

Marcello Piacentini's dome in the building for the Cripples and Invalids of War in Rome (*Casa Madre dei Mutilati ed Invalidi di Guerra*) (1925-1928) between classical space permanencies and technological innovations.

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Abstract The finding of a series of unknown studies and drawing plans of Marcello Piacentini for the *Casa Madre dei Mutilati ed Invalidi di Guerra* in Rome (from 1925/1928, to 1935/36) and a survey of the entire building have allowed to discover and analyze a fairly unknown piece of architecture, essential for the acquaintance of the history of design and architecture. The concrete dome, made of interlaced and curved ribbings springing from its keystone, shows a multitude of *lacunari*, covered with diamond shaped milky glass and ribbed in brass, which degrade as they near the top of the vault. This peculiar dome have suggested also the possible participation of the young Pier Luigi Nervi.

Keywords Marcello Piacentini, blueprints, concrete, razionalism, italy, geometry, dome, membrane

1. PIACENTINI'S DRAWING PLANS AND HIS CULTURAL IDENTITY, STILL AN OPEN PROBLEM

"I see our contemporary architecture framed in a great grace and a perfect measure. It will always accept the new proportions concurred from new materials but subordinating them with the divine harmony that it is the essence of all our arts and our spirit"

Marcello Piacentini, "Architettura d'oggi", Roma 1930

"The right place of Piacentini's work in hystoriography is still an open case" wrote Franco Borsi³, in spite of having at hand the whole Piacentini's archives "not even Lupano's monography⁴ was able of a balanced historical judgment". From those drawings, Lupano assumed a detached attitude and was able to read "...perhaps too diligently, the papers and not the works".

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³ R. Niccolini, *Dizionario di architettura e urbanistica*, Roma 1969, tomo IV

⁴ M. Lupano, *Marcello Piacentini*, Bari, 1991

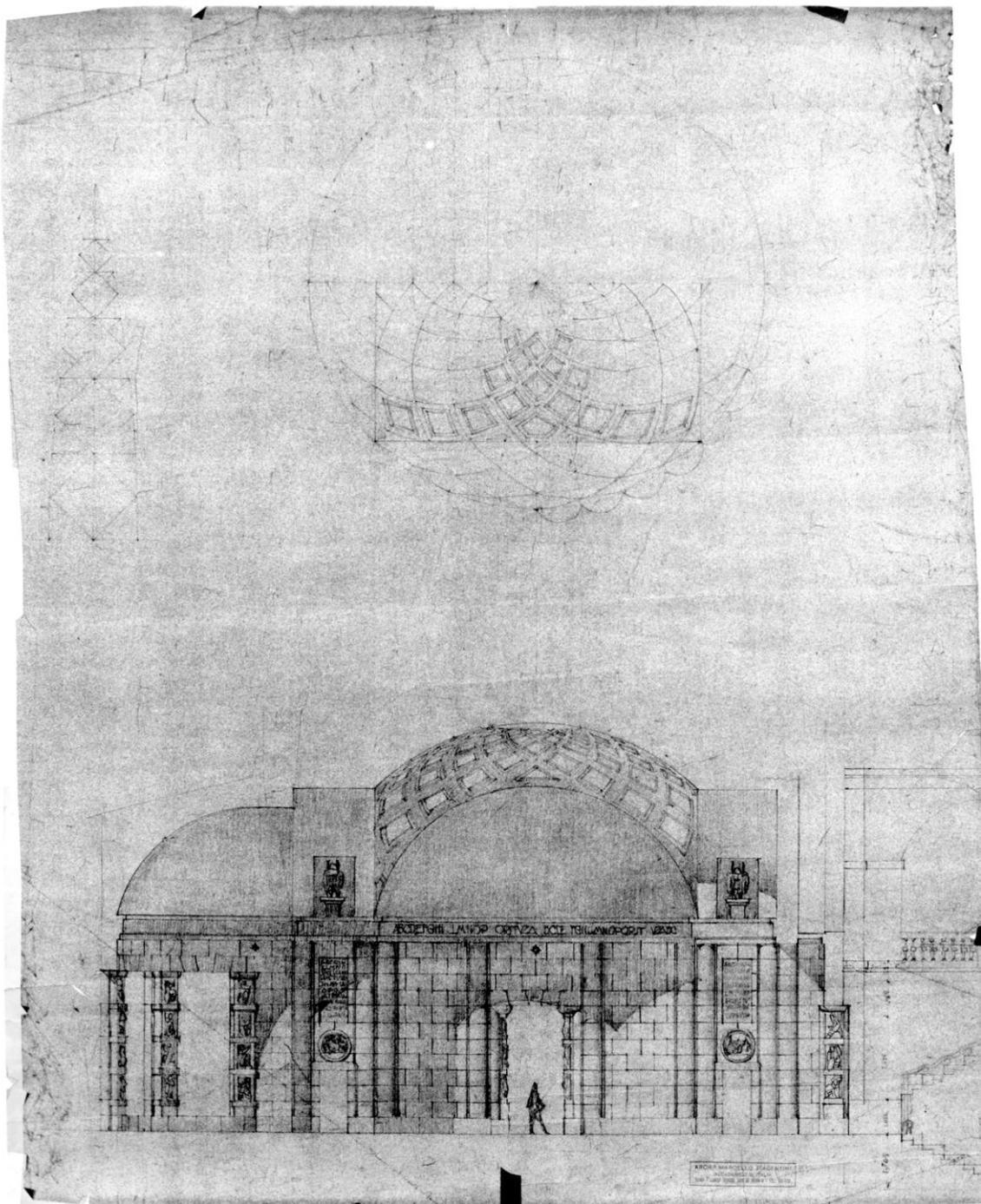


Figure 1 – Section drawing of the *Sala delle Adunate* with the construction algorithm of the dome; 1925-1928.
Marcello Piacentini, *Casa Madre Archives*, Roma, Italy

The surprising discovery, in 2009, in an old wardrobe into disuse, of thirty-six unpublished drawings by Marcello Piacentini for the *Casa Madre dei Mutilati ed Invalidi di Guerra* in Rome (1925/1928 - 1935/1936), has allowed to integrate the existing documentation through a complex reorder for thematic and times, to recompose a meaningful moment of the work of the architect, to rediscover and to reread a fairly unknown document of architecture, yet of foundation for the acquaintance of the cultural identity of Marcello Piacentini, of both the history of the design of plan and of the architecture.

The rediscovered designs show a clear path of the many operating passages that the architect has completed in order to realize his work and the multiple expressions of graphical language he has used. For the most part, these drawings are blueprints that Piacentini ordered himself and bear a blue stamp of his own studio :” ARCH.° MARCELLO PIACENTINI / ACCADEMICO D’ITALIA / ROMA – LUNGOTEVERE TOR DI NONA 3”. Perhaps it may be supposed that these reproductions have been partially intentional for his own private archives, even if many are sketched multiple times in order to change graphically the idea without altering the base concept.

In the continuous search of a satisfactory result and pressed by the requirements of the regime, Piacentini sketches multiple times on these prints using a variety of media; pencil, charcoal, red, green and blue pastels as well as red watercolor are used to modify, delete, and correct the space and the destinations of the rooms; he even annotates his thoughts on the margins of the blueprints.

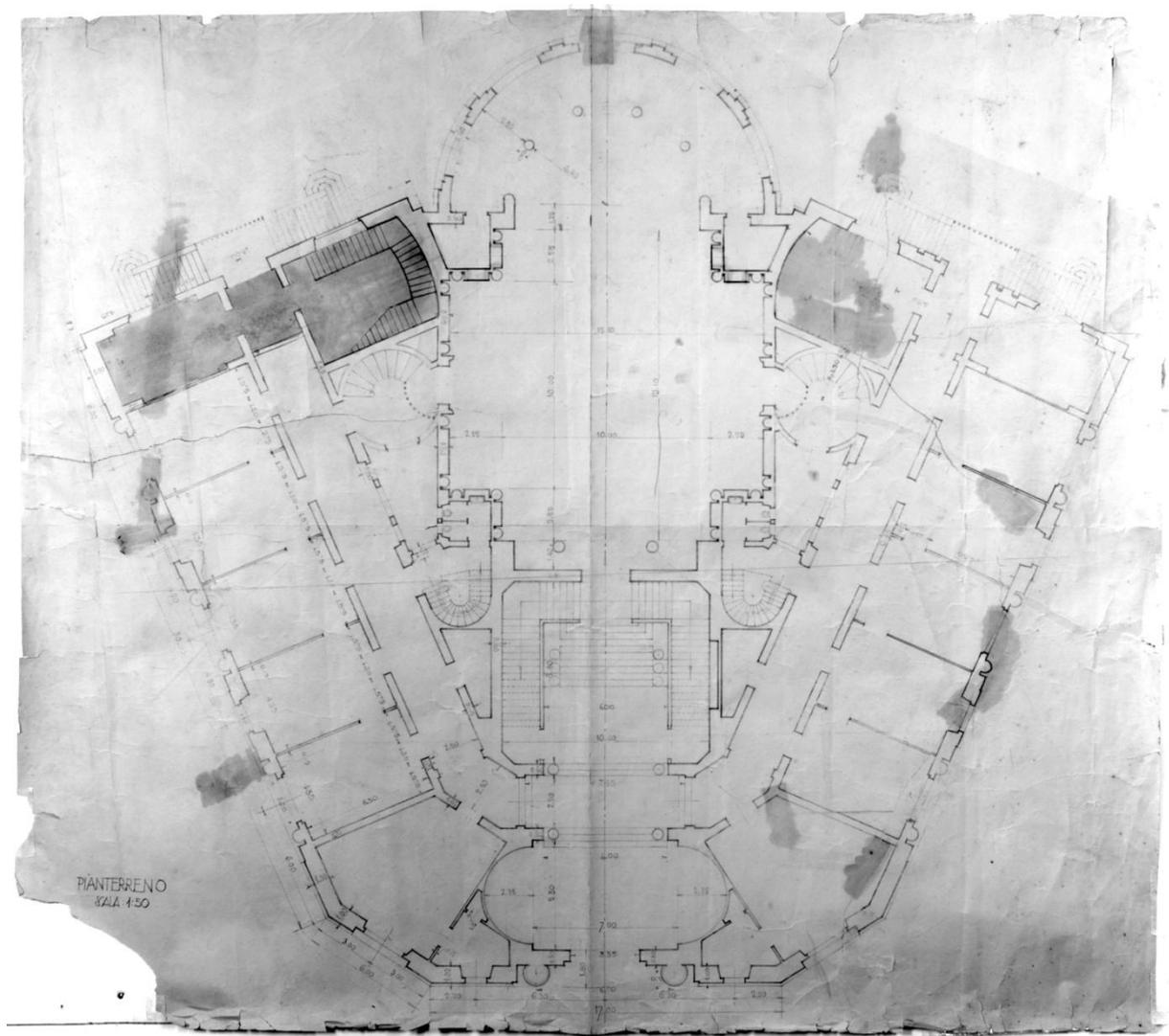


Figure 2 – Drawing plan of the ground floor of the *Casa Madre*; 1925-1928. Marcello Piacentini, *Casa Madre Archives*, Roma, Italy

The final result of this work is a suffered succession of varying projects, a continuous graphical dialogue that opens the field to necessary storiographical deepening, such as the connection between the architectonic language and the structural language, or the rising of the engineers inside the rich theoretical debate on what meant to construct in Italy in the first post-war period.

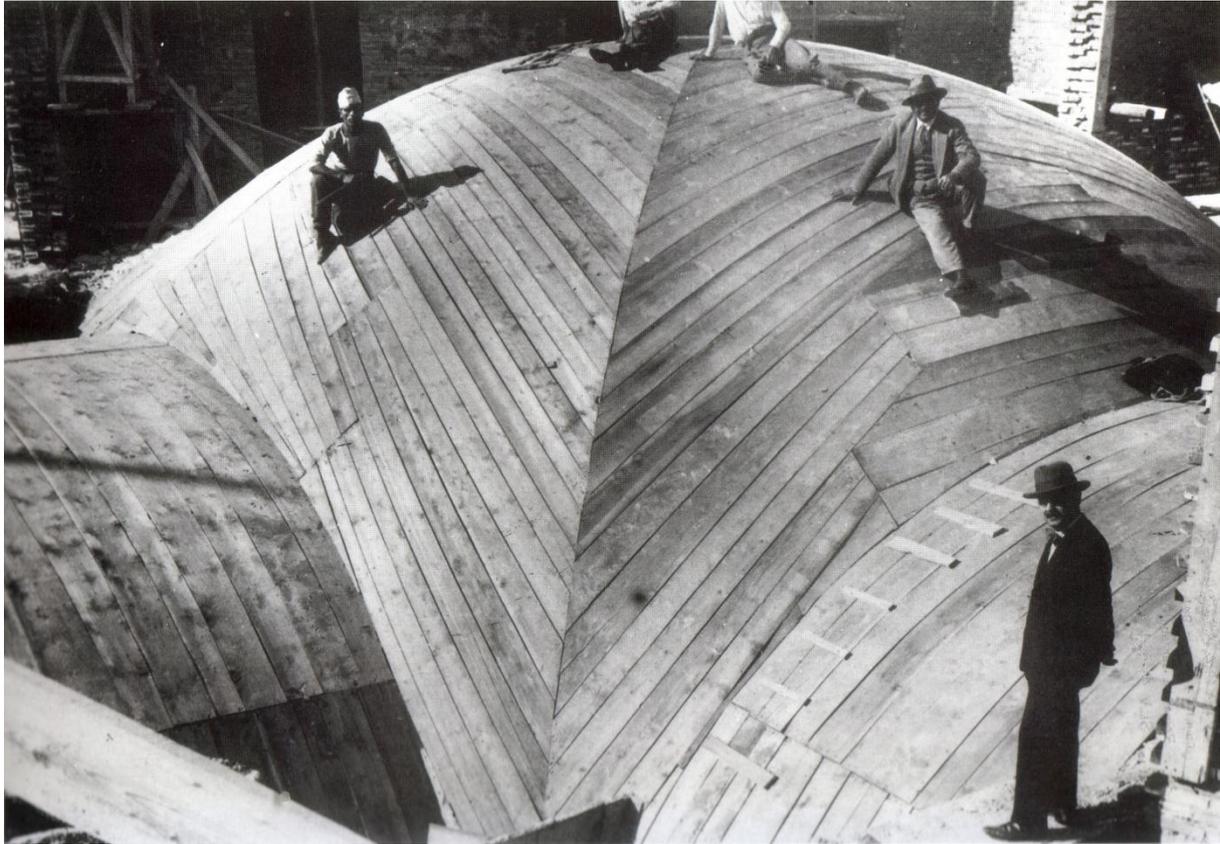


Figure 3 – Vintage photograph of the scaffolding for the reinforced concrete of the dome on the *Sala delle Adunate*, Silvia Danesi Squarzina Archives, Roma, Italy

But most of all, is the successive catalogation and the analysis carried out on those drawings, sketches and studies with notes and thoughts, axonometric projections, perspectives, details at scales such as 1:100, 1:50 or 1:20, all drawn with pencil or pencil and charcoal, that has brought to light the use of a particular kind of methodology for the management of the architectonic plan, meant both as a building, economic and environmental project as well as expression and graphic communication.

From most of those drawings we can see that Piacentini is often very distant from the realized work, he is an architect troubled by the impositions of the regime (in the *Casa Madre* Archives, as long with the drawings, it has been found the correspondence of the letters between he and Mussolini as well) and forced many times to modify or to completely redesign his work, to speed up, to simplify the forms that had to be more monumental, aulic and symbolic.

The *Casa Madre* has been planned and built in two different phases; the first part was built between 1925 and 1928, it measured 1,600 squared metres and was placed in the area between *Castel sant'Angelo*, *Palazzo di Giustizia* and *Lungotevere*. Seven years after its completion, Piacentini worked on its extension towards the Tevere river. The new building reached 5,000 squared metres and its opening ceremony took place in 1936.

In the first building there are the most important spaces. From the atrium, steps introduce to a triple entrance hall just before the *Sala delle Adunate*, it then splits into a two headed stairway that leads to the first floor where are placed big offices and meeting halls. The plans of all its five levels have been found, from the archives level to the attic, a section plan of the atrium, the two headed stairway and the *Sala per le Adunate* at 1:50 scale.

The *Sala per le Adunate* is the monumental and symbolic fulcrum of the entire building. It has a greek cross plan, opened on one side to a half-domed exedra with a vaulted ambulatory on six quadrangular pillars and five great steel windows with onyx slabs just as “*i bizantini usavano i trasparenti alabastri di oriente*”.

The hall is marked with twenty semicolumns with no capital or base, imbedded within tight niches “*alla maniera etrusca*” and is covered by a reinforced concrete sail vault. From the original drawings

and from the section of the *Sala delle Adunate* – that Piacentini sketched with extraordinary graphical sensibility – as well as from the integrated survey of 2010-2011⁵, it is clear that the plans, as well as the facades and the dome covering the hall, have all been modified at least twice while the exedra has been modified at least five times.

Piacentini, using the pencil the main tool for drawings, sketches his plans at 1:50 scale; the structures are drawn using the square while the all the details and the materials are sketches by freehand. The shadows are both the result of the strict geometric theory and of an emotional approach, he uses charcoal to emphasize the depths and the projections, the curves of the columns, the concavity of the dome and the complex game of the ribbings; transmitting suggestions, he is able to give every chromatic information, of material, of space and surface by using his own graphic language that differs from the strictly technical and academic way.

The final result of Marcello Piacentini's work is a suffered series of drawings and plans, a continuous a graphical dialogue that opens the field to necessary historical deepenings, such as the connection between the architectural and the structural expression or the introduction of the engineers, in the Italian first post-war period, in the rich theoretical debate on what meant as construction.

The architectonic element that more than every other transmits these reflections is the outstanding sail vault that overhangs the Assembly Hall, or *Sala delle Adunate*, creating a symbolic continuum between the great artistic past of our country and the present.

With it, Marcello Piacentini is able to transmute the traditional forms through the use of new technologies. Some vintage photos show the scaffolding used to set the helical ribbings of the vault; the works in reinforced concrete were executed by ing. Giano Passalacqua on Piacentini's plan.

The concrete dome, made of interlaced and curved ribbings springing from its keystone, shows a multitude of *lacunari*, covered with diamond shaped milky glass and ribbed in brass, which degrade as they near the top of the vault. Innovative, yet a sober reinvention of the classical forms of the past⁶ such as the Temple of Venus in Rome, the *Cortile Ottagono* in the Vatican and the *Chapel d'Anet* in France, this peculiar dome have suggested also the possible participation of the young Pier Luigi Nervi⁷. The ribbings, made by forty-eight interlaced spirals and springing from a bed of continuous masonry, are spaced with elements to high symbolic value, such as the twenty columns embedded in tightened niches, the semicircular deambulatory, or the five huge onyx windows from which it is approached the balcony of Mussolini.

Particularly through this work, the fascist Regime takes advantage of the figure of Marcello Piacentini to boost "...the ideological characters of the regime's politics, such characters had necessity of being express in architectonic forms suitable to the nobility of the place and the spirit that promoted it"⁸, a continuous and eclectic reference both to the classicism of ancient times as well as the renaissance, while the "advancement" is represented through the experimentation and the search of the possibilities offered from the new materials in the great dome.

This complex period of style alternation, of metamorphosis of the forms, of new spaces and materials, is emphasized from the same Piacentini when he writes "I see our contemporary architecture framed in a great grace and a perfect measure. It will always accept the new proportions concurred from new materials but subordinating them with the divine harmony that it is the essence of all our arts and our spirit". In the plans of Piacentini, the classic grace and the perfect measure of geometries will be molded to the rules of the new materials, rules that will always be "subordinate" to the divine harmony, the proportion that regulates, in this building, every constructed form.

⁵ The integrated survey of *Casa Madre* has been carried out during the course of *Scienza della Rappresentazione I –II - III*, by Professors Paola Quattrini, (*Rilievo dell'Architettura*) Alfonso Ippolito, Luca Ribichini, with the collaboration of arch. Emiliano Della Bella. Università degli Studi di Roma La Sapienza, Facoltà di Architettura.

⁶ M. T. Bartoli, *Scaenographia vitruviana: il disegno delle volte a lacunari tra rappresentazione e costruzione*, in "disegnare, idee immagini", Semiannual magazine by Dipartimento di Rappresentazione e Rilievo, Anno V/VI, n. 9/10, Roma1994

⁷ Franco Borsi, *Introduzione*, in "La Casa Madre dei Mutilati di Guerra", Roma 1993

⁸ Nicola Cerino, *La Casa Madre dei Mutilati e il contesto urbano*, in "La Casa Madre dei Mutilati di Guerra", Roma 1993

2. THE GEOMETRIC GENESIS

To draw the spirals of the ribbings, Piacentini uses a well known algorithm not dissimilar to the one used by Leonardo Da Vinci for his *linia d'equale obliquità naturale*.⁹ In Figures 4 and 5 it is shown the whole algorithm used by Piacentini.

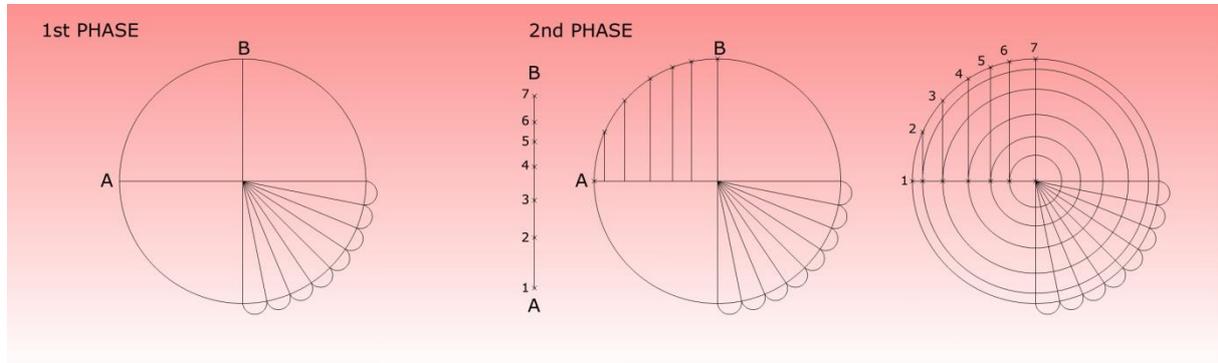


Figure 4 – Phase 1 and Phase 2 of the reconstruction of the geometrical genesis of the drawing of the dome in the *Sala delle Adunate*

1st Phase (top left). A quarter of the circumference is divided in eight parts of the same size; **2nd Phase** (top right). The arc of the circumference *AB* is firstly rectified and then divided in six different parts by a set of points numbered from *1* to *7*; the length of each part is obtained by the drawing of the *lacunari* shown in the fourth phase in which Piacentini measures and sets the proportions of the dome. After that, such points are placed on the arc¹⁰ and then projected downward to the *x* axis (the diameter) marking the radii of a series of concentric circumferences.

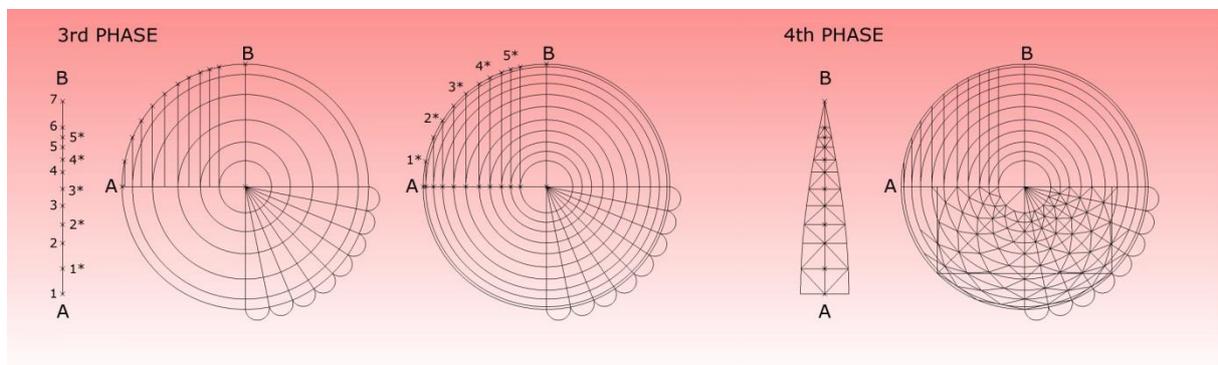


Figure 5 – Phase 3 and Phase 4 of the reconstruction of the geometrical genesis of the drawing of the dome in the *Sala delle Adunate*, Roma, Italy

3rd Phase (bottom left). Middle points, *1**, *2**, *3**, *4** and *5** are marked from the segments *1-2*, *2-3*, *3-4*, *4-5* and *5-6*. These, once positioned on the *AB* arc, are projected downward to the *x* axis as before, marking a second series of five concentric circumferences that will be used for the construction of the *lacunari* spirals; **4th Phase** (bottom right). Once all the construction lines (the radii of the circular sectors) and all the circumferences are settled, it is time to draw the spirals that will generate the *lacunari*. To do so, it is necessary to combine the points of the intersection of both radii and circumferences as shown in the picture.

⁹ M. Clagett, *Leonardo da V. and the medieval Archimedes*, in “Physis”, 1959, pp.110-113

¹⁰ To mark the point on the circumference we should work backwards the problem of the length of the circular sector. The angle of the two radii that enclose the arc is given by $\theta = \frac{L}{r}$ where θ is in radians, *L* is the length of the arc, *r* is the radius and one degree is $\frac{\pi}{180}$ radians; therefore $L = \left(\theta r \frac{\pi}{180}\right)$ where θ is in degrees.

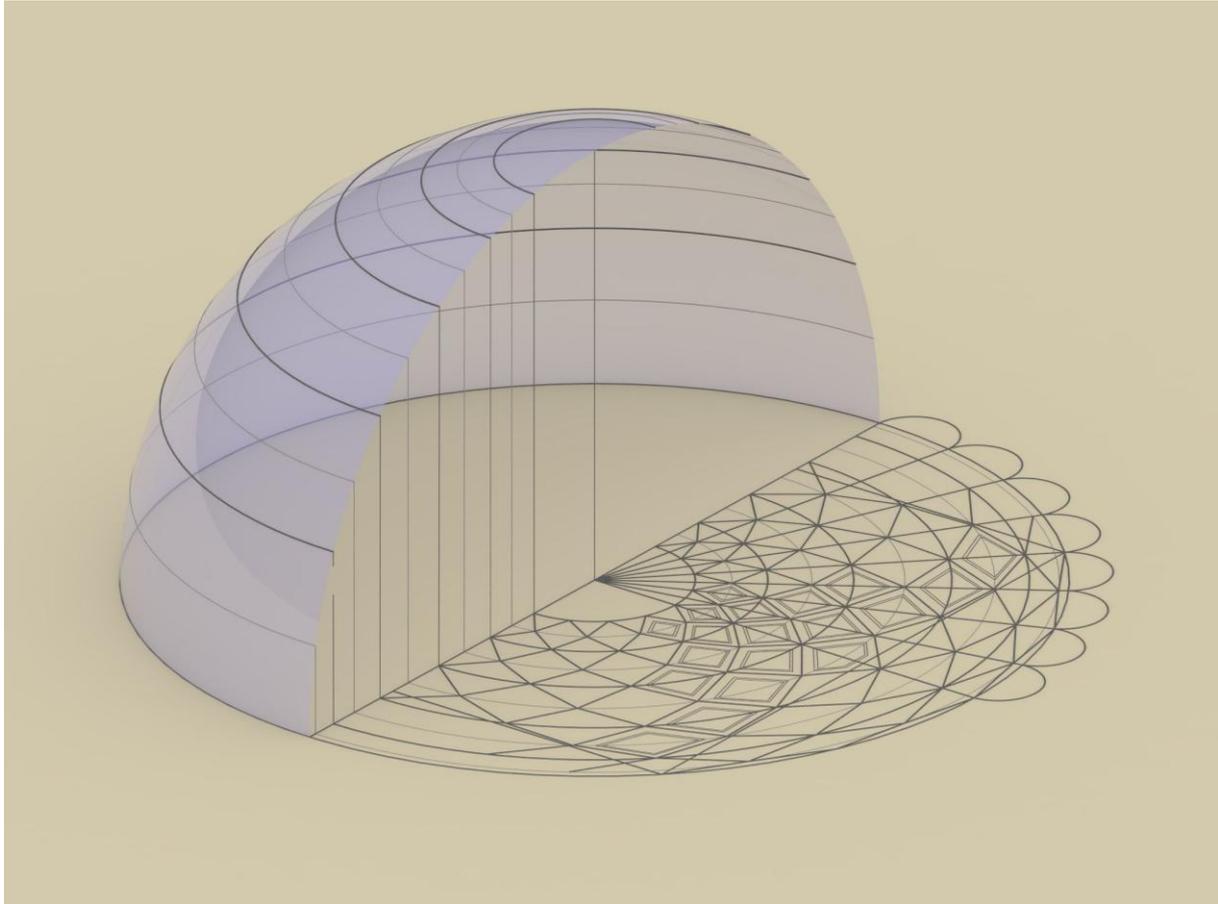


Figure 6 – A 3D model of the geometric genesis of the dome on the *Sala delle Adunate*

It must be said that while the original Piacentini's blueprint shows the quarter of the circumference divided in eight parts of the same size, this is not true for the dome that has been really constructed. One should ask himself now, why is there such difference between the two versions. It is fairly common to find differences between preliminary drawings, blueprints and what is really built; yet these are more than often only stylish changes while the dome is a structural element.

3. THE INNOVATION OF CONCRETE ON A CLASSICAL DESIGN

Though Piacentini's dome is a rounded vault forming a roof over an interior space of about 15 m very similar to its classical references (e.g. Hagia Sofia, c. AD 532), being a concrete dome, it differs from the common static of the masonry vaults. These ignore the elasticity of the material which is, as it has been said before, reinforced concrete.

Concrete is strong in compression, as the aggregate efficiently carries the compression load. However, it is weak in tension as the cement holding the aggregate in place can crack, allowing the structure to fail. Reinforced concrete solves these problems by adding steel reinforcing bars to carry tensile loads to withstand the tensile loads upon it.

Such vaults are often referred as thin vaults or shells¹¹ and differ from the masonry ones not only by their reduced thickness but also because they are elastic and perfectly continuous. Being both single or double curved they wholly reflect the membrane theory.

¹¹ J. Heyman. *The stone Skeleton*. Cambridge University Press, Cambridge, 1997

In modern engineering theory a shell is a structure which can be idealized mathematically as a curved surface (just as an arch may be idealized by its curved center line). When loads act on such a curved surface, whether imposed externally or arising from the weight of the shell itself, they must be resisted by forces within the surface. In membrane theory it is assumed that the surface has no stiffness against bending, so that the forces in the shell are purely tensile or compressive.

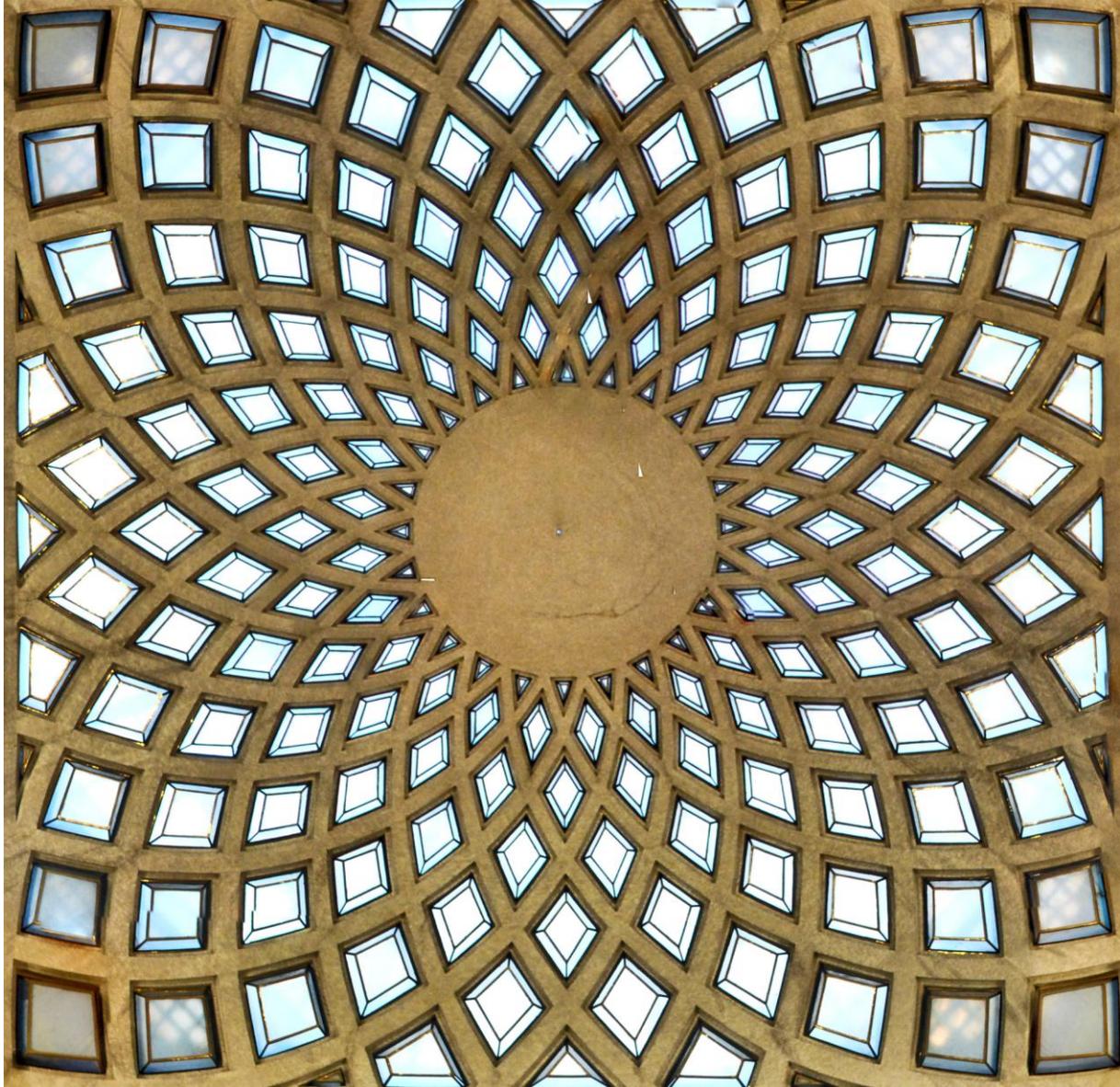


Figure 7 – Photograph taken from the interior of the dome on the *Sala delle Adunate*

If we set the right curvature to the membrane, is it possible to apply loads however directed to which the membrane itself will resist with an opposing force. In a curved surface, the internal tensions generated by the opposite edges are able to oppose a normal force.

Thus, although a certain minimum thickness is necessary to prevent local compressive buckling, the shell structure, unlike the arch, does not have to be built in practice with some reasonable thickness in order to accommodate safely a range of loads. The limits of the membrane behavior are much more evident for simple curved surfaces such as the barrel vaults rather than in double curved surfaces. In barrel vaults, there may be an elastic instability due to a lateral bending of the rectilinear generatrices. This may not happen in hemispherical vaults and hyperbolic paraboloids because of the lack of rectilinear elements.

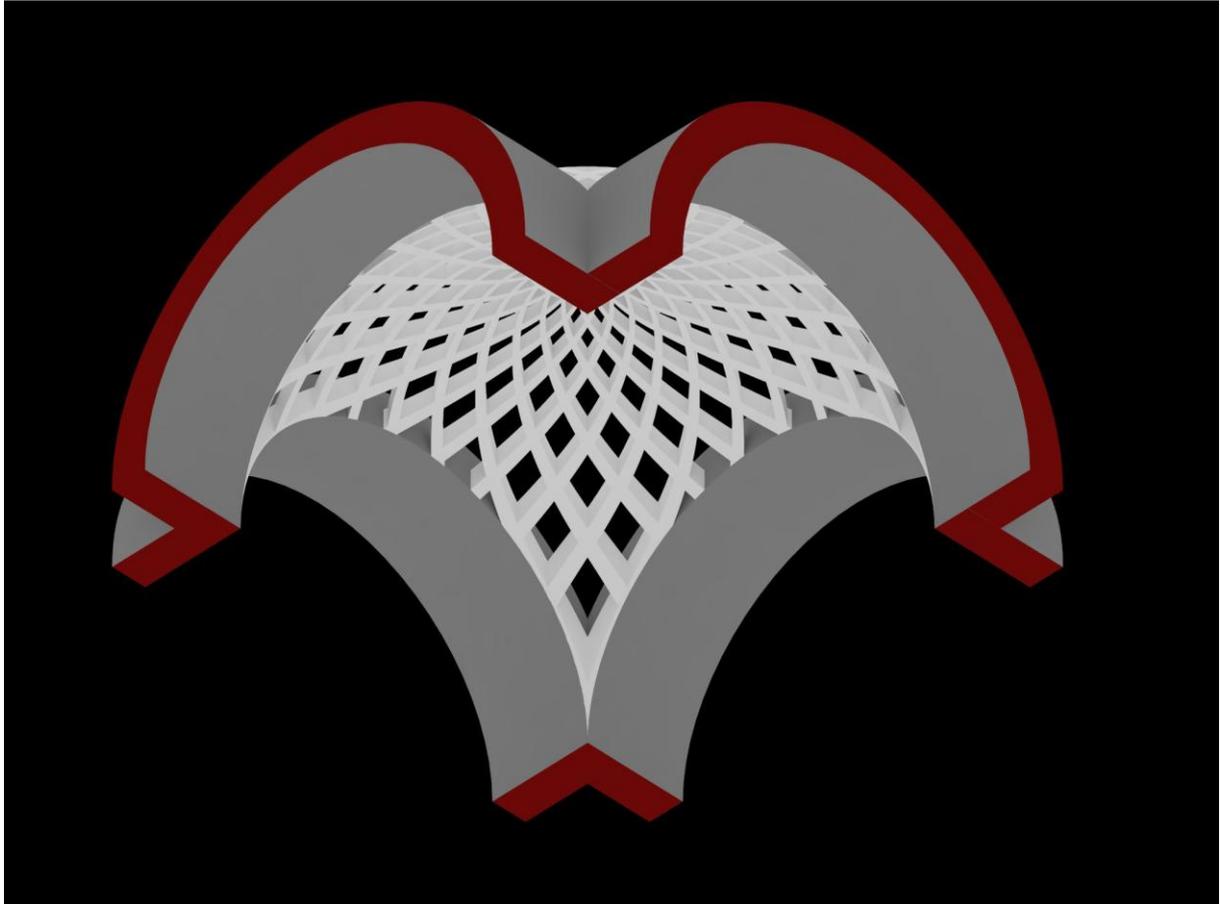


Figure 8 – Assonometric projection of the 3D model of the dome on the *Sala delle Adunate*

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