

The static model of San Gaetano church: New interpretive hypotheses

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ABSTRACT

One of the characteristics of the architecture of **Guarino Guarini** is the contrast between the **real static system** and the **apparent one**. The first consists of the structures that actually provide support for the building; the second one, instead, are the architectural elements that represent the formal transposition of constructive logic.

The goal is to offer an image of a miraculous balance. In the two churches built in Turin, San Lorenzo and the Chapel of the Holy Shroud, Guarini uses **hidden structures** that support the elements above. These elements are crossed arches of bricks, wooden rafters, metallic chains, all hidden in the thickness of the external walls. Pendentives are hanging on the back with metal anchors, being simply stone coating.

Starting from these data, the study analyses the church of **San Gaetano in Vicenza**, designed in 1675, through inedited three-dimensional models.

The aim is to reconstruct the **ideal static model**, looking for the presence of hidden support structures here too. The plan is a **double envelope**, composed of nine domed spaces; the middle one is identified by four pillars. The central space is surmounted by a **double-shell dome**, not supported by pillars, but that seems to rest on the domes of the side spaces. The pillars and the overlying pendentives only support a balustrade diaphragm, which hides the impost of the dome from.

It can therefore be assumed that Guarini would take a **hidden structure**, consisting of **four brick arches**, along the sides of the square surrounding the circle that identifies the dome, tangent to the inner faces of the pillars.

These arches perpendicular to each other, with impost on the central pillars, bring the loads of the dome on the pillars themselves. The static role performed by ambulatory is to ensure, through his vaults, the thrusts opposed to those generated by the central dome.

The very low thickness walls that surround the lateral spaces have no bearing function: the loads are concentrated at the intersections, identified by high thickness and free-standing columns.

INTRODUCTION

The representation of constructive logic is one of the elements that most characterize the architecture of Guarino Guarini.

The unusual structures designed by the Theatine break the continuity line with the Roman architecture: the Baroque architecture had as a fundamental element the expressiveness of the masonry wall, sculpturally articulated. Borromini had never drilled the surface of its domes that, although innovative, continued to be based on classical principles.

In the architecture of the Theatine, the static system adopted and represented in the form of the building, conceptually refers to a structure similar to a discretized one: the flow of the load above the domes to the isolated support of the lower levels, through three-dimensional arches and pendentives, suggests a structure that denies the function of the continuous wall. In these characteristics can be identified a clear, symbolic and expressive will of the architect, who wants to offer to the observer an image of a miraculous and unstable balance. In this approach, although it is never explicitly stated by the author, cannot remain aloof the predilection for the Gothic style, also mentioned in the pages of the treatise of "*Architettura Civile*." In the analysis of the architecture of Guarini, it must allow for a difference between the realized and unrealized projects. The latter show common features, in particular for the type adopted, that can be defined with double shell, for the presence of a central dome resting on isolated supports, for the role of the masonry wall, reduced almost to a membrane of tamponade.

With regard to realized buildings (the church of San Lorenzo and the Chapel of the Holy Shroud, both in Turin), it becomes essential to remember that the projects were heavily influenced by the fact that Guarini has always intervened during construction, suffering the constraints imposed by the structures already built. Here we have the implementation of structural elements that represent, inside the building, a static system that does not coincide with constructive reality, consisting of cleverly hidden structures, that unexpectedly become visible to the keenest observers.

The real static system of Church of San Lorenzo in Turin

Inside the church built in Turin, the unusual succession of volumes creates an overall system whose equilibrium is unstable: in the upper parts, the sequence consisting of double lantern and dome of crossed arches appears to be consistent, and each element appears necessary to support the above. You cannot say the same thing for the area of the pendentives: here it goes from a static system of line-forces and apparent plug structures, to a system consisting of heavy wall masses (the pendentives), which support the upper structures resting of two slender columns, through a sequence of serliane. The latter wrap and shape the hall and seem, therefore, to support visually the dome. Even the oculi, placed to pierce the serliane, suggest the impression that the huge dome is equipped, in fact, of other supporting elements: a unique system of hidden pillars and arches.

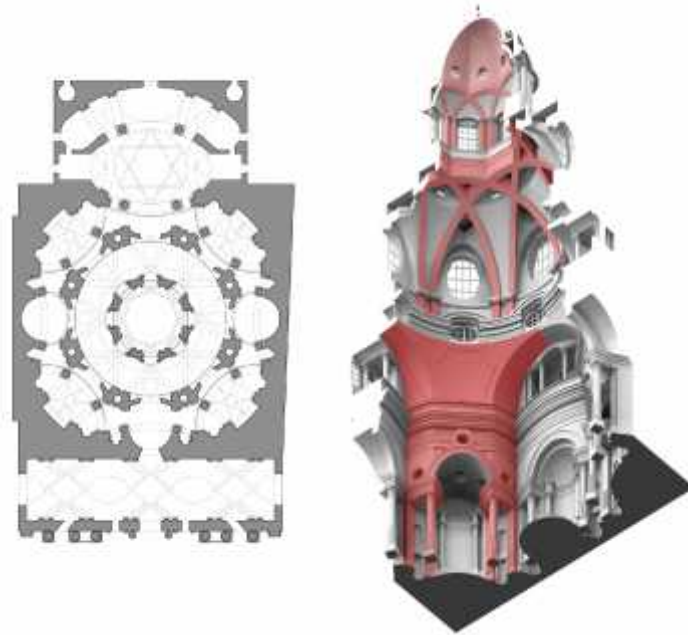


Figure 3 Church of San Lorenzo in Turin: plan and cutaway perspective with the apparent static system

The above demonstrates the clear will of the architect to create an "apparent" static system that, sacrificing the congruence between form and structure, create the impression of a miraculous balance. The reasons behind this may be mainly two. The first is the will, which is typical of Baroque architecture, to arousing wonder in the observer: not being able to use large size of the dome, given the constraints imposed by the site and by the existing project by Amedeo di Castellamonte, Guarini used a daring static system. Secondly, this could be justified by the demands of the Theatine: they require in fact a great number of chapels with altars; every chapel had the patronage of a noble of the House of Savoy, and was therefore one of the main sources for the economic grant of the work.

A copper engraving, entitled "Keystone of San Lorenzo", reveals the real substance of the bearing structures. This incision is made from a drawing by Guarino Guarini. The architect made all the drawings on one sheet: below, a portion of the plan, perfectly symmetrical, and up the elevation and the section of the large arches hidden behind the pendentives. The hidden arches are visible: in plan are indicated by pairs of dashed lines that intersect above the vault of serlianas placed on the diagonals of the base square. The impost of these arches are in the bottom of the vaults, in correspondance of the great wall masses that are located at the corners. In vertical projection are represented the elevation of the longitudinal arches and the section of the transverse ones: they are round arches of uniform thickness, perfectly equal and symmetrically arranged, so that the longitudinal are bypassed by the transverse. Bypassing, being equal arcs, it is obviously possible provided that the arc is elliptical or polycentric, with the same sagitta and the longer chord.

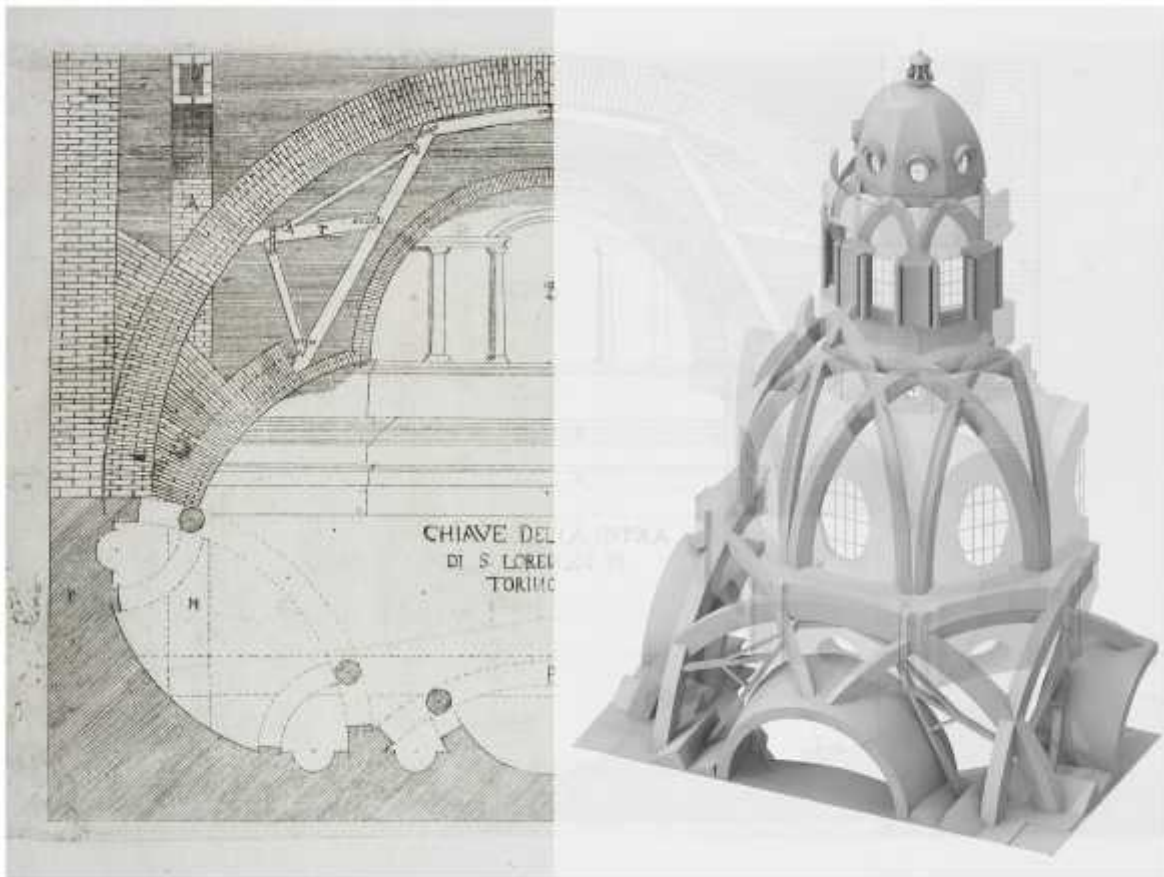


Figure 2 copper engraving entitled "Keystone of San Lorenzo" : and three-dimensional model of hidden bearing structures

Another hypothesis seems to argue that the arches intersect itself; anyway, as I was able to personally verify during the inspection, the inner part between arches and masonry, can be inspected at a height that does not make it possible to formulate certain assertions.

The thickness of the arches, that is the distance between intrados and extrados, is equal to 0.775 m, the chord is approximately 14.16 m. and the sagitta is equal to 7.08 m. The transverse arch is represented with a hollow section. The interior, in fact, is highlighted by a thick dotted line and especially by the letter "V", which does not indicate generically the arc, identified by the letter "A", but precisely its centre. The hypothesis that the arches are actually empty or crossed by wooden ties should be discarded. The most recent critics notes that both Vasari and Barbaro have talked about the technique to make the vaults and columns in wooden formwork with a mixture of gravel, lime and cement, attributing the invention to Bramante. It may therefore be that Guarini meant to experience this technique using the bricks as formworks.

Anyway, the most probable hypothesis remains that the arches are in solid masonry. To contain the powerful thrusts caused by the four arches, resulting by the weight of the dome, Guarini uses a wooden structure: the latter is configured as a centring composed of ten

elements, which support the arch in five points of the intrados, with connections reinforced with metal brackets.

Last element depicted here is the vault of the serliana that, in a point of apparent weakness of the structure, rests on a flying buttress which tapers gradually for three times.

Through the inspection of hidden parts, the actual geometrical configuration and the static function of the individual elements have been clarified. Therefore, the real static succession is configured in the following way: as previously mentioned, the succession double lantern - dome of crossed arches, exhibits its real static functioning. Conversely, the pendentives are not load bearing: this task is performed by four arches. Compared to engraving, there are four other segmental arches, placed at 45° with respect to the above, going to reconstitute the octagon coincides with the impost of the crossed arches above. The wooden structure of support coincides with the one depicted on engraving copper. The vaults of serlianas are generated by a conical surface, not cylindrical, with generatrix inclined by 8° . Finally, those that appear as arches are actually trompe which converge in the corners of the building.

The other important element is the will of Guarini to make readable, to the eye of the attentive observer, the existence of this opposition between real static system and apparent one, through a series of devices:

- the eight oval windows that open in the cornice below the impost of crossed arches hint at the keys of the arches behind;
- the arches surmounting this windows, suggest the location of the hidden arches;
- the oculi in the walls under the serliane deny the bearing function of the serliane itself;
- the round windows that open in the intrados of the vaults of the corner chapels glimpse the trompe hidden in the rear-wall.

The church of San Gaetano in Vicenza

The project is represented in Tables 26 and 27 of the treatise " *Architettura Civile* " by Guarino Guarini, and its design dates back to approximately 1675.

Contrary to the usual lack of documentation shared by most of the projects of Guarini, the building designed in Vicenza is possible to reconstruct accurately the historical events that led to its creation and to its failed achievement.

Brief historical notes

The desire to build a new church for the order of Theatines in the Venetian town dates back to January 18, 1674: on this date, after the canonization of San Gaetano Thiene, which took place three years ago, is documented the will of the Theatines to devote the church to the saint. The new building would replace the existing church, dedicated to St. Stephen.

The name of Guarini was proposed by the Teatini. The appointment to Guarini was due to a number of factors: the belonging to the same religious congregation, its recognized design skills, the reputation of his constructed buildings, as well as the ability to identify the most profitable sites and contain the economic costs.

The arrival of the architect in Vicenza dates back to October 15, 1675: ten days after, Guarini, along with the owners, met with local representatives, with whom he carried out a survey to identify the most suitable location for the edification of the church, to choose between three possibilities. A particularly prestigious site it was identified, near the house of Theatines, on the site the Library of Theatines themselves. On the same occasion, the architect presented a first design proposal, which encountered the approval of all present and which coincides with the plan depicted in a drawing preserved in the General Archives of Theatines in Rome.

Guarini left the Veneto on November 17 of the same year, with the certainty that the Theatines have defined the details of construction and the necessary resources, including the involvement of the Doge.

The problems actually arose very early, and were related to the need to provide both for the expensive expropriation of some houses and an inn adjacent to the site and both for the demolition and subsequent rebuilding, in another place, of some parts of the house of the Theatines.

In 1685, after the death of the designer, it was decided to abandon the project of Guarini, opting for the reconstruction of the ancient church of Santo Stefano. The project shown in the treatise seems to be a reworking of the first hypothesis of the project, produced in the encounter with the clients; this revision was due to the desire to obtain an ideal model of the project, which develops themes similar to those of the church of San Filippo in Casale Monferrato. On the treatise, the building is avulsed from the urban context: the external walls that surround faithfully follow the inner profile, as if it were an isolated building. On the contrary, in the archive plan, the church is part of a trapezoidal site and the exterior walls are straight. The most significant changes relate to the dome and relations between the central space and the spaces of the arms of the Greek cross: in the first hypothesis of the project, the dome is conventionally inscribed in a square and is therefore based on four spherical pendentives; the central space and the arms of the Greek cross would have intersected.

In this case, the project would be of lower complexity: would miss the interpenetration of the lateral spaces with the central one, interpenetration that originates the three-dimensional arches supporting the balustrade diaphragm. From the observation of the drawings, it is also conceivable the modification of the presbytery, with the elimination of space added to the bottom of the elliptical space, symmetrically arranged with respect to the entrance.

The structural model

Analysing the drawings depicted on the treatise, there is, from the point of view of the representation of the structural model, that the discretized elements prevail over continuous ones: the four isolated pillars, which identify the central space, constitute points around which are grouped six free columns. The loads, through the three-dimensional arches, which mark the intersections of vaulted systems, are reset to the ground by vertical supports; the continuity of the line-forces, marked by prominences of the trabeation, is represented.

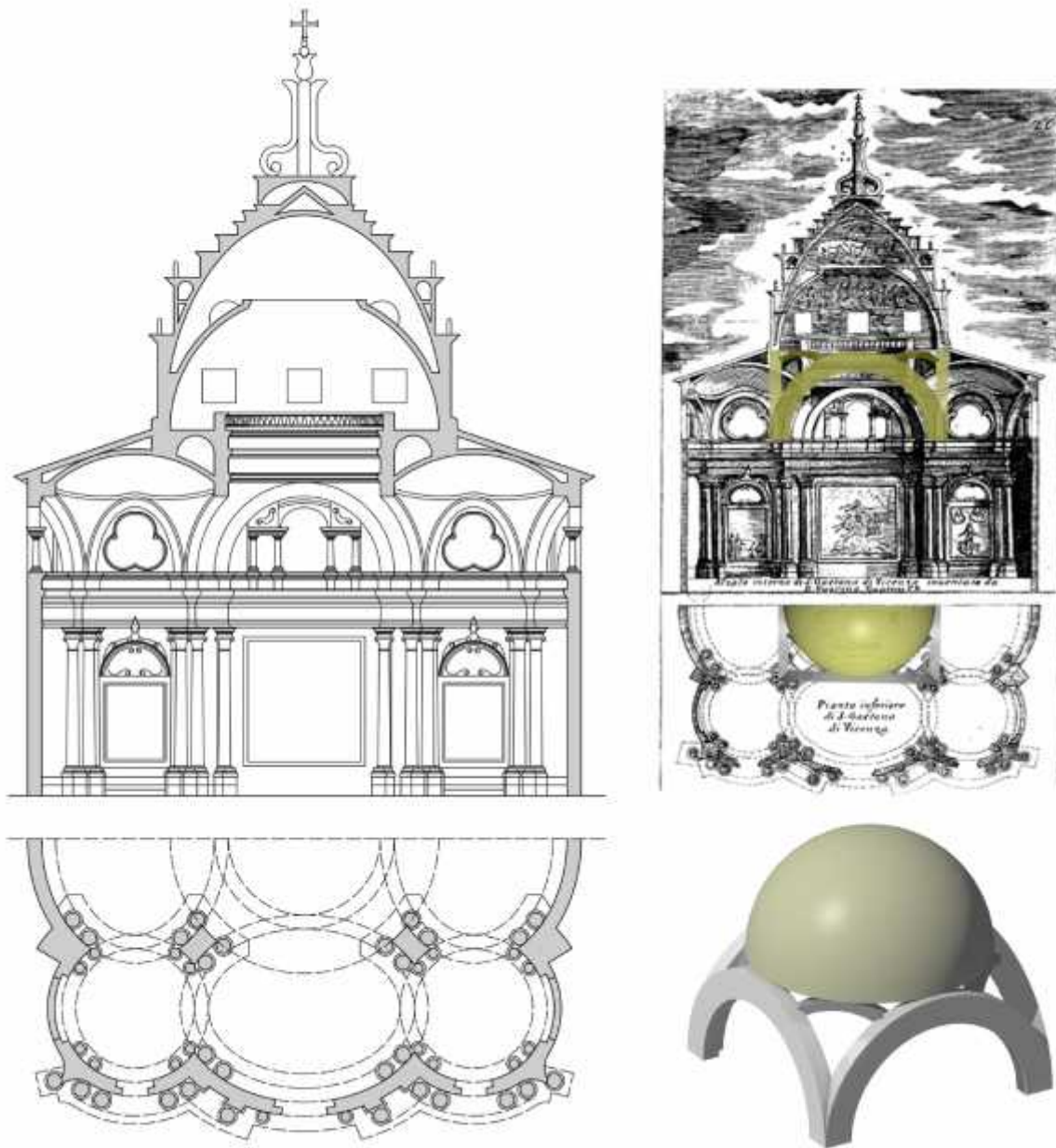


Figure 3 San Gaetano church: plan, cross-section and hypothesis of the hidden structure

The grouping of the columns around the isolated pillars highlights Guarini's predilection for Gothic architecture, although the presence of the trabeation, uninterrupted, unifies all spaces and avoid the isolation of the central group. Furthermore, the presence of the trabeation gives to the external walls a load-bearing function, from the point of view of its formal representation.

In reality, these walls seem to fulfill a function of delimiting the space and not a bearing function: it is highlighted, as well as the large windows which there are inserted, by their reduced thickness, when compared to that of the structural nodes marked by the groups of columns.

The metric scale shown on the treatise shows that the pillars supporting the dome have a width of 7 feet of Vicenza; the external buttresses, placed at the joints of the curved walls of

the lateral space, measuring 10 feet. The exterior walls of the elliptical spaces of the Greek cross measuring 2.7 feet and those of the diagonal spaces measuring 1.7.

The double shell dome, which has a diameter of 50 feet of Vicenza, does not transmit his thrusts to the pylons through the pendentives and through the four three-dimensional arches that define them: the latter, as already said, only support the balustraded diaphragm, having a diameter of 30 feet.

It can therefore assume a hidden structure similar to that of San Lorenzo, and that is constituted by four arches arranged along the sides of the square circumscribed to the circumference that locates the dome, tangent to the internal faces of the pillars. These structures, whose presence has also been hypothesized by Mario Passanti, would be detectable with the sections of masonry shown in Table 26 of the treatise, under the impost of the dome and near the keystone of the vaults of the side rooms. Would be conceivable, as said, four arches orthogonal to each other, having impost on central pylons and curvature similar to that of the domes of the arms of the Greek cross.

Observing the cross-section, are absent, however, formal expedients which reveal, inside the building, the presence of hidden structures. In this model, the static role played by the ambulatory is to ensure, through eight vaults that compose it, the counterthrusts opposite to those generated by the dome of the central space; this takes place both through the four elliptical domes which are arranged at the sides of the central dome, both through the four circular domes that, on the diagonal, collaborate with the central pillars by their actions.

The plan preserved in General Theatine archive of Rome, similarly to the treatise, presents the walls of the side chapels extremely thin; the resistant wall masses are concentrated, also in this case, at the points marked by the groups of free-standing columns placed in correspondence of the passages between elliptical and circular chapels.

CONCLUSION

The studies case of the projects, not exhaustive of the production of Guarini's buildings with a central plan, testifies to the desire to create structures with a virtuosity and a static concept refers to discretized systems, characterized by a apparently miraculous balance. Apart from the symbolic and perceptual meanings, and apart from the desire to inspire awe and wonder in the viewer, typical of the baroque spirit, it is clear the reference to Gothic architecture and to its interpretation made by Guarini in the treatise.

In the first projects, the reference to Gothic architecture is expressed through the use of diaphanous structures, obtained both with the system of crossed arches, also present in the church of San Gaetano in Nice (probably designed around 1660) and in the church of Santa Anna Reale in Paris (1662), both with the succession of superimposed arches of the chapel of the Holy Shroud.

The use of hidden bearing structures, successfully tested in the realized projects, is extended to the further production, if they are valid the hypotheses proposed for the San Gaetano church in Vicenza.

In any case, when the project concerns systems complex and free from external influences, the central space is always identified by discretized pillars that support a complex series of domes and tholobates.

Consequently, the structural model, given the inability of the isolated support to contain the horizontal thrust of the domes, is configured as a double shell in which the ambulatory contributes to the support of the central spaces.

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