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Resumo The Teatro Comunale was built in Ferrara at the end of the 18th century, at a time when modern theatre was gradually leaving the space of the Duke Court and Academy to become part of the urban fabric, shifting from representing the elite to turn towards wider communities. The models of Court theatre and public theatre with several levels of boxes coexisted for a long time, until the complete codification of the “teatro all’italiana”, of which the Comunale represents one of the clearest examples....

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TEATRO COMUNALE, FERRARA

Geometry and layout: debate over the curve

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Abstract: The Teatro Comunale was built in Ferrara at the end of the 18th century, at a time when modern theatre was gradually leaving the space of the Duke Court and Academy to become part of the urban fabric, shifting from representing the elite to turn towards wider communities. The models of Court theatre and public theatre with several levels of boxes coexisted for a long time, until the complete codification of the "teatro all'italiana", of which the Comunale represents one of the clearest examples. Over time there have been several renovations. However, the plan has never been strongly altered and has come almost intact to this day. This makes comparison between measured survey, and available historical sources particularly significant and interesting.
The construction of the Teatro Comunale, which lasted over a decade, started under the papal domination and ended at the time of the Cispadan Republic. Around 1786, at night, the dwellings on the so-called Isola del Cervo were demolished, to start the construction of a first project by Giuseppe Campana. However the built theatre follows the design by Cosimo Morelli, which includes several oval curves for the shape of other spaces such as the courtyard for carriages and the hall. His design also recalls the neighboring oval church of San Carlo designed by Aleotti.
From the written sources we can see that the question over the shape that the curve of the theatre cavea should have followed has been intensely debated, in parallel with the measured survey of the Ferrara Theatre and the analysis of the actual geometrical layout.
The comparison between the documents found at the Biblioteca Ariostea archive in Ferrara and the data obtained from the metric analysis allow us to state with absolute certainty that the solution of the oval adopted in the construction of the Ferrara Theatre is neither the one called AA nor the one called BB.

Keywords: Theatre; Curve; Space.

Geometry and Layout: debate over the curve.

The Teatro Comunale was built in Ferrara at the end of the 18th century (1773-1797) (Fig.1), at a time when modern theatre was gradually abandoning the space of the court and the academy to become part of the urban fabric, passing from representing an elite to turning towards wider communities. The models of court theatre and public theatre with overlapping boxes coexisted for a long time, until the complete codification of the "teatro all'italiana", of which the Comunale represents one of the clearest examples (Fabbri, Beriteri, 2002). Over time there have been several renovations that have affected the decorative apparatus by Migliari, technological systems and structures. However, the plan has never been strongly altered, and has come almost intact to this day. This characteristic makes the activities of survey, verification and comparison of theatre spaces with descriptive and figurative historical sources particularly significant (Fabbri, Beriteri, 2004).

The construction site of the Teatro Comunale, which lasted over a decade, was started under the papal domination and ended at the time of the Cispadan Republic. At night, at the behest of the Pope, the dwellings on the so-called Isola del Cervo were demolished, to create a first project by Giuseppe Campana. As shown in Fig. 4A, this project involved a horseshoe-shaped curve on which 19 boxes were grafted, including the royal box, which was never built (see Fig. 5B), as well as the two further proscenium boxes.

The building respects the creation by Cosimo Morelli, the author of an interesting correspondence between the two parallel axes of the oval courtyard for carriages and the hall, as well as the neighboring oval church of San Carlo designed by Aleotti. The building, inserted harmoniously into the consolidated urban fabric, determines a strong interpenetration between the inside and the outside, being the oval courtyard facing along Via Giovecca, on which there is the largest, in terms of size, of the two longitudinal elevations (Dalla Negra, Ippoliti, 2014). Even the treatment of the facades, in smooth ashlar work on the basement, such as the Archbishop's Palace, and in "cotto", a typical material from Ferrara, avoids its perception as an autonomous element in the city. The interior is characterized by the absence of the royal box, as well as the absence of the proscenium boxes, although all the four orders of 23 boxes each (Fig. 4B), and the gallery, are directly joined to the semielliptical arch of the proscenium. A lowered vault covers the room. The orchestra space could accommodate up to 60 elements, the total capacity was 1500 spectators, a number currently reduced to 946.

These characteristics were modified several times during the construction, which began parallel to that of the Teatro alla Scala, with the same protagonists. In particular, the integration in the urban context also determines the formation of accessory spaces that can be used both by staff and by the spectators, who

served as a model, also taken up by the Teatro alla Scala itself. Consider in this regard the projects that foresaw, in Milan, the use of the rooms of the former Casino Ricordi. The presence of numerous service spaces has led over time, at Teatro alla Scala, to the need for a general rethinking, for Botta's unifying project. In Ferrara Theatre, on the other hand, the system, structured around the aforementioned skillfully designed geometric patterns, has remained almost intact, marking the success of the integrated model. The curve of the cavea, designed to guarantee the best acoustics and visibility, was the subject of subsequent surveys, starting from the early nineteenth century, to build further theatres in different European cities such as Vienna.

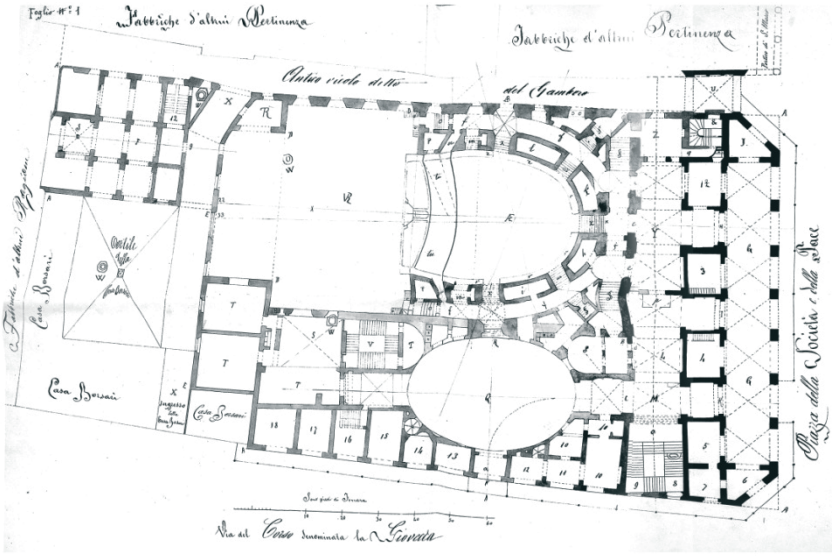

Figure 1. Plan of the Teatro Comunale, Ferrara, 19th century with the metric scale in the historical unit of measure (feet of Ferrara). [Biblioteca Comunale Ariostea, Fondo Antolini, busta n. 70]

A long debate has remained unresolved, related to the shape that the curve of the theatre should have taken and to the definitive authorship of the building. To complete the work on the Campana construction site, soon interrupted, Antonio Foschini, whose role in the design of the theatre was claimed over time, and Cosimo Morelli anonymously submitted their own solution to the opinions of Piermarini and Stratico. The paternity of the tables marked with the letters AA and BB (Fig. 2), was never identified because they have been lost.

Retracing Piermarini's opinion, in favor of the BB solution, we obtain important observations of geometry, of the study of visuals and acoustics. Piermarini emphasizes that the design of the plafond of the BB project is certainly preferable as it describes a regular whole figure, elliptical, and that the view is better, since

it is not impeded, as in the solution AA, by the first three boxes, too advanced compared to the proscenium. In terms of acoustics, Piermarini underlines the importance of the proscenium, and of the impediments represented by the scenic backdrops in the propagation of sound. Finally, Piermarini states that the BB design curve is '*la medesima che si è posta in uso in uno dei grandi Teatri d'Italia*'[1], at Teatro alla Scala, and since it worked '*a meraviglia*'[2], he sees no reason to attempt new configurations.

The opinion by Simone Stratico, Professor of the University of Padua, is dated May 25, 1791. From the text, the main measures of what was hitherto constructed and the geometric, spatial, functional and acoustic characteristics of the two design solutions presented can be deduced. First of all, compared to the Campana's work with 19 boxes for order, in addition to the two at the proscenium, the solution is affirmed, and then realized, with 23 boxes per order, the absence of the proscenium, and the greater breadth of the Prince's stage, today absent. Stratico suggests that the aforementioned conditions have been respected in both designs, and that they differ exclusively '*nel modo di descrivere la curva che deve servire al contorno della Sala Teatrale, o Uditorio e nella disparità di alcune dimensioni*'[3]. You can also read in the opinion:

> '*trovo che nel disegno AA gli archi circolari CI, EH, i quali uniscono gli altri archi BC, LI e BE, HK, non sono descritti da centri posti nelle rette, che passino per i punti C, A : I, F : E, A : H, F, nelle quali sono i centri A, F de' due cerchi BEDC, SIGH. Quindi invece di continuarsi la curva in una flessione regolare BCIL, BEHK risultano necessariamente quattro angoli d'intersezione degli archi ai punti I, C, E, H, i quali comunque nel lavoro possono essere con industria occultati, formeranno non pertanto una centina irregolare, e d'effetto spiacevole alla vista, che nella figura in piccolo non si può per avventura discernere, ma nella figura reale ed in grande verrà sentito, ancorché a colpo d'occhio da tutti non sia per apprendersene la ragione*'[4]. (Stratico, 1791)

[1] the same one that was used in one of the great Italian theatres (translation by the autors)

[2] wonderfully

[3] in the way of describing the curve that must serve the outline of the Theater Room, or Auditorium and in the disparity of some dimensions (translation by the autors)

[4] I find that in drawing AA the circular arcs CI, EH, which join the other arcs BC, LI and BE, HK, are not listed by the centres placed in the straight lines, which pass through the points C, A: I, F: E , A: H, F, in which are the centres A, F of the two circles BEDC, SIGH. So instead of continuing the curve in a regular bending BCIL, BEHK we have four angles of intersection of the arches at points I, C, E, H, which however can be hidden in the work, will form not an irregular centring, and it is unpleasant effect to the view, which in the small figure cannot be seen, but in the real and large figure it will be seen (translation by the autors)

Instead in the BB drawing the arcs constituting the curve present the same tangent in the point of their union, determining a continuous theatrical curve, not disturbed by the angles of intersection of the arcs. The AA curve is comparable to a '*poligono di lati curvi*'[5]. Stratico, with regard to dimensional disparities, describes two types of problems. In fact, there are measures that should be the same in both designs, as they relate to the pre-existing buildings and others that differ precisely because of the different thinking of the designers.

> *'Rispetto alle prime: parmi di rilevare che le muraglie principali che chiudono l'arco del Teatro siano già costruite. Ciò posto: nel disegno AA trovo la larghezza totale di quest'area misurata nella linea MN, comprendendo la grossezza delle muraglie, di piedi 64 : e la lunghezza totale misurata nella linea GB compresa la grossezza delle muraglie di piedi 63. Nel disegno BB trovo la prima di queste misure di piedi 63: la seconda di piedi 62 e ½. Non m'arresterei a questa osservazione, se non mi guidasse a dell'altro. Un palchetto corrispondente nel disegno AA di diametro UT ha piedi 3 e ½ di sfondato, e così anche il palchetto del Principe. Nel disegno BB il palchetto corrispondente al diametro KK ha piedi 4 e ½ di sfondato e quello del Principe ha piedi 5 di sfondato'*[6]. (Stratico, 1791)

These differences make it difficult to understand the real dimensions of the future boxes, especially in the depth, and should therefore be eliminated. As regards to the differences dictated by the designers' intuitions, there are in Ferrara Theatre:

Distance of the maximum width of the Room from the parapet of the Prince's box: AA: 47 and ½ feet; BB: 47 and ½ feet; Maximum width of the theatre room: AA: 38 feet; BB: 39 feet; Opening of the scene: AA: 38 feet; BB: 33 feet; Distance of the maximum width of the Hall from the Curtain: AA: 20 feet; BB: 25 feet; Distance of the maximum width of the Room from the parapet of the Prince's box: AA: 27 and ½ feet; BB: 22 and ½ feet.

In summary, the curve of the AA solution is excessively elongated, as well as significantly narrower, with more oblique views than those guaranteed by the

[5] Polygon with curved sides

[6] Compared to the first: it seems to me to note that the main walls that close the arch of the Theatre are already built. In drawing AA I find the total width of this area measured in the MN line, including the width of the walls, of feet 64: and the total length measured in the line GB including the width of the walls of feet 63. In the drawing BB I find the first of these measures of feet 63: the second of feet 62 and ½. I would not stop at this observation .. A corresponding platform in the AA design with a diameter of UT has 3 and ½ feet of a hole, and so is the Prince's platform. In the BB drawing, the platform corresponding to the diameter KK has 4 and ½ feet in the depth and that of the Prince has 5 feet in the breakthrough (translation by the autors)

BB curve instead (Fig. 3).

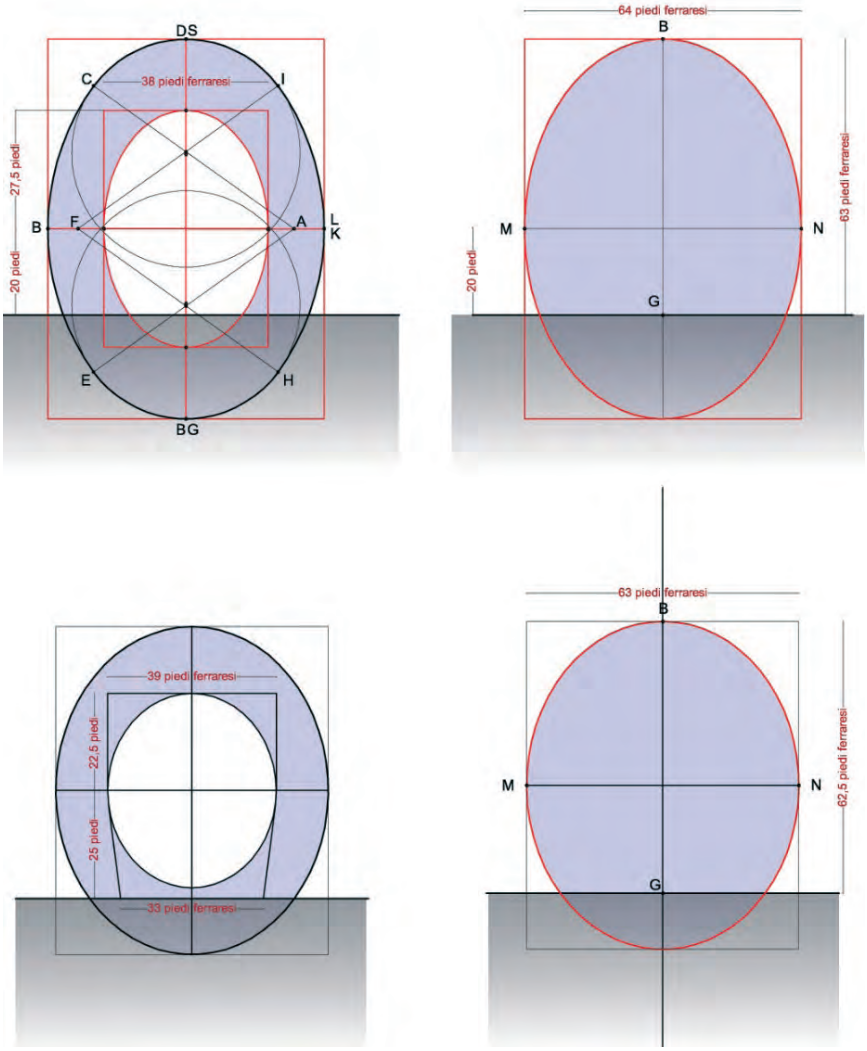

Figure 2. Geometric schemes of the data of the AA (top) and BB (bottom) solutions

'Se poi si riguardi il tratto dal diametro di massima larghezza all'apertura di scena sarà facile dall'addotte misure di computare, quanto più rapidamente convergano i lati della Curva nel disegno AA di quello che nel BB. Una retta condotta per l'estremità del diametro di massima larghezza, e per l'estremità dell'apertura di Scena dalla stessa parte, va ad incontrare il diametro di lung-

hezza della Sala teatrale alla distanza dal diametro di larghezza, di piedi 88 nel disegno AA, e di piedi 138 nel disegno BB'[7]. (Stratico, 1791)

In the field of acoustic Stratico represents that not enough theories have been developed to favour one curve over the other. They are therefore considered similar, given that the halls have small dimensions compared to the limits identified for the propagation of the human voice, and that the construction materials and ornaments are chosen to favour the diffusion of sounds.

Finally, Cardinal Spinelli opted for a realization that would put together the best elements of the two alternatives, that is to say, without the proscenium boxes and at the same time not too long.

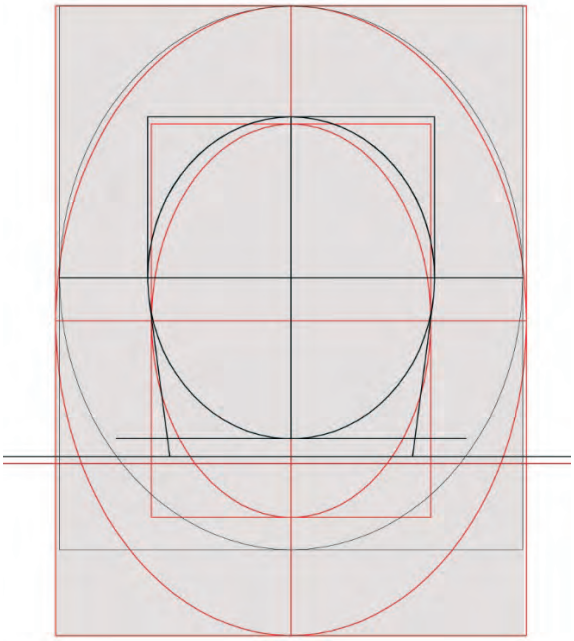

Figure 3. Comparison and overlap of the AA (red) and BB (black) schemes

In the figures 4 and 5, partly unpublished, taken from the Fondo Antolini

[7] If you then we observe the section from the maximum width diameter to the scene opening, it will be easy to calculate how much the sides of the curve converge in the AA design compared to those in the BB. A straight line from the end of the maximum width diameter, and from the end of the opening of the scene, meets the length diameter of the theatre room at the distance from the diameter of width, of feet 88 in the drawing AA, and of feet 138 in the BB design (translation by the autors)

at the Biblioteca Comunale Ariostea, through the diagrams showing the properties of the boxes of the first order, this final configuration can be deduced, which, although summarized, can help the reconstruction of the curve and further confirm its dimensions and proportions. These images are in fact certainly subsequent to the expression of the aforementioned opinions, since neither the royal box nor the proscenium boxes are present in them. At the same time, the curve is not too long.

As regards the verification of the project measurements with respect to what was actually carried out, the image, much better known, shown in Fig. 1, a representation of the theatrical performances of both the theatre and the annexed rooms is of particular importance.

Geometrical layout of the Ferrara Theatre

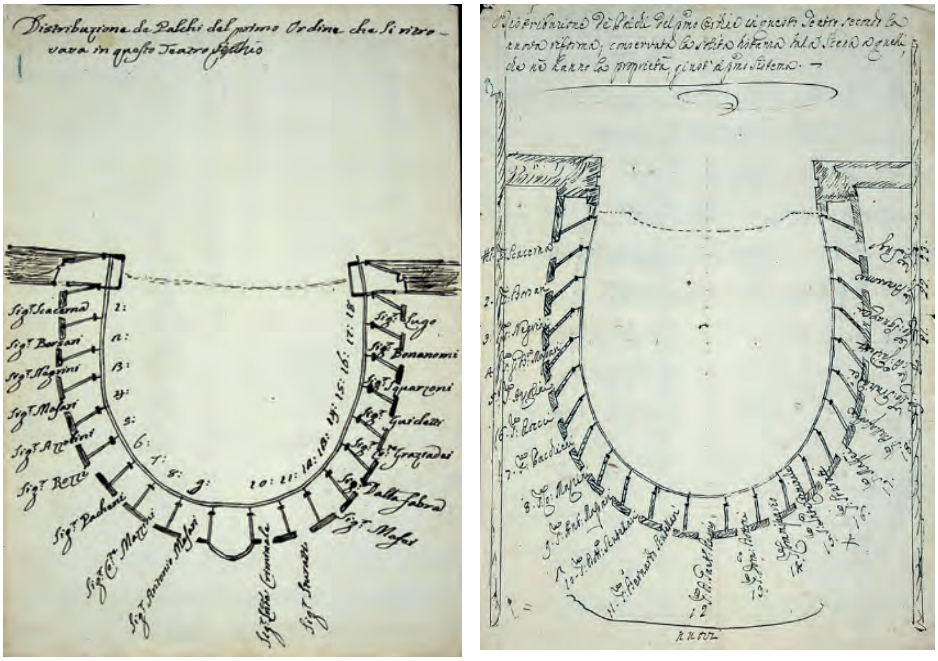

Figure 4. A) Distribution of the Boxes of the first Order that was in this old Theatre. B) Distribution of the Boxes of the first Order in this Theatre according to the new reform; preserved the same distance from the Scene to those who have the right ownership of the first System. [Biblioteca Comunale Ariostea, Fondo Antolini, busta n. 77]

The survey was done with two different methods: the manual one and the 3D. The manual survey, the one with 3D Laser Scanner and that with a 3D laser EDM were integrated to produce a model, a two-dimensional database, which had the metric quality to fulfil the scientific requirements. A database that can process more themes and analysis, useful not only to the project, including the restoration, but also to the management of the monument. An informative document of this kind, accurate and detailed, produces knowledge and can give answers and set many questions as well to all scholars who wish to investigate it. The metric analysis of the survey, based on the historical unit of measure, the "piede ferrarese" (0.403854 m), made it possible to relate number and measure, to identify the geometric scheme that generated the so much discussed oval by historians.

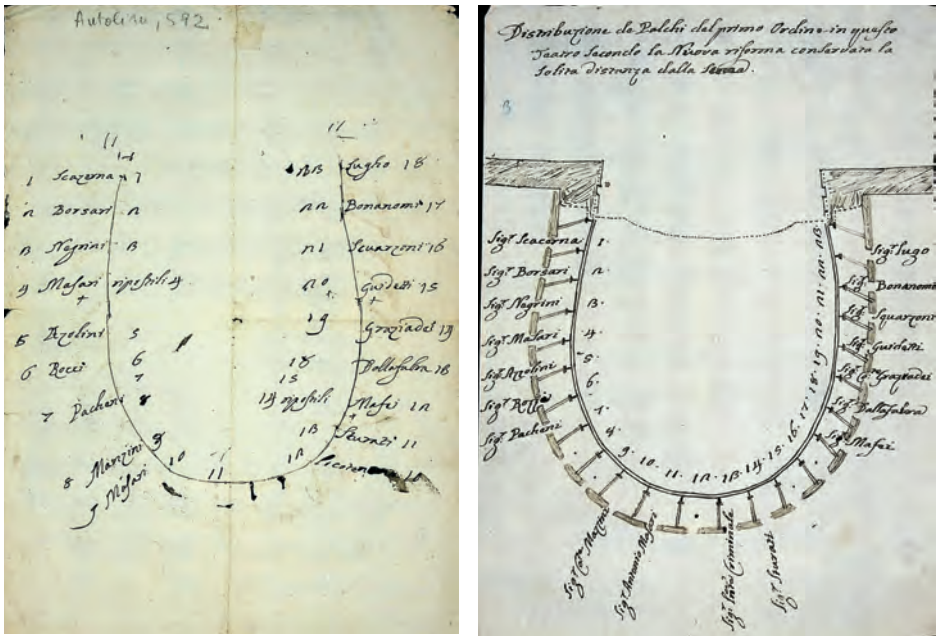

Figure 5. A) Sketch on the back of the sheet in Figure 3. B) Distribution of the Boxes of the first Order in this Theatre according to the new reform preserved the same distance from the scene. [Biblioteca Comunale Ariostea, Fondo Antolini, busta n. 77]

The result, obtained through the indirect survey carried out by laser distance meter 3D, was very helpful. By this instrument, the profile that faces in the audience, at the first order of boxes, where the oval had to have the intact measures - net of the mouldings - has been detected (Fig. 8). The resulting dxf

file has been analysed in a CAD environment to find the oval centres and their metrics relations. We have a very precise scheme that shows an oval whose the measure of major axis A,B is 80+9/10 feet (32.67 m). The minor axis C, D amounts 61+1/4 feet and is parallel to the proscenium (Fig. 6), and the distance Q, S, from the royal stage to the proscenium, is 44 + 19/20 feet.

The maximum width O, P is 39 + 3/20 feet. The depth of the boxes is another concentric oval with a radius greater than 65 feet (Fig. 6, 7). The width of the corridor, leading to the various entrances of the boxes, is still a concentric oval that is 5 feet from the last and has a radius greater than 75 feet. The measurement of the perimeter of the oval is essential to divide it, and identify the rhythm of the boxes. The problem is solved as the sum of the perimeters of the respective arches of circumference. The formula that puts in relation the measure of the arch l with that of the circumference C and the one of the central angle of the radius, that delimits the arch φ with that of the round angle, is $l/C=\varphi/(360°)$ from which it results that $l=\varphi/360 \times 2\pi r$. The perimeter of the portion of the oval to be divided is 113 + 1/2 (33.5 x 2 = 67; 67 + 46.5 = 113.5). The central stage box is 5 + 1/2 feet and the other 22 minor boxes (11+11) are 4 + 9/10 feet (113.5 – 5.5 = 108; 108 : 22 = 4.9).

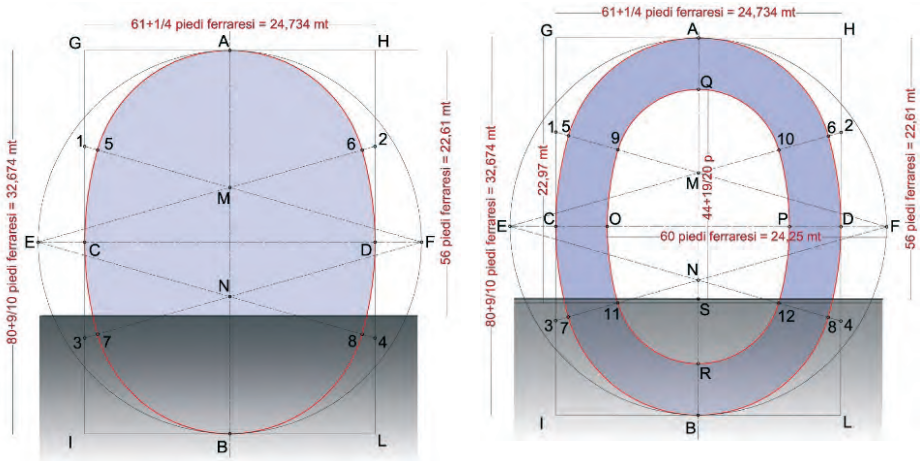

Figure 6. Geometric patterns obtained from the metric analysis of the survey: solution CC

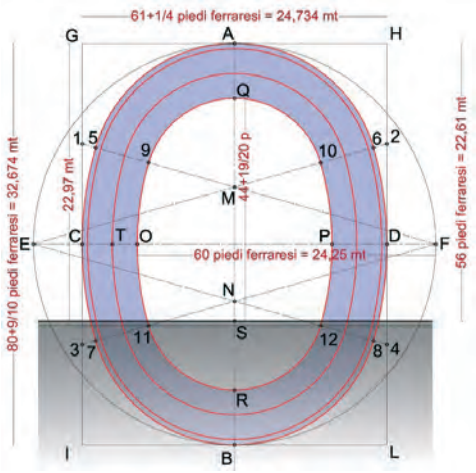

Figure 7. Geometric patterns obtained from the metric analysis of the survey: solution C

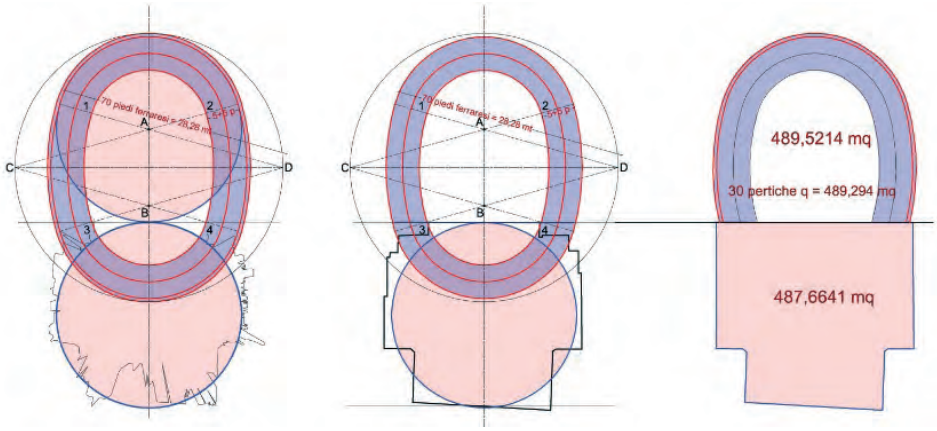

Figure 8. Geometrical schemes of the oval describing the hall of the Teatro Comunale

Conclusions

The comparison between the documents found at the Biblioteca Ariostea archive in Ferrara and the data obtained from the metric analysis allow us to state with absolute certainty that the solution of the oval adopted in the construction of the Ferrara Theatre is neither the one called AA nor the one called BB (Fig. 2). The third solution proposed by Cardinal Spinelli that we will call CC (Fig.7), adopted in the construction, is remarkably different in size from those commented and

analysed by Piermarini and Stratico. The dimensions of the solutions AA, BB and that found thanks to the CC metric analysis are reported below. Distance of the maximum width of the Room from the parapet of the Prince's box is in AA: 47 and ½ feet; in BB: 47 and ½ feet; while in CC is feet 44+1/2, that is almost 17.97m. Maximum width of the theatre room is in AA: 38 feet; in BB: 39 feet; in CC solution is 38 feet (15.34m). Opening of the scene is in AA: 38 feet; in BB: 33 feet; in CC: 33+9/10 feet. Distance of the maximum width of the Hall from the Curtain is in AA: 20 feet; in BB: 25 feet; in CC: 18 feet (7,26m). Distance of the maximum width of the Room from the parapet of the Prince's box is in AA: 27 and ½ feet; in BB: 22 and ½ feet; in CC: 30+2/3 feet. In summary, the oval of the solution AA has the major axis of 88 feet and the minor axis of 64, that of the solution BB has the semi major axis of 38 feet and the minor axis of 64, that of the solution realized CC has the major axis 80 + 9/10 feet and the minor of 61 + 1/4 feet. From the few notes above, it is clear that the final solution adopted as the shape of the oval does not correspond to those described by Piermarini and Stratico. It is clear that a third solution was studied and implemented. At this stage and on the basis of these two documents it is not possible to establish the authorship of the CC solution, however it is possible to see that the architect's goal is to build a well-proportioned portion of an oval to have good acoustics, and that it had the same surface of the stage (30+30 = 60 square poles), following the requirements for the type of "teatro all'italiana" (Fig. 8 scheme 3).

Acknowledgments

We thank the Biblioteca Comunale Ariostea and the Archivio Storico Comunale di Ferrara for having allowed the consultation and the study of the rich documentation and the iconographic apparatuses, without which the relief and the reconstruction of the original spaces and of the subsequent evolutions would have been much more difficult.

References

Teatro Comunale - Brano di relazione intorno all'operato dell'architetto Campana. Attivo e passivo del Teatro Comunale. Nota dei proprietari dei palchi nel dic. 1802. Calcoli intorno alla curva teatrale e note relative alla fabbrica suddetta - sec. XIX [Biblioteca Comunale Ariostea, Fondo Antolini, busta n. 69]

Piante due del Teatro Comunale di Ferrara - sec. XIX [Biblioteca Comunale Ariostea, Fondo Antolini, busta n. 70]

Foschini Antonio - Biglietto con cui dichiara al March. Camillo Bevilacqua di eseguire la curva del Teatro come allo schizzetto inviatogli, 15 agosto 1791. Lettera al March. Bevilacqua intorno al consegnare la pianta del Teatro ai costruttori imolesi, 11 luglio 1791. Medaglioni pubb. nel 1816, incisore F. Padovani - sec. XVIII [Biblioteca Comunale Ariostea, Fondo Antolini, busta n. 73]

Copia di una lettera del principe Gabrielli a d. Rodolfo Varano intorno alla curva del Teatro di Tordinona fatto dal Morelli, 13 giugno 1791 - sec. XVIII [Biblioteca Comunale Ariostea, Fondo Antolini, busta n. 74]

Pareri degli ing. e prof. Piermarini e Stratico sulla curva del Teatro Comunale di Ferrara e la distribuzione dei palchi - sec. XVIII [Biblioteca Comunale Ariostea, Fondo Antolini, busta n. 76]

Schizzetti tre della curva del Teatro Com. di Ferrara. I. Distribuzione de' palchi del 1° ordine che si trovava in questo Teatro vecchio. II. Distribuzione dei palchi del 1° ordine secondo la nuova riforma; conservata la solita distanza dalla scena a quelli che ne hanno la proprietà giusta al primo sistema. III. Distribuzione de' palchi del 1° ordine in questo Teatro secondo la nuova riforma conservata la solita distanza dalla scena - sec. XVIII [Biblioteca Comunale Ariostea, Fondo Antolini, busta n. 77]

Saggio sopra l'architettura teatrale, ossia dell'ordinanza la più vantaggiosa ad una sala di teatro relativamente ai principii dell'ottica e dell'acustica - sec. XIX [Biblioteca Comunale Ariostea, Fondo Antolini, busta n. 84]

Teatro Comunale di Ferrara - Circolari, progetti, contestazioni, imprese - sec. XIX [Biblioteca Comunale Ariostea, Fondo Antolini, busta n. 85]

Teatro Comunale di Ferrara. Lavori 1823 – 1851 [Archivio Storico Comunale di Ferrara, Commissione Pubblici Spettacoli – Direzione Teatrale, busta n. 89]

Teatro Comunale di Ferrara ristaurato l'anno 1851 dal celebre artista Prof. Francesco Migliari e successiva morte di questi – sec. XIX [Biblioteca Comunale Ariostea, Fondo Antolini, busta n. 120]

Teatro Comunale di Ferrara. Lavori 1852 – 1885 [Archivio Storico Comunale di Ferrara, Commissione Pubblici Spettacoli – Direzione Teatrale, busta n. 90]

Teatro Comunale di Ferrara [Archivio Storico Comunale di Ferrara, Mappe, stampe e disegni, 1/10 dal 12 al 61 edifici di interesse storico]

Mappe del Catasto Teresiano [Archivio di Stato di Mantova, Catasto Teresiano, 1771 – 1888]
Fabbri, P., Beriteri, M.C. (2002). *I teatri di Ferrara*. Lucca. LIM Editrice.
Fabbri, P., Beriteri, M.C. (2004). *I teatri di Ferrara. Il Comunale*. Lucca. LIM Editrice.
Dalla Negra, R., Ippoliti, A. (2014). *La città di Ferrara, architettura e restauro*. Città di Castello. Ginevra Bentivoglio Editoria.