BDC

Università degli Studi di Napoli Federico II

14

numero 1 anno 2014

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Complex Evaluations for Hybrid Landscapes

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BDC - Bollettino del Centro Calza Bini - Università degli Studi di Napoli Federico II
Registrazione: Cancelleria del Tribunale di Napoli, n. 5144, 06.09.2000
BDC è pubblicato da FedOAPress (Federico II Open Access Press) e realizzato con Open Journal System

Print ISSN 1121-2918, electronic ISSN 2284-4732

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GOTHIC LINE: MAPPING GOTHIC IN NAPLES. SHARING CULTURE FOR CONSERVATION

Mara Capone

Abstract

The safeguard actions, to guarantee the conservation and to improve enjoyment of Cultural Heritage, contribute to preserve memory and to promote development of culture. The restriction nature of these actions is not enough to guarantee safeguard of Cultural Heritage, it is necessary that the knowledge is not exclusively aimed to supervision, but it has to communicate the meaning of Cultural Heritage, thus the reason of protection. Our research on a multi-purpose survey of cultural Heritage located in UNESCO Historical Centre of Naples has the following goals: to test communication actions that are able to make aware public of less known Cultural Heritage and to solve the problems connected to disrepair and to management; to design "sustainable enjoyment" systems for Cultural Heritage based on the use of interactive systems available online, in remote or on-site, for different kind of users.

Keywords: survey, gothic architecture, ICT for Cultural Heritage

GOTHIC LINE: PER UNA MAPPATURA DEL GOTICO A NAPOLI. CONOSCENZA CONDIVISA PER LA CONSERVAZIONE

Sommario

Le azioni di tutela che una società intende attuare per garantire la conservazione e la fruizione del patrimonio culturale concorrono a preservare la memoria di una comunità e a promuovere lo sviluppo della cultura. La natura prevalentemente vincolistica di queste azioni non è sufficiente da sola a garantire la salvaguardia dei beni, è dunque necessario che la Conoscenza non sia finalizzata esclusivamente al controllo, ma che sia utilizzata per Comunicare il significato di cui il bene è veicolo materiale, e quindi il motivo della tutela.
La nostra ricerca nell'ambito del patrimonio religioso localizzato nel sito UNESCO del centro storico di Napoli ha i seguenti obiettivi: sperimentare specifiche azioni comunicative in grado di catalizzare l'interesse verso un patrimonio religioso minore al fine di contribuire alla risoluzione delle problematiche di natura gestionale; progettare sistemi di "fruibilità sostenibile" dei beni con soluzioni tecnologiche basate sull'utilizzo di interfacce interattive accessibili online, in remote o on site, destinati a diversi utenti.

Parole chiave: rilievo, architettura gotica, ICT per i Beni Culturali

1. Sharing knowledge for safeguard of Cultural Heritage

Sharing knowledge is the first form of protection and promotion of Cultural Heritage.

We think that you must replace the concept of knowledge\protection to the indissoluble concept of ignorance/neglect. The knowledge is understood as part of an open system in which different processes of knowledge can interact. The goal is to spread culture in order to strengthen civic sense and remove degradation.

Inventory and cataloguing are the first step to preserve and to valorise Cultural Heritage. You can't preserve what you do not know, but knowledge is not enough to transform Cultural Heritage in economic resource, to do that you have to share cultural meanings.

From 1995 Historical Centre of Naples is in the UNESCO World Heritage List, there are more than 1,500 UNESCO point of interest in Naples, 700 are churches and some of these are closed or not used, for this reason they are usually in a bad condition.

We are looking for strategies that are able to best practise in Heritage Conservation management. The research main goal is to find strategies to transform knowledge in shared culture. The idea is to design thematic itineraries to test new ways to preserve and to promote cultural heritage less known. *Gothic Line: mapping gothic in Naples* is the thematic itinerary that we are developing to guide users to discover some of the large number of churches that are in Naples that could be linked to gothic churches built during Angevin period.

In this paper we are going to resume the methodological path on which we are based the design of thematic itinerary and the communication actions.

The mains steps of the research are:

- definition of the theme, gothic French features, to compare the theoretical models with built architecture;
- mapping gothic churches of Angevin period in Naples;
- mapping gothic in Naples, partially transformed churches;
- mapping gothic in Naples, completely transformed churches;
- sharing cultural meaning using interactive communication systems.

2. The main features of French Gothic architecture

Gothic architecture spread in Naples when Charles I of Anjou came to Naples in 1266.

To understand the gothic architecture in Naples you need to compare it with original model, thus you have to know the main feature of French Gothic architecture.

From reading of the *Livre de Portraiture* of Villard de Honnecourt, a fundamental document for the study of Gothic architecture, you understand how the geometric rules used in the Middle Ages constructions are defined.

The vaults system regulates the building of medieval cathedrals, a system in which you can clearly distinguish the elements carried by the ribs, whose load-bearing function becomes explicit when the groin vault transforms.

The geometry of medieval vault could be originated by two different shapes: the sphere, the domical vault, from which the vaults with domed trend typical of Aquitaine, and the cylinder, the groin vault, characterized by perimeter semicircular arches and elliptical diagonal arches, from which derives the rib vault typical of Ile de France (Fig. 1). The secret of Gothic buildings is the use of geometrical rules, rather than fixed modules, designed to optimize the construction stage; only the knowledge of these rules will help you

to understand these architectures, where the figurative outcome is closely related to construction methods.
First of all there is the rule of the three arches, illustrated by Villard de Hoonecourt (1230), thanks to which you can construct some different pointed arches with the same circle, then you can achieve semicircular diagonal arches and pointed arches with the same supporting structure and the same stones (Fig. 2).

Fig. 1 - French Gothic features. The geometry of Gothic vaults

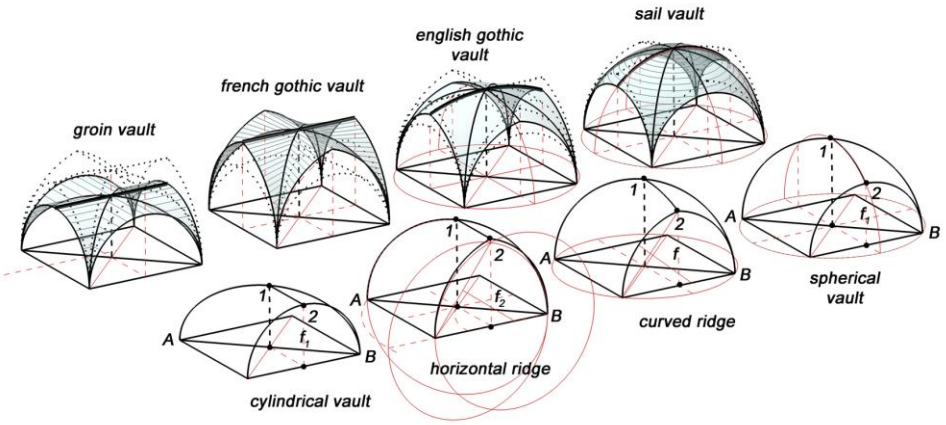
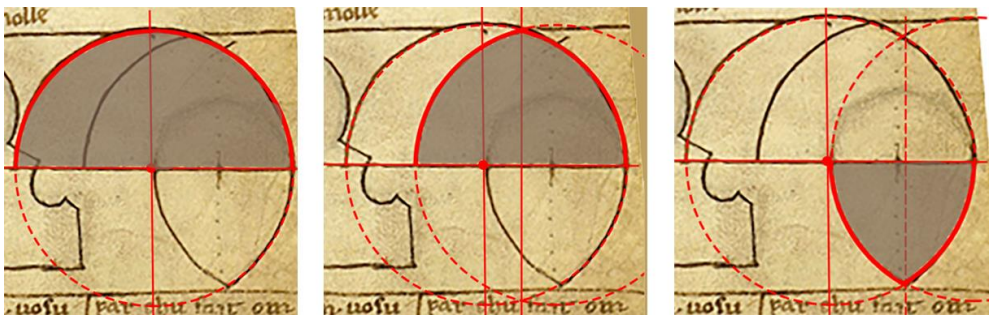


Fig. 2 - Villard de Hoonecourt: the rule of three arches



Source: elaborated by the author from de Honnecourt (1230)

Another important constructive simplification arises from the possibility to preserve the alignment of the keystones in order to obtain horizontal ridges. Applying the rule of three arches the keystones of the pointed arches are at different level compared with the keystone of the vault, thus the arches will be raised to have horizontal ridges.

The first Gothic vaults are quadripartite rib vaults on square or rectangular plan. They have curved ridge if they are originated by transformation of the dome or they have horizontal ridge if they are originated by groin vault.
The feature of these vaults is to have semicircular diagonal arches and the others are generally pointed arches. The arches can be composed of arcs with the same curvature of the diagonal arch, the keystones can be at the same level (horizontal ridge), or may have different curvatures and keystones placed at different heights (curved ridge).
The survey has allowed us to compare the theoretical model with the exact configuration of the two case studies chosen from among the most significant in the context of Naples: the choir of S. Lorenzo and the apse of Santa Maria Donnaregina.

3. Mapping gothic churches in Naples

Our gothic itinerary is designed to communicate the real meaning of the very complex Historical Centre of Naples, that is built on itself during the time.
Following a time line, the tour starts from 1266, from the reign of Charles I of Anjou. Talking about the birth of Gothic in Naples and the many changes that the most part of churches have undergone, you can understand what you see today. The goal of our tour is to create a high standard of cultural tourism and to tackle degradation with culture.
Along Gothic Line you meet, first, the churches where it is possible to recognize the original French Gothic features. The comparison with French models and theoretic model allows you to understand the transformations of the original matrix.
We have identified three groups of churches according to the transformations that they have undergone (Fig. 3):

- Gothic Churches with French Gothic features;
- Gothic Churches partially transformed;
- Gothic Churches completely transformed.

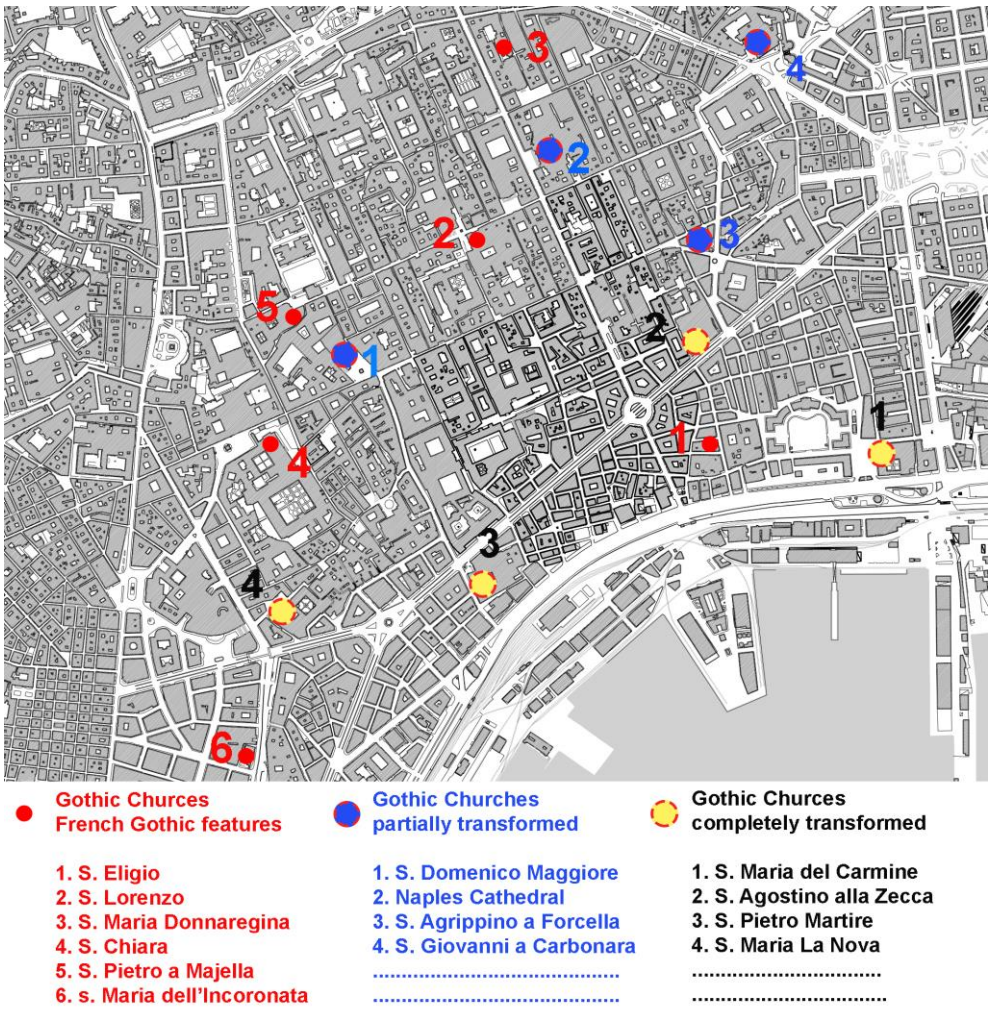
In the first group there are churches that take directly from French gothic, they can be considered gothic masterpieces. In this group we have included S. Eligio, S. Lorenzo, S. Maria Donnaregina, S. Chiara, S. Maria dell'Incoronata and S. Pietro a Majella.
In the second group there are churches built during Angevine period but partially transformed and we think that are Naples Cathedral and S. Domenico Maggiore.
The third group includes all churches completely transformed, built during the Angevin period but that are very different look now, such as S. Maria del Carmine.
Our goal is to link these most famous churches to less known churches, sometimes closed or not used and thus in bad condition. Including these churches in a cultural itinerary could be a way for public awareness and to solve the problems connected to neglect. We are going to test AR and VR applications to spread the cultural meaning to a wide audience, to show the original look of these buildings only when it is possible to formulate reliable reconstruction hypotheses in line with the international principles or when they are closed (virtual restoration).

4. The Gothic Line in Naples: Gothic Churches with French Gothic features

The Gothic develops in Naples between 1266 and 1495, during the reign of Charles I of Anjou until the death of Alfonso of Aragon. French and Spanish architects worked in Naples for the Angevins and the Aragonese together with local architects creating new typologies. Most Gothic buildings in Naples have changed very much during the time and

in many cases the original matrix is unrecognizable. There are not civil architectures of Angevin period while you can see many churches of this period. When Charles I arrived in Naples in 1266, in France, the cathedral system was already widespread and French architects tried to apply here the geometric rules that they used at home to define the configuration of the complex vaulted systems.

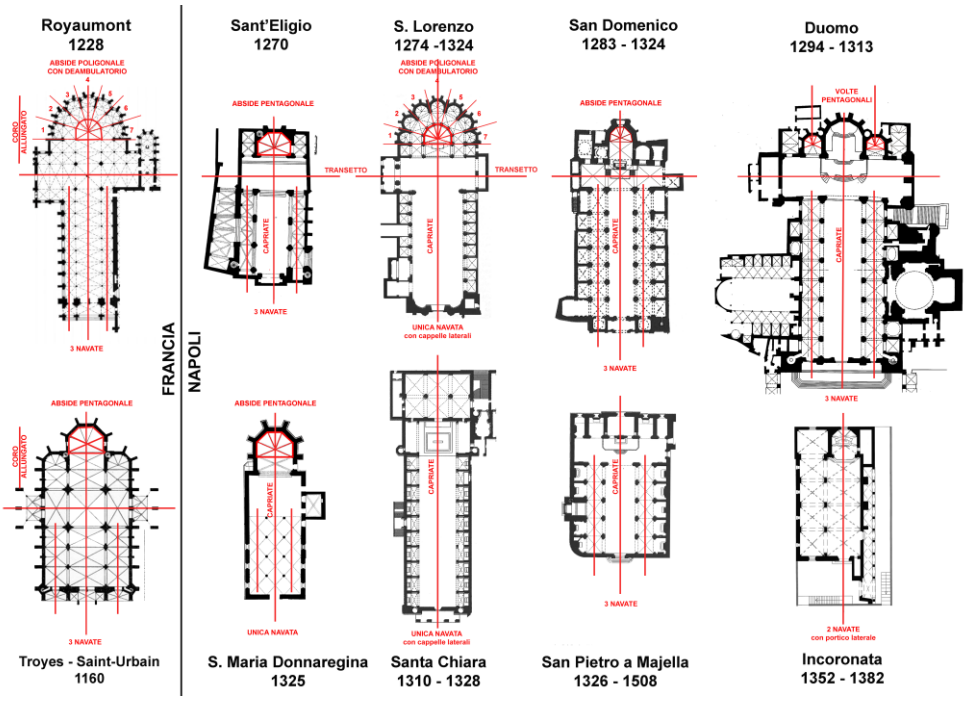
Fig. 3 - Gothic Line: mapping gothic churches in Naples



In most cases the principles of French Gothic architecture mingle with the local character generating new hybrid forms, but these principles are perfectly recognizable in the apse of San Lorenzo, built according to the models of Northern France, and in the S. Maria

Donnaregina, built according to the models of Southern France. The quadripartite or esapartite vaults system, that strongly characterizes the roofing of the nave and transept of the French cathedrals, is lost in Naples. Also in San Lorenzo and Donnaregina this system is replaced by wooden trusses (Abbate 2005). The use of the truss becomes the main feature of all Gothic churches built during the Angevin period. Sometimes there is not a real transept (such as in Santa Chiara, in Donnaregina and in the Incoronata), in some cases they have a unique nave, with or without side chapels, or they have three naves (such as in S. Eligio, S. Domenico and in the Cathedral), many of them end with a pentagonal apse (such as in Donnaregina, in St. Eligio and in S. Domenico) or, according to French model, with a polygonal apse with ambulatory and radiating chapels, such as in the S. Lorenzo's choir (Fig. 4).

Fig. 4 - Gothic Churches in Naples: French Gothic features and transformed



Compared with the traditional typology of French cathedrals, characterized by: considerable development of the choir surrounded by ambulatory with radiating chapels, three naves, the main nave covered by a system of *quadripartite* or *esapartite* (Grodeki, 1978) vaults, in Naples you can find only some of these features. Despite the spread of the French quadripartite vault, the structuralism trend, typical of the Ile de France, which allowed the masters of French Gothic to eliminate all inert parts of the building, never applies completely in Naples (Venditti, 1969). The result of meeting between French

Gothic and local tradition was original more then hybrid, it was a good mediation between the mystical vertical impulse and the classical tradition typically southern (Venditti, 1969).
The main goal of the research is to define, through survey, permanent features and mutations in the Gothic churches in Naples compared with theoretical models and French models.
The survey of the two most important Gothic churches in Naples, S. Lorenzo Church and Donnaregina Church, is a part of a broader thematic study about the geometry of the vaulted systems made in the Angevin period.
The main goal of the research was to define a methodological approach, to study Gothic, based on knowledge of the *forma mentis* of the early Gothic, constantly seeking solutions defined always with the aim of simplifying the construction process.
The study allowed us to show how, through the ingenious use of geometry, medieval builders have developed constructive methodologies to bring the gothic works to simple rules, which knowledge is the key to discover the secret.

5. Case study: S. Lorenzo Church, survey for sharing knowledge

Case study allows us to show the methodological path to compare gothic architecture in Naples with theoretical models from survey.
The church of San Lorenzo is the oldest church built by the Angevins in Naples during the early years of the reign of Charles I and it is considered the symbol of ideological conflict between the French architects, that worked in the choir, and the southern masters, that worked in the transept and in the nave (Venditti, 1969). The system is characterized by a large nave covered by trusses, nine chapels on each side and a transept, without vaults (Venditti, 1969). On the contrary, the apse is Gothic. It is composed by a polygonal presbytery with ambulatory and radial chapels, where you can find all the typical features of French architecture, such as the quadripartite vaults, the clustered pillars, flying buttresses and buttresses.
The geometry starts from the centre of the presbytery, from which branches a radial structure that divides the space into seven equal parts. Around this space you configure the ambulatory, characterized by trapezoidal quadripartite vaults, and the seven radial chapels with pentagonal rib vaults. The presbytery area is connected to the transept with a rectangular vault, which is at an intermediate level between the roof of the choir and the truss system of the transect (Fig. 4). This element of transition, between the transept and a polygonal apse, is enhanced by the opening of two *oculi* in the upper wall of the transept and an *oculus* opened in the wall between the rectangular vault and the apse vault, thanks to the difference height of the two roofs (Venditti 1969) (Fig. 5).
In this case the survey's goal is to compare the real geometry of the vault system with the theoretical model, that we have built based on the study of the Treaties and on the French models. The knowledge of the geometrical rules of construction dissolves doubts about the interpretation of 3D laser scanning data, data that are critical to compare the case study with the theoretical hypotheses.
The apse of S. Lorenzo is composed of the following kinds of vaults: quadripartite vaults on a rectangular plan, present in the element of transition between the transept and the apse; ribbed vaults in the area of the polygonal apse and radial chapels; quadripartite vaults on trapezoidal plan in the ambulatory.

Fig. 5 - S. Lorenzo. Point Cloud from 3D laser Scanner survey

Fig. 6 - S. Lorenzo. Comparing geometric rules with survey data

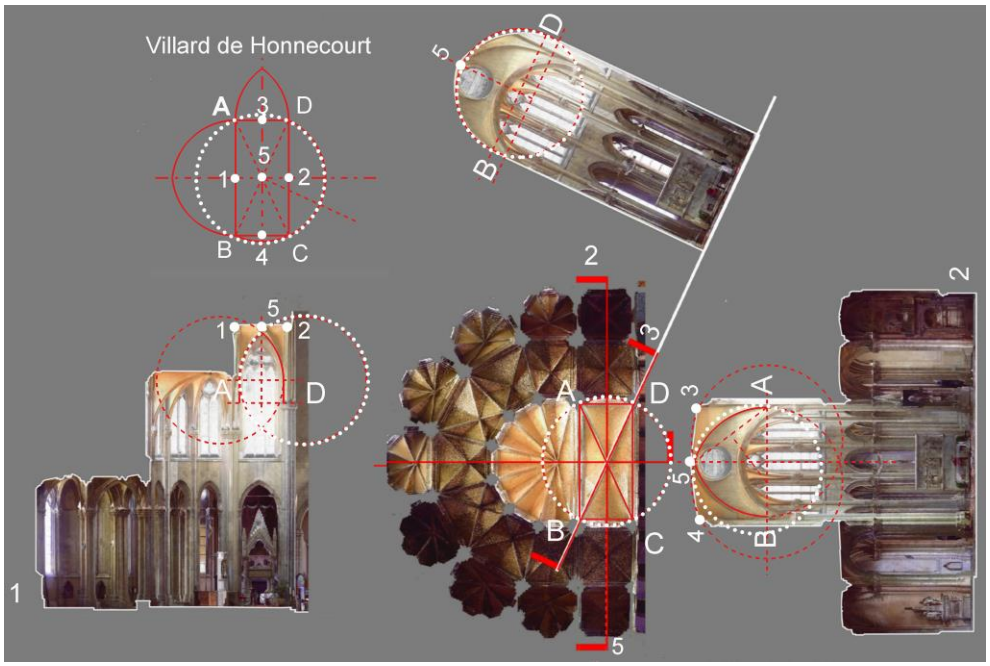
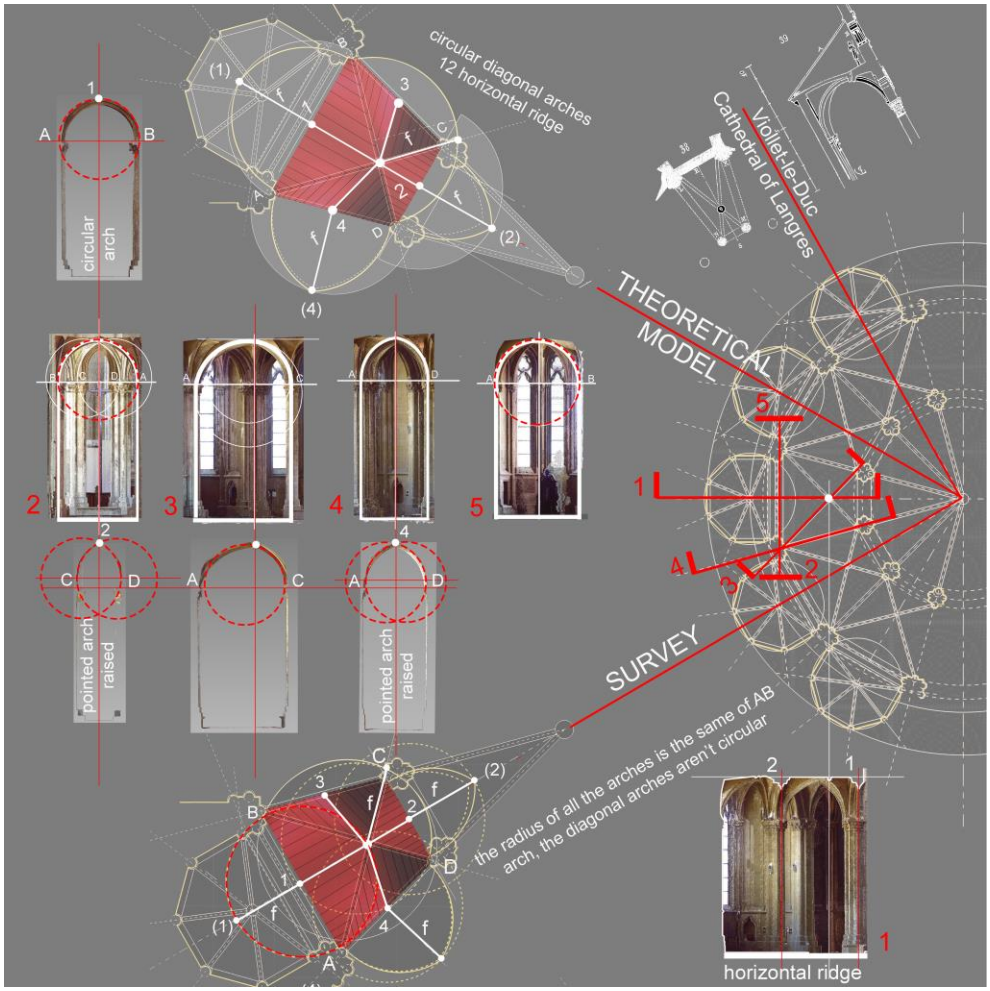


Fig. 7 - S. Lorenzo. Quadripartite vault on trapezoidal shape: comparison



For the construction of the quadripartite rectangular vault, ABCD, we suppose that: the arcs diagonals AC and BD are rounded arch; the ridges 12 and 34 are horizontal; the keystone, 5, is at the same height of the keystones of the main arches, AB and DC, and of lateral arches AD and BC; the pointed arches are built with same curvature of the diagonal arc BD, according to the rule of the three arches of Villard (Fig. 6).

The survey shows that the diagonals arches, AC and BD, are semicircular and the main arches, AB and DC, and the lateral arches, AD and BC, are probably obtained by applying the rule of Villard and therefore they have the same curvature of the diagonal arch AC. In fact, comparing the two different ways to draw the pointed arch AB the difference between two lines is minimal. The ridge 12 is horizontal while the heights of the keystones of the

lateral arches, 3 and 4, are at a lower level than the keystone 5, thus the ridges 35 and 54 are straight, but slightly inclined.
Very similar to the choir of the abbey of Royaumont (Fig. 4), the choir of San Lorenzo is characterized by a polygonal space divided into seven segments, five of them are equal and two are for connection, surrounded by ambulatory and radial chapels.
The very widespread custom in Ile de France, to surround the presbyters of the churches of ambulatory, with or without radial chapels (Viollet le Duc, 1981), determines the development of geometric solutions for the ambulatory vaults. In the case of S. Lorenzo these radial vaults are trapezoidal shape and the architect has thought that it was not possible to trace these pointed arches using the broken lines (Viollet le Duc, 1981) in horizontal projection, for this reason the keystone is closer to the shorter side of the trapezoid. Unlike the French model, the trapezoidal vaults in San Lorenzo have diagonal arches belonging to the same plane and are not broken, as in Royaumont. The theoretical study shows that there are several possibilities to build a quadripartite vault on trapezoidal shape (Fig. 7). Assuming that the arcs diagonals AC and BD are semicircular, and that the main arches, AB and DC, and lateral arches, AD and BC, are pointed arches with a radius equal to BD, and that the keystones of arches are at the same height of keystone of the vault, it follows that the lateral arches are slightly raised. According to this hypothesis the ridge 12 is horizontal. This is not the only possible solution, in fact, in some cases, the ridge is tilted as shown in the drawing of Viollet-le-Duc of the cathedral of Langres.
From the survey it appears that the main arch AB is round arches, the ridge 12 is horizontal, therefore the level of the key of vault is equal to that arch AB. The diagonals arches, AC and BD, are not semicircular but they are composed of two arches. The pointed arch CD has the same curvature of the arc AB, this arch is raised because the ridge 12 is horizontal. The arches of the side BC and AD are pointed arches, they have the same radius of the arc AB and they are raised. From the survey results that the keystones of the lateral arches are placed at the same height of the key of the vault, the ridge 12 is horizontal and that all the pointed arches have the same curvature.
As a matter of fact that is very difficult to understand all that, thus we are going to do a specific communication project to spread the complex geometry of gothic vault system to wide public based on the use of interactive interfaces. The goal is sharing knowledge to go behind the look (form) to understand the structure and therefore the real meaning of Gothic architecture.

6. The Gothic line in Naples: Gothic Churches partially transformed

The second group includes all those churches partially transformed. The most important are the Cathedral of Naples and S. Domenico Maggiore (Fig. 8).
S. Domenico Maggiore, built during the reign of Charles II of Anjou, probably from 1283 to 1324, is a Latin cross church, with a long nave, a transept and a pentagonal apse. It is three naves church with side chapels. The Church has been transformed during the time and now it looks like a Barocco church, but if you see behind the look you can recognize the gothic origin especially looking the apse and outer faces.
Also Naples Cathedral is Latin cross church with three naves, built during the reign of Charles II of Anjou, it is closed by a polygonal apse transformed during Barocco time. You can discover the Angevin look only from pointed arches, that are in the nave, and especially

in the four chapels located on the sides of apse: Galeota, Tocco, S. Lorenzo and Minutolo (Fig. 9).
There are also less known churches partially transformed, such as S. Agrippino in Forcella, where you can see some gothic features, visible especially in the apse, combined with Barocco style one (Fig. 11).

Fig. 8 - S. Domenico. The Church has been transformed, now it looks like a Barocco church

Source: elaborated by the author from it.wikipedia.org

Fig. 9 - The original look of the gothic Naples Cathedral is recognizable in Minutolo Chapel

Source: elaborated by the author from it.wikipedia.org, www.pienterest.com, www.duesicilie.net/napb0005.html

The thematic itinerary suggest you how to discover gothic traces in the churches of Naples. Our goal is mapping all of these less known churches with the same features (partially transformed) and to link them to the most famous one (Fig. 12). We are going to design VR or AR applications to show the original gothic reconstructive hypotheses based on the study of the sources or to show the virtual restoration when they are closed.

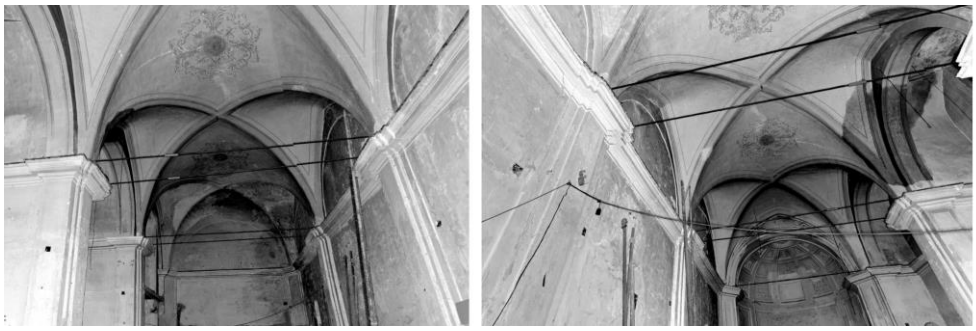
Fig. 10 - S. Giovanni a Carbonara. Started in 1343, the church is a result of work in progress

Source: elaborated by the author from it.wikipedia.org

Fig. 11 - S. Agrippino a Forcella: Gothic features combined with Barocco elements

Source: elaborated by the author from it.wikipedia.org

Fig. 12 - Following Gothic line to awake public interest and to save closed or not used churches



Source: 3D laser scanner survey, images from 360° panorama

7. The Gothic line in Naples: Gothic Churches completely transformed

The third group includes all those churches completely transformed, built during the Angevin period but that are a very different look now.

As a matter of fact, most of the gothic churches in Naples were rebuilt because they were damaged by earthquakes or fires, such as S. Agostino alla Zecca, S. Maria La Nova and S. Pietro Martire, or they were turned into barocco churches, such as S. Maria del Carmine that was completely covered by decorative plasters. Now it is impossible to recognize the original look of these gothic churches. We are looking for gothic trace behind barocco look of most Naples churches, and following the Gothic Line we are going to awake public interest on these churches.

We are going to test AR and VR applications to show the original look of these buildings when it is possible to formulate reliable reconstruction hypotheses in line with the international principles. The comparison between the reconstructive hypotheses concerning the different historical periods, defined according to the elaboration of all the available resources, with the historians and the study of treatises, allows us to understand the internal continuity of each building.

The reconstructive hypothesis must be formulated in line with the internationally principles summarized in the *London Charter for the Computer-based Visualisation of Cultural Heritage* and *Seville Charter*.

Survey will be the first step to formulate a reconstructive hypothesis scientifically correct, through study and critical analysis of all the sources you can define what to rebuild, how to rebuild and which technology to use.

8. Sharing knowledge using interactive communication systems

The development of ICT is rapidly changing the communication system, thus it is necessary to test Digital Media to find new ways of enjoying, improving and managing Cultural Heritage, especially when it is closed or not used.

The research has the following goals: to test some innovative strategies to improve public enjoyment for inaccessible sites; to explore the use of some interactive systems to show and to study cultural heritage in remote; to explore how to access the information system through AR applications.

The main target is to explore the power of multiple interactive representation methods to enjoy and to study Cultural Heritage in remote, to offer to researchers (historians, administrative technicians, etc.) even without any particular competence in using technical interfaces, such as the ones for using data performed by scanner lasers sensors or image based modelling techniques.
The aim is to generate an interactive database, which offers information on different layers, each for any different kind of potential user. The goal is not only to offer a visual experience of the heritage analyzed, but to give the possibility to take directly other information as, for example, to measure parts and elements of the architecture. This case happens very often, especially when different kind of researchers has to approach to the same historical heritage for several study aims. The need to have particular information to endorse some hypothesis could oblige to catch some dimensional measures that could need difficult to survey.
The possibility to make these operations in remote mode could give an interesting spectrum of possibilities of investigation. In order to give as much information as possible to users, the database has to integrate different systems of data, obtained by different methodologies, to join a wider range of cultural elements: the systems based also on the interactive use of 3D models easily navigable, such as 3D PDF file, could offer a solution to the problem.
In this way, it is possible to have multiple acquisitions that can be compared to a double goal:

1. to take the best type of information to match with the capability and skill of the final user;
2. to make a comparison among different methodologies and techniques, so to define a system of data that takes advantage from all of them and gives a result with the most high degree of accuracy, to create a system more useful and more adequate for maintenance, restoration or analyzing Heritage.

Fig. 13 - S. Lorenzo. 360° panoramic image

9. The use of 360° panoramic image for Cultural Heritage study and enjoyment

One of the interactive representation systems is the use of 360° panoramic images. Within cultural heritage applications 360° panoramic imagery is increasingly being applied (Fig.

13). Immersive imaging techniques can be used to provide virtual tours. This panoramic image can be explored by PC, smartphones and tablets using dedicated software, you can produce interactive videos that can be linked to maps, hotspots, and dynamic text.
The systematic use of panoramic images within a database allows you to gain a thorough understanding especially linked to the perceptual aspects. But if you want to go beyond the look, because you want to study and not only to look, you have to be able to measure the object. We have two different solutions to this problem: we can use 360°panoramas as a user interface to access 3D data or we can use them for 3D restitution, the first solution is suitable for all users, while the second is just for experts.

10. The use of 3D PDF as interface to access 3D data

In our research we are going to use 3D model to produce an interface to access 3D data. Interfaces are generally all physical or virtual "devices" that allow exchange information between two or more different systems. We can define "user interface", everything allows humans to interact with the machine. So the concept of interface is tightly connected to interactivity. The choice of the interface depends on the structure and the goals of the database, for this reason it can be designed in different ways.
Research is increasingly oriented towards identifying structures that stimulate the cognitive mechanisms to facilitate the transformation of information into knowledge. Therefore designing interface plays a key role because interface allows the user to access information in a natural and instinctive way. Usability, Comprehensibility, Originality and Agreeableness are the basic requirements in the design of an interface that is able to reflect the aim of the information system which it refers to, trying not to reduce the interaction to a simple path. Interactivity is the difference between analogical and digital media, and the interaction between man and computer system evolves from multimedia to multisensory, developing interfaces that let us interactively explore virtual environments and interact with 3D objects. For this reason to produce this kind of interface you have to produce a 3D model and you can do it in several ways. The great advances in 3D modeling allow us to design a multimedia database both for wide public and for scientific research aim.
3D model construction is the first step to produce a user friendly interface for serving data, thus the representation code should be chosen in relation to the database goals. When we design a 3D interface we have to decide if it's better to use a realistic representation or an iconic one, if we want to show the look of the object or his hidden structure to spread its cultural meaning.
Generally, the aim of 3D modellers is to produce a photorealistic 3D model that sometimes is a sort of a clone of the real object because they are often more interested in the technological aspects than to the cultural ones.
A multimedia database with a realistic 3D model is not so interesting for our case studies because we can see the Churches using the 360° panoramic images better then a virtual simulation of them.
We are going to use this 3D model to generate a 3D PDF and to explore the possibility to use it like a user "friendly interface" both from generic users and from scholars to acquire information about metric data but not only.
It is possible to generate a 3D PDF establishing different types of visualizations (opaque, transparent, wireframe, etc.) that can be easily viewed using Acrobat Reader (Pletinckx, 2011). Generally, 3D PDF is not a photorealistic model but it allows the users to acquire a greater awareness through the interaction with the 3D model. The use of 3D PDF let us to link to 3D model some others data by layering, named views, action and so on.

The experimentation in this field is to produce models using different forms of visualizations for different communication aims and to develop a measurement tool based on the use of 3D PDF files (Figg. 14-15).
Our goal is to use 3D PDF to show gothic features, to discover the real structure of the gothic churches transformed under barocco look or to compare the reconstructive hypotheses of Angevian period of the gothic churches rebuilt during the time.

Fig. 14 - S. Lorenzo. 3D PDF an interface to study. For scholars

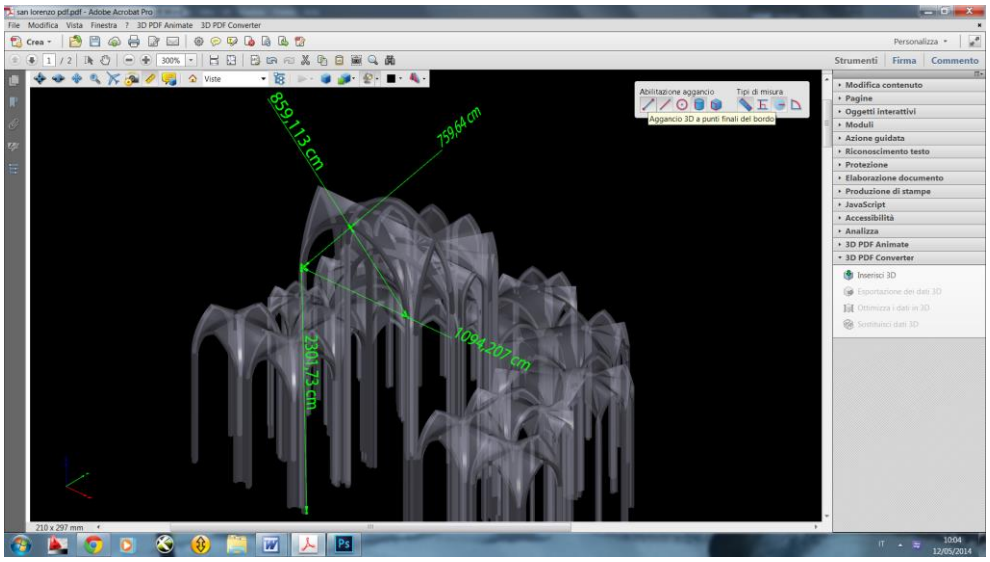
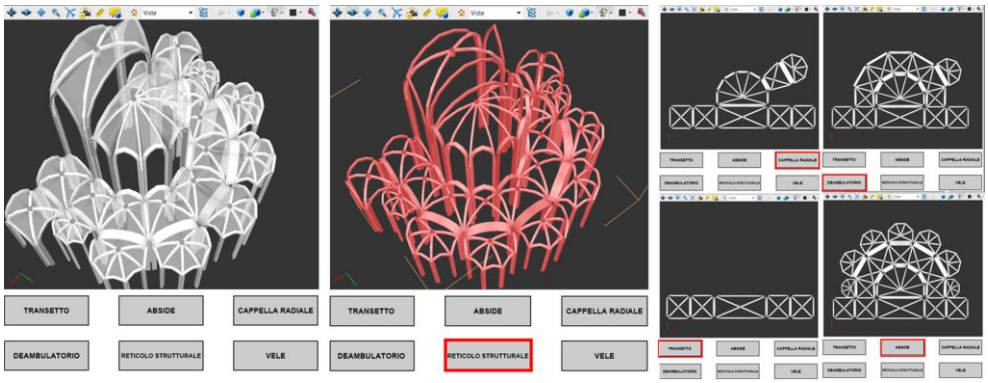


Fig. 15 - S. Lorenzo, 3D PDF. User friendly interface for general users. Showing complexity



11. Conclusions

The aim of this paper is to show the methodological path from studying to promote Cultural Heritage and to suggest a way to guide users to discover a part of very extensive Religious Heritage of Historical Center of Naples based on the use of thematic itinerary.

12. Acknowledgements

The author is thankful to Raffaele Catuogno and Angela Buonafiglio for the laser scanner survey and to Lucia Acanfora for the work carried out on the modeling about the S. Lorenzo Church.

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