors can be positioned on the vehicle to acquire specific information, such as thermal imaging cameras, profilometers to measure the wrinkles in the road surface, radar to evaluate buried elements, etc..
There are multiple possible applications for the data found with mobile mapping systems and they involve aspects linked to documentation, management/maintenance and communication. In particular:

- documentation of the state of shores, banks and overlooking buildings;
- management/maintenance of the structures of bridges, the road surface, sub-installations, lighting systems, road signs;
- aid in planning interventions, also in emergency situations, on historic buildings;
- communication and promotion of the existing built heritage (and its urban context)
- simulation of interventions, in multiple sectors: lighting, realizing scaffolding and relative shielding;
- modelling and risk assessment in situations such as flooding, crowd movements, etc..

GeCo Lab. has recently gained some important experience in photogrammetic surveying, with cameras mounted on both multirotor and fixed-wing UAVs, and it is set to acquire 3D and multisensor documentation of the urban rivers in Florence with a mobile mapping system.

4. GEOMATICS: NEW TOOLS FOR SUSTAINABLE CULTURAL ENHANCEMENT

Over recent years, numerous digitalisation projects have been set in motion on both environmental contexts and monumental buildings, sculptures and artefacts of various dimensions.
An important European project has been Europeana, whose goal was to provide content and technology demonstrators. In the Europeana archive, with an impressive collection of millions of objects, it is possible to find books, paintings, films, museum objects and archival records that have been digitised throughout Europe. Some specific projects focused on 3D digitisation: CARARE (http://pro.europeana.eu/web/carare) and 3D-COFORM (http://www.3d-coform.eu), up to the most recent 3D-ICONS (http://pro.europeana.eu/web/3d-icons), whose goal is to digitise in 3D architectural and archaeological monuments and buildings identified by UNESCO as being of outstanding cultural importance.
In addition, we cannot forget the numerous initiatives carried forward by research centres and private companies. GeCo Lab. has been involved in the MusInt project (virtual INTeractive MUSeum of the Aegean and Cypriot collections in Tuscany, on

line: http://musint.dreams.sns.it), and in the 3D documentation of the Gallery of the Accademia and the Baptistery of San Giovanni in Florence, the Basilica of the Holy Sepulchre in Jerusalem, some historical buildings in the city centres of Multan in Pakistan and La Habana in Cuba, and other significant architectural and natural contexts.

Now the question for the near future is "how can the digital cultural heritage be used and enhanced?". The open call for European projects focuses on the use and promotion of digital cultural resources by businesses and citizens and on the exploitation of cultural digital resources, providing clear rules for their use and re-use, especially in the fields of education, tourism and leisure.

The first draft document from the latest UNESCO Forum, held in Florence in October, is entitled “Culture, Creativity and Sustainable Development. Research, Innovation, Opportunities”. The Declaration requests that culture be given due consideration in the post-2015 development agenda and identifies "the key role of cities and regions as actors of change and where the culture in and for human development acknowledges the monetary and non monetary aspects of the economy through cultural expression, artistic practice, safeguarding of tangible and intangible heritage, promotion of cultural diversity, urban planning and architecture." (Florence Declaration, 2014)

4. CONCLUSION

3D models are widely used in cultural heritage to create accurate records of individual monuments and buildings as well as complete sites.

Thanks to the innovative ways of documenting the city, its streets and its buildings, the traditional codes of cartography and drawings can now be surpassed to instead produce digital, 3D, texturised maps that at the same time are able to describe the material consistency of roads, structures, infrastructures and their relationships with each other. What is more, they have an added value thanks to the fluidity with which the digital data can be used, transmitted, integrated and updated. The new maps are no longer just technical drawings characterised by objectivity and accuracy; today they have dynamic and captivating interfaces and they can present new images of the city.

At the same time, a big challenge for the near future will be to manage heritage and culture [Barthel-Bouchier], while redefining some past strong power relations and encompassing more players in the process.

Already available digital assets should become accessible, high-quality, well-organized and attractive information used for creative ends by cultural industries, supporting culture and sustainable development.

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