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## THE ACOUSTICS OF THE *TEATRO IDEALE* BY FRANCESCO MILIZIA (1773)

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### Abstract

During the 18<sup>th</sup> Century several French scientists before Pierre Patte proposed a new idea of theatre architecture. This new idea was based on a democratic vision of the theatre, which was founded on the neoclassic architecture. The French vision of the theatre architecture recalled the Teatro Olimpico in Vicenza, designed by Andrea Palladio, and reintroduced many neoclassical (i.e. Greek/Roman) elements like columns, semicircular shape and large balcony instead of boxes.

The new French ideas about theatre architecture did not find many followers in Italy. The only scientists that accepted this new concept of a “democratic theatre” were the architects Earl Enea Arnaldi (Vicenza, 1716-1794) who wrote his *Idea di un teatro nelle principali sue parti simile a' teatri antichi all'uso moderno accomodato del conte Enea Arnaldi* (Vicenza, 1762) and Francesco Milizia (Oria, 1725-1798) who wrote the *Del Teatro* (Rome, 1773 and Venice, 1794) [1].

Milizia wrote his book after having read the Arnaldi's work and followed the idea of a semicircular plan of the theatre with columns and other elements. He was therefore influenced by the Teatro Olimpico architecture in Vicenza, and introduced many neoclassical elements in his idea of theatre architecture. He proposed the *Teatro Ideale* that would solve several problems existing in the modern theatre architecture, including acoustic difficulties.

In this paper, the *Teatro Ideale* proposed by Francesco Milizia is acoustically analysed. Starting from the sketches that were provided by Milizia, a numerical model was realized and utilized for simulating the acoustic behavior of the theatre, in the same way as today a new proposed modern theatre is acoustically analysed. The results from the simulation are presented and commented, compared with the acoustic data measured in Teatro Olimpico, and rendered by means of 3D auralisation.

### Keywords

*Teatro ideale; numerical simulation; stereo-dipole auralisation; Francesco Milizia*

### 1. The new ideas of Arnaldi and Milizia for theatre architecture

The international debate on the renovation of the theatre architecture started in 1749 when Voltaire inserted the *Préface-pamphlet* into the *Semiramis*.

Afterwards, the Académie d'architecture sent two architects in Italy in order to analyse the Italian theatres. One of the Architects was Charles-Nicolas Cochin, which wrote a report in 1758 [2] that approved the Palladian theatre in Vicenza, but criticised the architectural distribution of the boxes in the Italian theatres. In 1765 Cochin published a *Projet d'une salle de spectacles* with elliptical plan.

These publications influenced the Italian neoclassicism, and as a consequence Earl Enea Arnaldi published in 1762 the idea of a theatre that should be «as much as possible similar to the ancient theatres» [3]. However, the Arnaldi theatre maintains the boxes and converted the stalls into a semicircular terraces stair (figure 1).

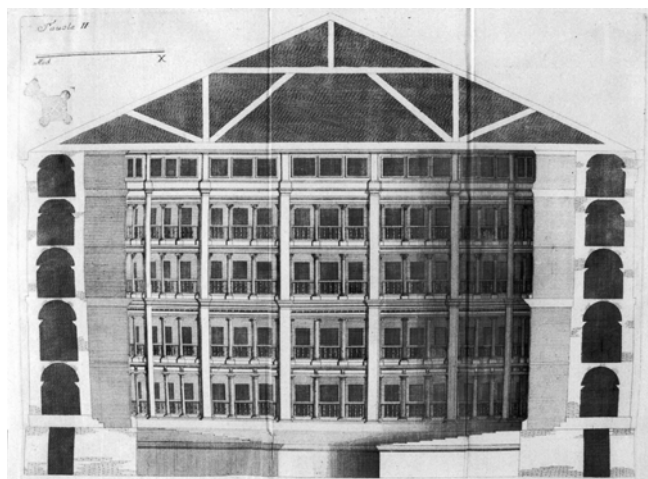


Figure 1 – the Arnaldi theatre – section – Tav II (1762)

Francesco Milizia knew the Arnaldi work. He also believed that the Teatro Olimpico «designed by the Vitruvian Palladio», «... could be considered as a good theatre ».

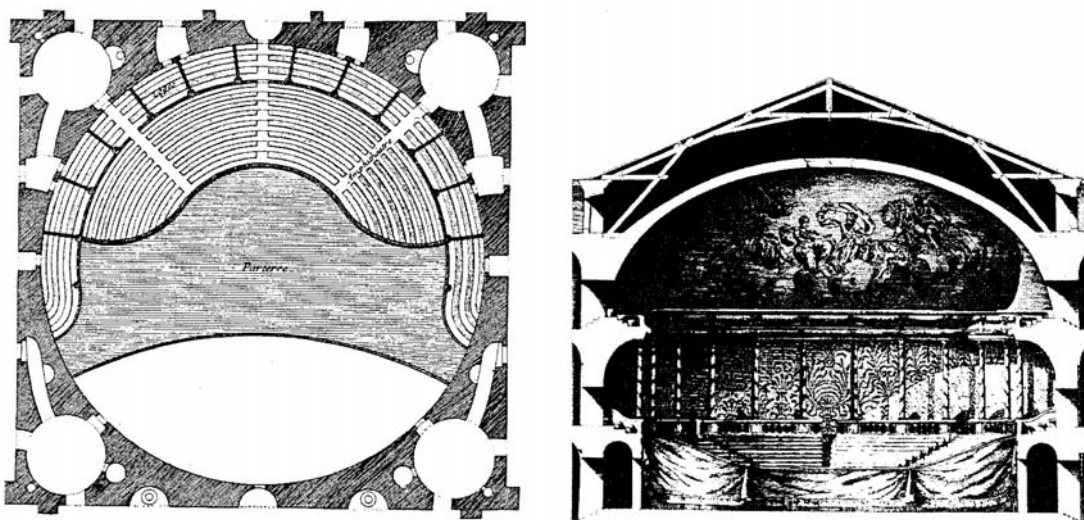


figure 2 GPM Dumont – 1764-1766

However, Milizia considered the Arnaldi theory not exhaustive and 10 years later published a more radical project, which also mentioned the need of acoustic enhancements in the room. «Due to the circular plan and to the boxes» he wrote «many time in the Italian theatres only whispers could be heard from those strange people [the singers], and never could be heard the words». Since Milizia worked also in Rome, he probably knew the Gabriel-Pierre-Martin Dumont and his work [4], and his idea of theatre architecture, which would be thoroughly realised in the France neoclassicism.

Milizia introduced also the French revolution themes for the theatre: He wrote: «Everybody must seat comfortably and must see the scene. Therefore, it is necessary to recall the semicircular shape and avoid the boxes».

The new ideas from Arnaldi and Milizia ideas will not be realised in Italy. All the new theatres, e.g. Milan (La Scala, 1778), Venice (La Fenice, 1790), Rome (Tordinona, 1794; Costanzi, 1880), Naples (San Carlo, 1817), will be realised in the baroque style, whereas in France many new theatre were realised in this new way (1777-1780 Grand Théâtre of Bordeaux; 1778-1784 Besançon).

## 2. The Teatro Ideale of Francesco Milizia

In 1773 Francesco Milizia published his book in which he proposed a new *Teatro Ideale*, which should solve many of the problems of his contemporary theatres. The most important new elements that he introduced are the following:

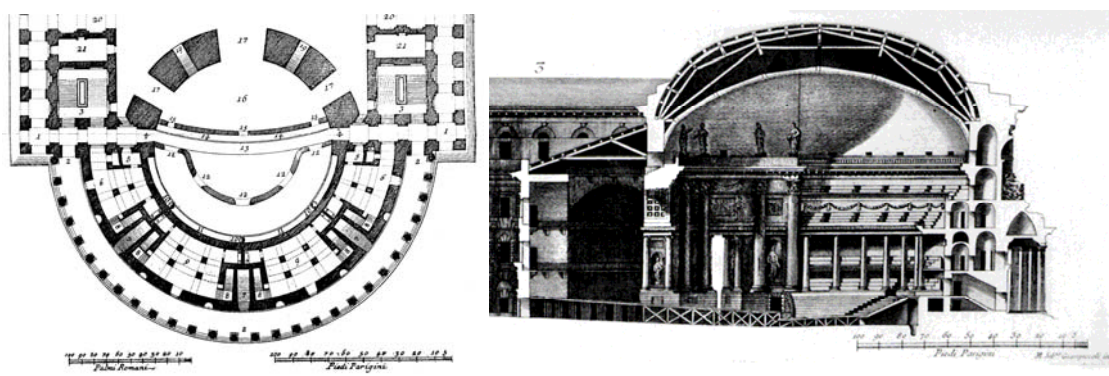


Figure 3 Milizia's Teatro Ideale: plant and section

### 2.1 Semicircular plant

In 1765-66, Joseph-Jérôme de La Lande wrote about the theatre Alibert in Rome: «the emisphere in the ceiling is too flat, and the voice cannot reach the stalls». The solution would have been a circular shape of the ceilings, as in the Vitruvian writings. Milizia added that the circular shape enhance visibility. He also wrote that the Farnese theatre in Parma (realised in 1618, having a U-shaped plan), despite of visibility, has a good acoustics.

Milizia considered the Teatro Olimpico in Vicenza as a good theatre. The theatre, despite of its semicircular plants, contains many wooden panels and elements on the lateral walls, and these components avoid focalisation, as measured in 2003.

### 2.2 Lateral walls and ceilings

Analysing the Arnaldi project, no evident focalisations would appear, since the gradons are made in wood, and the theatre has lateral boxes. (Fig. 1). Milizia proposed a

larger theatre with probably more focalisation. Therefore he proposed to cover all lateral walls with wooden panels, at a certain distance from the walls, which act as resonance panels, like in musical instruments, as designed by Galli Bibiena in Teatro Filarmonico, Verona (1724-1729)

The ceiling proposed by Milizia was strongly circular. Considering the dimension of the theatre (60 m diameter, which could host up to 5000 seats) and the geometry of the hall, it is likely that it could have focalisation. However, the ceiling had an elastic mechanical structure that avoided strong reflection at low frequencies.

### 2.3 Resonators

Arnaldi and Milizia tried to enhance the “resonance” of the theatre by adding Vitruvian vases and wooden panels. Milizia proposed cylindrical wells that could work as Helmholtz resonators or bass-traps. However, the wells should be cylindrical and grained. In his *Teatro Ideale*, Milizia proposed 3 cylindrical wells that «are necessary to amplify the voices» (Fig. 3). Indeed, many other cylindrical cavities could be found at that time: Nicodemus Tessin in Venice reported that «a great well that amplifies the sound of the voices» was found underneath the Teatro Vendramin in 1688. Similar devices were realised in Naples in 1742, and later in Lisbon (1792) and Ravenna (1840).

### 2.4 Boxes and galleries

One important aspect is related with boxes. The French theatre architects abandoned boxes, which were considered not democratic. Arnaldi maintained boxes, «for tradition», but Milizia abandoned boxes both for acoustic and visibility reasons. One previous experiment was done in Teatro Marsigli in Bologna, where the walls that separated the boxes were substituted with some light wooden structure. Francesco Algarotti in 1762 proposed to lower the fence in front of boxes, for acoustic and visibility reasons, and because «the spectators must be involved in the show».

## 3. Acoustic simulation and auralisation

Milizia provided a full-scale set of drawings of the *Teatro Ideale*, which have been utilised to verify the acoustics. A 3D model was realised and used to estimate the sound propagation in many positions in the room.

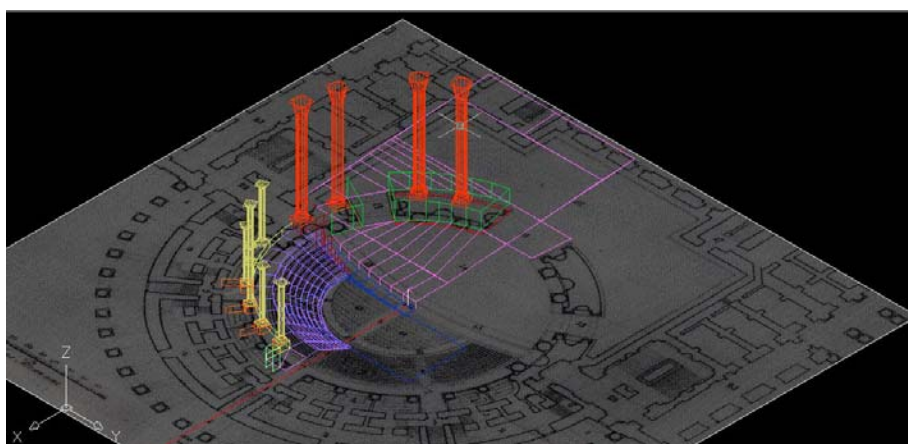


Figure 4. Realisation of the 3D model of the Teatro Ideale of Francesco Milizia.

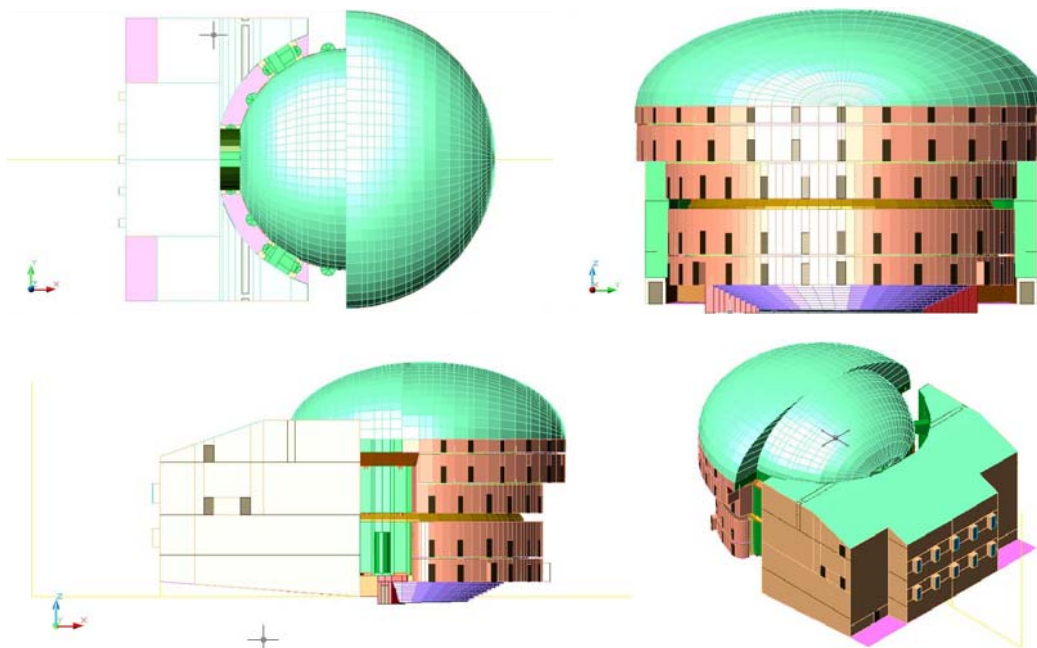


Figure 5. The 3D model of the Teatro Ideale of Francesco Milizia.

The geometry and the materials of the model were defined following his proposal. The absorption coefficients of the material were chosen considering other theatres, previously studied, which were similar in geometry. From the simulation, Binaural Impulse Responses (BIRs) were obtained in many positions of the room, considering up to 10 early reflections for each position, using a procedure that utilises the measured Kemar HRTFs that was developed previously [5]. The BIRs were utilised for the Stereo Dipole experiments in the *Arlecchino listening room* at DIENCA – CIARM for auralisation [6].

#### 4. Results

The overall acoustic parameters obtained from simulations are reported in table 1.

Table 1 – Overall value of acoustic parameters obtained after simulation.

Freq (Hz)	125	250	500	1000	2000	4000	8000	Lin	A
EDT (s)	3.3	3.0	2.8	2.8	2.9	2.7	2.1	3.0	2.7
T15 (s)	3.1	2.8	2.6	2.6	2.7	2.6	2.2	2.9	2.6
T30 (s)	3.2	2.9	2.6	2.6	2.7	2.5	2.1	3.0	2.6
C50 (dB)	-6.6	-6.4	-5.9	-5.9	-6.0	-5.7	-4.5	-5.9	-5.6
C80 (dB)	-3.7	-3.3	-2.8	-2.8	-2.9	-2.6	-1.3	-2.9	-2.6
D (%)	17.9	18.7	20.3	20.5	20.2	21.4	26.0	20.4	21.5
CT (ms)	219	203	184	185	191	178	142	194	179
STI (%)	0.52	0.53	0.55	0.55	0.55	0.56	0.61	0.55	0.55

Considering the overall values of the acoustic parameters reported in table 1, the *Teatro Ideale* appears as a slightly reverberant theatre. However, the numerical values here reported do not differ considerably from those values which were previously measured in the Teatro Olimpico in Vicenza, where the reverberation time resulted approximately 2.7 seconds at mid frequencies, and therefore the acoustics of the *Teatro Ideale* seems to be very similar to it, and this confirms the intentions of Francesco Milizia, who considered that theatre as a reference.

One more issue was the sound distribution in the theatre. The circular shape of the main hall could have provoked focalisation in the middle of the room. Nevertheless, the maps of the distribution of energy parameters (i.e. clarity or center time) shows that focalisation was limited, thanks to the acoustic treatment on the ceilings and lateral walls.

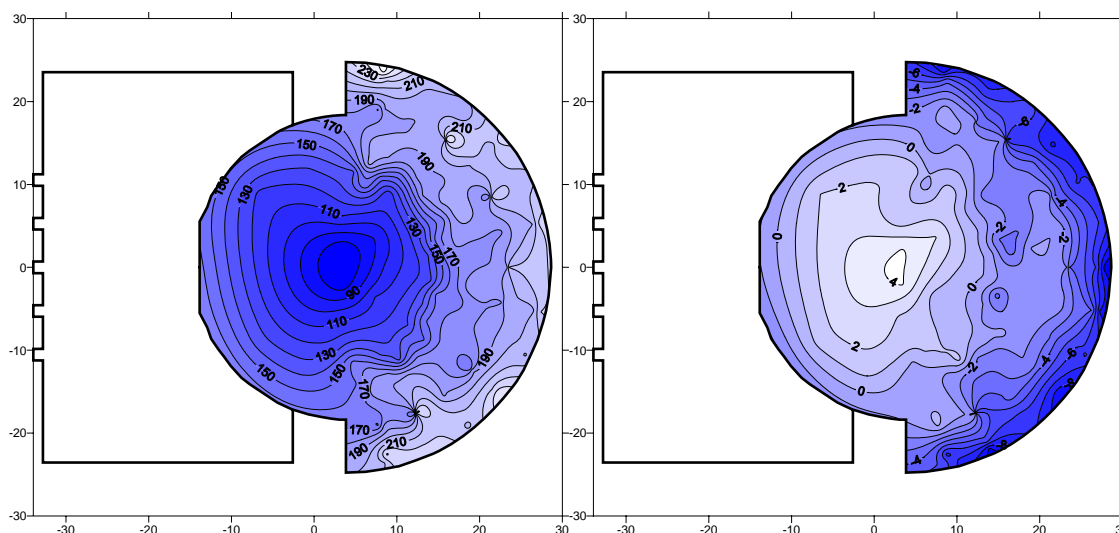


Figure 6. Spatial distribution of CT (left) and C80 (right) in the *Teatro Ideale*.

## 5. Conclusions

Francesco Milizia proposed a detailed project of his *Teatro Ideale*, which should improve acoustics, visibility, comfort and democracy for the spectators. Despite of the dimension of the theatre, the simulation and 3D auralisation made more than 200 years after, demonstrated that its acoustics would be very similar to some our contemporary theatres, like Teatro Olimpico in Vicenza and Teatro Colon in Buenos Aires.

## Acknowledgements

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## References

- [1] Francesco Milizia, “Del Teatro”, Roma 1771-2; Venezia 1794
- [2] Charles-Nicolas Cochin, “Voyage d’Italie, ou recueil de Notes sur le ouvrages de Peinture e de Sculpture, qu’on volt dans les principale villes d’Italie par monsieur Cochin”, III, Paris, Jombert 1758
- [3] Enea Arnaldi, “Idea di un teatro nelle principali sue parti simile a’ teatri antichi all’uso moderno accomodato”, Vicenza, Veronese 1762
- [4] Gabriel-Pierre-Martin Dumont, “Parallèle de plans des plus belles salles de spectacles d’Italie et de France”, Paris, c. 1764-1766
- [5] L. Tronchin, A. Farina, M. Pontillo, V. Tarabusi: “The calculation of the impulse response in the binaural technique”, Proc. of 7th International Congress on Sound and Vibration (ICSV), Garmisch, Germany, 2000
- [6] L. Tronchin, V. Tarabusi, A. Giusto: The realization of Ambisonics and Ambio-phonics listening room “Arlecchino” for car sound systems evaluation, Proc. 21st AES Conference, St. Petersburg, Russia, 2002