CAMPANIA FELIX (ITALY) : MEASUREMENT, ADVANCED SURVEY AND VISUAL COMMUNICATION OF CULTURAL LANDSCAPE RURAL AND SMALL URBAN CENTRES

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Abstract:
In recent years, the Department of Urban Design and Planning of the Faculty of Architecture, University of Naples Federico II and in some research activities related to the analysis and representation of cultural heritage in some areas of the Campania Region (Italy), studies were carried out on the geometric and modular analysis of designs of ancient and modern architectural projects to identify graphical models being fundamental for the graphical and architectural construction of the detailed works. In particular, the programmatic lines of the research "Campania Felix (Italy), Cultural Landscape and rural environments governance"(work prepared for 10 Municipalities of the High area of Caserta - Italy) – international research "Rural Vernacular Heritage 2007-11" UNESCO WHC (Paris) - reflect the multifunctional role played by the agricultural activity in terms of richness and diversity of landscapes, cultural and natural heritage. Therefore, in defence of the identity of small urban centres of historical value by promoting:
- the identification, conservation of rural landscapes and small urban centres on the function of the Corridor1 (cultural tourism) Berlin-Palermo;
- the indicators for recognising the rural vernacular heritage in each country, connected to the land, farm, buildings and production are applied on the rural vernacular heritage; The indicators from the study provide a methodology for the management of rural vernacular heritage and a tool to assess the impact of any project on rural areas and surroundings.
- the promotion of land through application of appropriate indicators which contribute to the maintaining of a sustainable balance between urban and rural areas;
- the sustainability of rural areas through the protection of biodiversity;
- the highlighting of the fragmentation phenomena to protect the natural environment of rural areas, the process of biopermeability.
The study of rural cultural heritage is an opportunity to deepen the ways in which traditional procedures of surveying- topographic and photogrammetric can complement one another, and integrate with modern techniques as laser scanners. The misalignment of the vestments and the variety of factors can be effectively analyzed by combining the different methods of data acquisition.
The transition from heterogeneous 3D data to the digital representation model involves further considerations related to the problem of digital space simplification and the adaptation to coded communication criteria, especially to very detailed scales. The rapid diffusion of laser scanners in the architectural survey resulted in some modifications in the general methodological framework with regard to control the quantity and quality of information. The data acquisition done with a laser scanner is the first major step in the operation of detection. These two factors are specific and correlated with the resumption of a laser scanner are: the centrality of the instrument position and resolution of points.

1. PRINCIPAL OBJECTIVES AND THE SCOPE OF THE INVESTIGATION

1.1 Programmatic and methodological lines of the research

In recent years, the Department of Urban Design and Planning of the Faculty of Architecture, University of Naples Federico II and in some research activities related to the analysis and representation of cultural heritage in some areas of the Campania Region (Italy), studies were carried out on the geometric and modular analysis of designs of ancient and modern architectural projects to identify graphical models being fundamental for the graphical and architectural construction of the detailed works. In particular, the programmatic lines of the research "*Campania Felix (Italy), Cultural Landscape and rural environments governance*" reflect the multi-functional role played by the agricultural activity in terms of richness and diversity of landscapes, cultural and natural heritage. Therefore, in defence of the identity of small urban centres of historical value by promoting:
1- the identification and conservation of rural landscapes and small urban centres of Caserta territory having great historical and cultural value;
2- the management of the transformations of the small rural centres (Axe V European Union) with respect to the cultural, tourism and economic (agricultural) interests of the territory, and depending on the function of the *Corridor1* (cultural tourism) Berlin-Palermo, and on the location of Campania and the Province of Caserta at the centre of the logistic platform in the Mediterranean;
3- the upgrading of local infrastructures (transport, energy and water);
4- the strengthening of rural areas and of their food products that constitute the foundation for growth and employment generated by tourism and accommodation capacity;
5- the promotion of land through application of appropriate indicators which contribute to the attractiveness of rural areas and to the maintaining of a sustainable balance between urban and rural areas;
6- the connection of Regional Ecological Networks with the National ones integrating the different connective types to defend all aspects of biodiversity;
7- the highlighting of the fragmentation phenomena found in the marginal areas to protect the natural environment of rural areas, the process of biopermeability and the identity of urban areas.
From the methodological point of view, the research was articulated according to:
- **Human semiology**, **natural and absolute views of the territory** to identify new forms of visibility and accessibility of the sites;
- **Definition of territorial macro-areas and micro-areas having a landscape value** (Rural and Urban) **resulting from territorial dynamics**, to establish a cultural and managerial presence interfacing with technical Institutions, cultural Institutions, Universities;
- **Levels of sensitivity** (trend threshold) of anthropogenic territories to encourage the process of interchange between urban systems on the territory (cultural-tourist-archaeological, urban system, manufacturing system and landscaping) that occur in fixed points known as "critical" within the rural and urban environments, and which are or may become characterizing places of attraction.

1.2. Territorial macro-areas and micro-areas, territorial dynamics and a landscape value

The research works for the definition of the transformation processes of the anthropic environment in *Campania Felix* (Terra di Lavoro), both at the urban small scale, such as the rural one (microcosmos), and at the territorial great scale (macrocosmos). At the small scale it pursued the reconstruction of rural areas from the territorial, social, urban point of view in the area of *Campania Felix*, already reported in the publication *Architettura Rurale tra Villa Literno e Carinola (Caserta)*, Alinea Editrice, Florence – Italy – 2006 (No.18 Patronages: *Council of Europe, Italian Ministry of cultural heritage and environmental conservation, Link Campus-University of Malta*, etc.). That in order to evaluate which value presently assumed the relationship between the impressive rural architecture diffused in the study area (*the great farms*) and the Roman centuriation being still present in the sites. (Figure 1)
The territory is still centuriated and organized in harmony with the system of inland waters. The Roman roads, plotted as a function of the economic-political vision of Caserta area and efficiently linked to the coast (Mondragone), with the production and storage centres (pagus) are still in operation.
The rivers and the physiography of the plain and hilly territories, along with the historical infrastructure, the Great Farms (built on the *Pagus and/or Vici*) and the Farmhouses (hamlets composed of ten living units) gave rise to local ecosystems called since antiquity *ager Falernus*, *ager Calenus*, *ager Campanus* e *ager Statanus*. The progressive evolution of the territory rural in Hamlets, Farmhouses, Royal Sites and, finally,

into urban microstructures, shows their capability to promote cultural and productive exchanges with evident reflexes on the territorial vitality.

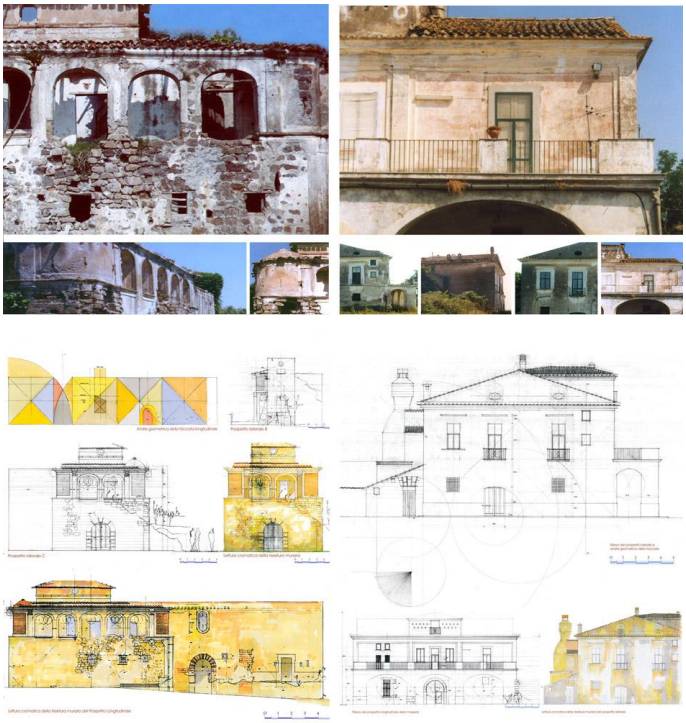

Figure 1-From left, the Great farmhouses Angiolillo, the Casoni Saraceni – Caserta, Italy (*Architettura Rurale tra Villa Literno e Carinola* – Alinea Florence 2006) – Survey of A. De Masi

The rural anthropic environment is influenced by the presence on the territory of actors (*stakeholder analysis*), that is protagonists being able to activate the circulation of innovations fit for the involvement of the entrepreneurial system with the research world. On the other hand, the sustainability of the areas subtends the knowledge of the *key connections* (attraction indexes) and the relations between the citizen-consumer and the cultural and productive Institution.
The attracting elements (economical-social) of the urban territory are present on the meeting nodes between cardines and decumans of the territorial grids of urban planning (*pagus, vici, terma and villae rusticae)* and favour the cultural, productive and infrastructural exchange between environment and society of individuals. The attractors, when present, characterize a territorial environment and, according their importance, confer a district dimension of the same environment.

The research, at the macro level, was performed for the 1st Report of the International Team Research, established by UNESCO World Heritage Centre (Paris), "Rural Vernacular Heritage" - 2007-2011 "*Campania Felix (Italy), Cultural Landscape and rural environments governance*" (October 2008)[1].
The historical, productive, physiographic, cultural, urban-rural and landscape complexity of the environments study and their interactions were analyzed by identifying "characterizing aggregation systems" and their exchanges with nature and the anthropic reality.
In fact the rising of the rural macro-area for the Province of Caserta, encouraged the reading of the investigation data into the examined study. This is inserted in a "diffused naturalness" environment having a high specialistic agricultural vocation dating back to ancient times which, in the North, is in close contact with protected natural areas, sites of Community interest and special areas while, in Southern areas, borders territories characterized by an "eco-systemic fragmentation" (urban environments).
With the processes of self-recognition and self-organization of the local identities it was possible to identify six "territorial dominant features" to form the main systems (urban, naturalistic, rural-manufacturing, rural-cultural and landscape-environmental-cultural) which are related to rurality, natural resources and agroforestry, physiography of places and biodiversity. These systems coexist with a strong and meaningful presence of historical-artistic and landscape assets, in close contact with nature and with the system of inland

waters.
The dominant features connected to nature, agriculture, landscape, culture of the sites, have as a referent the ecosystem and the landscape. The latter, which brings together all categories, is a key component of the life environment of the populations, of the diversity of the common cultural and natural heritage; it is the foundation of their identities and opportunity for the economic development based on sustainable use of territory in respect of its natural, agricultural and cultural resources. (Figure 2)

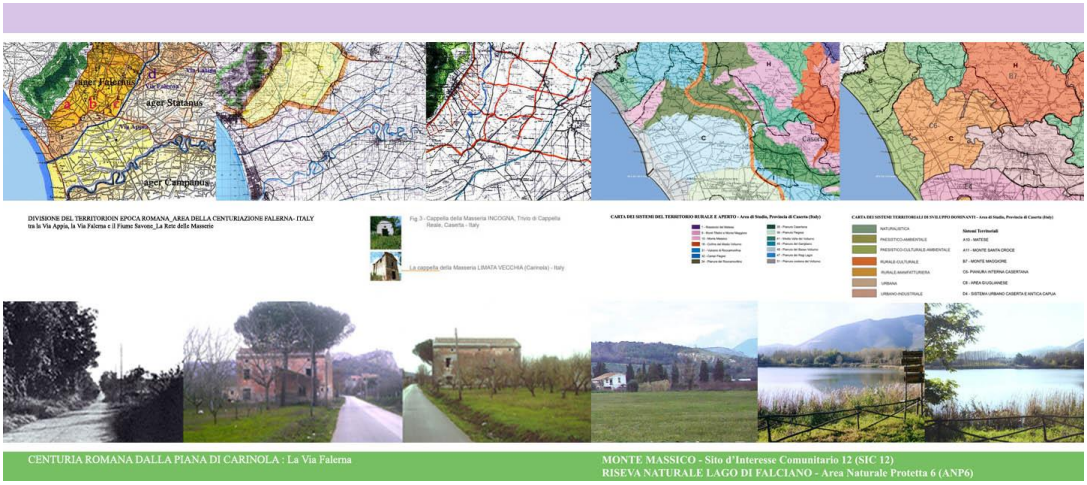

Figure 2- *Campania Felix* (Italy) the territorial districts and landscape areas. A. De Masi

The network of competences built on an economical-cultural model – environment, has as its *spin-off* the preservation, valorisation and safeguard of the landscape and cultural heritage, intended as resources – income for a model of eco-sustainable development. All this comes within a framework of structural strategical researches for the development of the territory as well as of the synergic process between scientific research, market and territorial dynamics skills.
The need to promote the creation of *districts* represents also an effective reply to the progressive impoverishment of the biodiversity and, consequently to the landscape degradation, strengthening the biopermeability of the interested areas (connectivity and porosity) and the functions of ecological connection among mainly rural areas. On the other hand, the district*s*, while connecting the local diversities, as well as their specific competences, propose assemblies of different and significant historical cultures for the process of political and economic development. The creation *of territorial districts* and natural and anthropic cultures promotes sustainable development through a landscape value supported by an ecological network.
The "fragmentation" phenomena found in the investigated areas constitute one of the main factors of degradation, not only of the ecological landscape, but also of the visual landscape which in such a way looses its character of readability and recognisability, above all within the so-called cultural landscapes, product of a secular relationship between human activities and nature.
Therefore, the study aims at starting the requalification process of the anthropic environment by analysing the problems arising from the strategic vision of the *Trans-European Corridor 1* (tourism and cultural) Berlin – Naples – Palermo, and of *Corridor 8*, being transverse to the previous one (along the Volturno river), coming from the Tirreno Sea towards Bari, Varna and the countries of the Balkans and, finally, of the *Ionic Corridor* directed toward the Mediterranean Sea. From this point view, the Caserta territory which is strongly interconnected with the Mediterranean reality, comes as an hinge area with Europe.
The Landscape, therefore, is an essential component of the population life, foundation of their identity, expression of the diversity of their cultural and natural heritage and occasion of social welfare. The strict relationships among biodiversity, landscape diversity and previous historical and cultural events testify that the landscape is likely to change over time.
This perspective promotes the sustainable development of the territory, supported by the lowest soil consumption, through the institution of an ecological network to be intended as an extended process of protection, requalification and connection of landscape and environment resources.

2. SURVEY AND THREE-DIMENSIONAL DIGITAL MODEL

2.1 Acquisition data, elaboration of the survey data

The evolution of the technology of the automatic survey has allowed for the creation of three-dimensional data banks that constitute a fundamental archive of geometric memory from the necessary goods to the outcome of the protection and conservation and to the eventual process of restoration. The three-dimensional model that can be obtained by the elaboration of the laser scanner data is measurable and it constitutes a realistic representation element. Such digital models are capable of supporting the possibility of the measurement, reproduction and analysis of the state of decay and all other information that can be inferred from the geometric model. In cultural heritage documentation, choosing the appropriate technology, the appropriate procedures, designing the workflow and assuring that the final output is in accordance with the set of technical specifications is always a challenging matter (Patias et al., 2008). The leading parameters are the size and the complexity of the object and the level of accuracy required. Generally 3D data acquisition as well as 3D modelling of cultural heritage monuments can be performed by different approaches, such as analysis of existing plans and elevation drawing, surveying, laser scanning, photogrammetry or computer vision methods (Gonzo et al., 2004). More over, the 3D-RGB model, achieved by some digital images of model, appears as a very powerful procedure of survey because it makes possible to link easily the survey of a detail to its entire context and makes possible to acquire not only metrical but also chromatic and thematic data.
Advantages of imaging methods are their level of details, economic aspects, portability, handling in spatial limited environments and a short data collection time. Disadvantages remain in the post processing when the texture of the object is poor. Advantages by using an active sensor system like terrestrial laser scanners are 3D survey capacities and 3D surface acquisition. Nevertheless, this technology is not optimal for capturing linear elements and produces a large amount of data which implies to be reduced for further processing. Whereas classical photogrammetry implies a heavy amount of manual and very time consuming interaction, unfortunately the automation around laser scanning acquisition and data processing is really developed. Several parameters effect thermographic measurements namely emissity, reflectivity, environmental condition, colour, etc. To evaluate the influence of some of these parameters, simple test are carried out using the LFCs termography equipment, both in laboratory and in situ.
In this methodology, 3D modelling is done with the help of the three techniques. I compared the historical analysis to this morphological data of the studied object. In order to create a three-dimensional model of the studied object, and in-depth historical and socio-economical examination was necessary as was to be able to restore the environment.

2.2 The centrality of the instrument position and resolution of point

The data acquisition with a laser scanner can influence not just subsequent materially affect the quality. A basic consequence resulted from the introduction of laser scanning 3D is that it has accentuated the distinction between the two main phases of relief, that of the harvest and processing and interpretation. These two phases are connected to the question about the importance of objectivity and subjectivity. So you want an objective, scientific, and therefore, the acquisition phase of the data and subjective interpretation and therefore, the phase of restitution.
One aspect often overlooked in surveying with 3D laser scanner is connected to the moment of taking the data. The elements that contribute to the elaboration of a project are taken: instrumental knowledge, broad objectives of the survey, knowledge of the place.

The centrality of the instrument position and resolution of point are two factors very important. The resolution point with 3D laser scanner is always given the amount of horizontal and vertical dots in the unit of measure of the spherical surface. The centrality requires a selection of station point for the minimize dead spots due to form internal factors and factors to external interference.
The form factors are those related to the internal shape of the object space in which to detect the presence of projections, recesses or trends planimetric detail can lead to large areas of shadow.
The external interference factors are those related to the presence of natural or artificial barriers that are inserted between the object and to detect points of station or in any case involving a limitation in the second half. You can, in analogy with the theory of shadows associated with the shooting laser scanner to a point light source that is generated to detect the object of their shadows, cast shadows and shadow self-supporting.
In most cases you need to define the project of taking the number of stations and their correct placement. The

first criterion to consider is that relating to the form factor of the object to be detected.
A first fact to consider is therefore to be noted that the size of the object can be only partially offset by a different distance taken; In the case of photogrammetric shots, if you are forced to remain too close to the object you have to compensate the acquired data by several times, making it more laborious and the stage of taking on "Field" that the subsequent processing.
The project must therefore include the right socket assessments on the possible mode of "registration":
- Manual, that is, recognition of homologous points on the object architecture;
- Automatic, that is, through the recognition of target conveniently located before;
- Taken in advance to control points with a topographic instruments.

2.3 Types of resolution

Using a laser scanner 3D laser there are two types of resolution: the instrumental and the real one.
The instrumental resolution is given in most of the instruments now used, the amount of horizontal and vertical dots in the unit referred to the equatorial circumference and a meridian of a sphere that you can set the radius. The points on the sphere are identified through a system of polar coordinates defined angle horizontal and zenith angle. The amount of points affects the horizontal distance between the meridians, and then the degree horizontal angle between a meridian and another. The higher the resolution, the greater the number of meridians he vertical dots identify the subdivision zenith angle in degrees and thus the amount of horizontal circles that underlie all the same angle at the center.
Combining this data to the distance of the object returned by the laser you get the point coordinates in space relative to a reference system in which the origin is at the center of a virtual sphere, coincident with the center of the instrument.
Note also that a resolution is now set on the sphere results in an intensity equal on points on different meridians, but parallel with a thickening of points as you approach the center of the sphere.
The real resolution is rather the intersection of laser beams with the object to be detected and varies greatly depending on the shape of the surfaces and the distance to the station
recovery. This has two important consequences in the setting of the project setting: choosing points to obtain a resolution homogeneous parts detected and choose multiple stations.

An important factor is certainly the size of the vertical plane can be scanned and the positioning of the instrument from a projective point of view the distribution of laser scanner points corresponds to a gnomonic projection of the sphere in which the points remain on vertical lines in the horizontal direction and distribute the points on the second floor hyperbole. Having to detect, for example, curved surfaces can be observed that much depends on the radius of curvature and its shape from the point of recovery, concave or convex. If you have a concave surface optimization of the resolution the more the real point recovery is near the centers of curvature. In the case of convex surfaces there is an accentuation of dispersion of points as a function of the radius of curvature and the same shooting distance in the case of a planar face in which there are projections and recesses of the instrument should be generated in the central position the "shadows" in correspondence with the projections on the walls and a poor resolution perpendicular to the main floor of the facade. In many cases is appropriate to split resulting in a shooting and a resolution covering the total real smoother. To the relief of a circular base surfaces are generally required at least three stations; in this case, however, consider well the shooting distance and the overlap between the two generators of apparent contours that define the portion of the surface taken from two adjacent stations.
For the suvey of farmhouses Angelillo and Casoni Saraceni (Caserta, Italy) the environmental conditions were quite favorable to detect the interior and the side chapels, were sufficient only two shooting stations, the outside was no major obstacles. For the recovery of facade, very high, it would be necessary to have more space in front. Because of this, the recovery of the upper part of facade is less accurate than the portal,

2.4 Methodology

In the first phase of the operation, a number of reflective targets were positioned along the entire parameter of the wall, both the external and internal areas. The coordinates of the centers of the corresponding targets were then utilized in the alignment and in the geo-referencing of the point clouds of the laser scanner. The distribution of the targets was projected in such a way as to include at least three or four of these in every scan. The topographical measurements were taken by utilization of a Leica 706 no-prism total station.

The overall synthesis of the operations resulted in the execution of approximately 400 scans from nearly 40 different position, with the acquisition of more than 400 million points. The elaboration phase of the data collection in the various survey session completed was developed based on a previous programmed organization and conducted by means of the utilization of the specific Leica Cyclone version 6.1. All model created are configured according to the organization of the relative thematic layers in portions of the point clouds. This first elaboration allows for the easy management of the same models and also allows for the creation, within the examined model, of the view from which it is possible to create images at a high resolution (see you the visualization of the model in central and perpendicular projection). These visualization properties allow for, making use of the software that is predisposed to the creation of the capture video. This type of bi-dimensional elaboration have constructed the foundation upon which we have developed our hypothesis of reconstruction, creating a three-dimensional model of various scales, integrated with retouched photographic images that can enrich the information provided by geometric data.
The acquisition of 3D data with the laser scanner generates a high resolution model with questionable and exact data, with generated and interpolated faces. The acquired model are further optimized within other three and bi-dimensional graphic software, used for texturing, decimation and the graphical quality of the rendering. The method can also generate low polygon resolution version of the meshes without modifying the perception of the model, keeping the frame rate of the application higher than 25 frame/sec. With this modelling approach we obtain a fluid navigation through the mesh.
The application of virtual 3D modelling allows a spatial analysis and punctual verifications, both architectural and structural. The realization of the model is obtained through complex algorithms that control not linear behaviours of the reality. The geometric-spatial simulation is introduced like the simpler and intuitive case: in fact, it is a construction realized in the ritual space with morphological and dimensional property. A reconstructive process must be visible and transparent, supported by scientific data that determinates three different level of reliability. The structural verification through the graphical statics calculation is a fundamental instrument in order to ratify the reconstructive hypotheses.

3. SUMMARIZED RESULTS

A completed digital 3D processing of acquisition and representation will be the best basis knowledge according to an integrated approach in order to minimize the risk to lose scientific data (Forte, 2003). The recording and communication of the images through the digital archives has become a strategic instrument for the numerous activities. Scientific digital modelling of Cultural Heritage favours a conceptual surrounding defined by the perceptive restoration of architectonic space.
Overall these operations bring into production the bi-dimensional and three-dimensional elaborations having a diverse nature and completed with different objectives. In the process of the digital survey, the phase dedicated too the collection of the data consists predominantly, in the operations of the quantitative type, intending with this that one proceeds to the acquisition of an enormous quality of data that is not simplified and one depends notably on the quality of instrument the completion of the single operation.
While in the past the essential architectural survey was intended to introduce a building, itself affixed by its representations, today the purpose of the survey is multiple: form relief to know that for intervention through a complete range of options that can be solved with new technologies. Today we have technologies available that allow you to operate in many different solution.

4. CONCLUSION

The technological evolution has contributed much to raise the scientific value, and it is undeniable that the latest development, the information technology, has increased exponentially this component. But the relief is also and above all, interpretation of the reality; this interpretation inevitably leads translation models through iterative processes of decomposition and re-aggregation of multiple aspects that distinguish it from the shape, material, history, the iconography.
The trend objectification of the acquisition phase-formal metric inherent in the survey instrument and especially in 3D laser scanning needs a critical understanding of the instrument and operational phases through which to operate the choices.
The cloud of points is in itself a possible model, certainly very rich in information and you can get through this and other processing, other models, but it's still a model, with its advantages and its defects, must be assessed qualitatively, as well as quantitatively, through proper project picking up and summarizing its

scientific identity.

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