

Petrarca Theatre: A case study to identify the acoustic parameters trends and their sensitivity in a horseshoe shape opera house

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ABSTRACT

This article is intended to describe possible acoustic parameters' trends and their sensitivity in a horseshoe theatre, considering the characteristics of the Petrarca Theatre in Arezzo (IT), one of the co-called "teatri all'italiana".

In this theatre's typology, the public is distributed in the stall and in surrounding little boxes (the "palchetti"), located on more levels of balconies.

Several authors have come up to a fairly unanimous definition of the descriptors characteristics in a Opera House and have assigned their optimum values.

In this case study the physical parameters, that contribute to the sound quality, are evaluated in relation to geometry and materials of which the theatre is made and they are compared with the values of another rectangular hall with a similar room volume, the so called Sassi di Verbania (IT) Theatre, to understand the possible merits of the horseshoe shaped hall for Opera.

A percentage deviation $\Delta\%$ is defined and the results are linked to the specific horseshoe shape which characterizes the space geometry. The precious boxes, in particular, are identified through a grid in which rows represent the balconies' levels and columns the different sectors.

To evaluate the acoustic parameters' sensitivity the JND (just noticeable difference) is considered.

The parameters' trend for the different levels and sectors and for the receivers in the stall is described. Because more than one receiver is placed in a single box, the local sound distribution is related to the global one of the hall.

It comes out the success of the Italian theatre shape is undoubtedly linked to its sound quality, thought for the genre it was represented first, namely the Melodrama and the Opera, but also to the fact that the introduction of the balconies with boxes symbolically represented the social structure of Italy of the time: in the stall of public theatres poor people gathered together; the boxes at different levels were rented annually to the aristocrats.

A earlier shorter version of this paper was presented at AIA meeting 2017 [1].

1. The Opera House form from the horseshoe shape to the twentieth century spaces

1.1. The horseshoe shape in the Opera Theatre

The shape of the room with balconies around the perimeter walls was thus consolidated from Venice throughout Italy and Europe. The Horseshoe theatre-building boom can be likened to that for variety and music hall entertainment in the second half of the nineteenth century, the period in which also the Petrarca Theatre was realized (Fig. 1).

1.1.1. Italian Theatre's genesis and evolution [2]

The genesis of Italian theatre is to be found in the studies of 16th

century humanist architects who sought to integrate court theatre, housed in courtyards and rectangular rooms, and the Greek and Latin theatre. The first attempts were inspired to the ancient ones, trying to insert in the new theatre the parts named and described by Vitruvius: the cave, the orchestra, the proscenium, the front and the sides of the scene.

In this spirit, the Olympic Theatre of Palladio in Vicenza (1584) was inaugurated, the first stable theatre of the modern era, built for an autonomous institution, the Olympic Academy, designed by Andrea Palladio.

What marked the conformation of the new theatre at the end of the fifteenth century was the birth of the melodrama, the so-called "recitative", a new melodic language born from the study of ancient music

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Fig. 1. Petrarca Theatre – interior view.

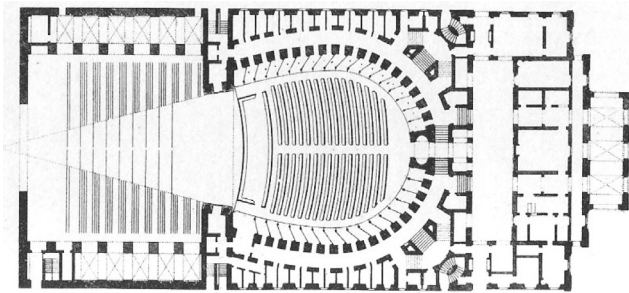


Fig. 2. Teatro alla Scala: the plan.

and from the search for the right tuning for such works, in which the music had the task of increasing the sense of the words. From Florence the melodrama spread immediately to Rome, Venice and Naples.

The first public distribution in different levels of balconies was in 1636 in the Stallone Hall of Padua.

In 1637, however, the first opera house with payroll public, the Theatre of San Cassiano, was inaugurated in Venice. By the end of the sixteenth century, the success of the opera in Venice was witnessed by the opening of many theatres erected or adapted to host this new theatrical genre.

The shape of the room with balconies around the perimeter walls was thus consolidated from Venice throughout Italy and Europe.

This success of the Italian theatre shape is undoubtedly linked to the genre it represents, namely the opera, but also to the fact that with the introduction of the balconies, it symbolically represented the social structure of Italy of the time: in the stall of public theatres poor people gathered together; the balconies were rented annually to the aristocrats.

In the Renaissance period, geometric acoustics was born with the first attempts to focus the sound and modify the shape of the room. The earliest Renaissance theatres were set on a circular plan. Following various studies related to geometric acoustics, new forms have begun to be considered, such as parabola, hyperbola and ellipse.

The hall configurations take on different shapes: a V, an U, elliptical, ovoid, but especially a horseshoe, a logarithmic spiral, in order to accommodate the greatest number of people while at the same time ensuring a certain visual comfort and privacy because of the numerous boxes placed on the different balconies' level, the so called "palchetti".

Despite the indications in the treaties, it was not the elliptical shape that prevailed between the eighteenth and the eighteenth centuries, but other curves, wider and more generous.

In San Carlo of Naples (1737), the greatest theatre of the time, Giovanni Antonio Medrano adopted a figure "a racket" in which a pseudo semicircular arc is connected to the proscenium through two straight lines.

The reference model of the Italian theatre is, however, that of the Scala Theatre (Fig. 2), inaugurated in 1778, which will contribute to the success of Italian opera and its diffusion, becoming the ideal imitation model for subsequent theatres. Its plan is a classical horseshoe with boxes in six tiers; the auditorium volume is 11250 m³.

Table 1

Petrarca Theatre: technical data.

Technical data	
Volume (fly tower excluded)	3100 m ³
Box depth	2.2 m ca.
Stall middle width	12 m ca.
Stall middle length	19.5 m ca.
Stage middle width	18 m ca.
Stall middle length	14 m ca.
Fly tower height	20 m ca.
Total seats number	680 (144 in the stall)

Its seating capacity of around 2300 is considered enormous for its time. This number initially appears impressive given that the furthest audience is only 31 m from the stage front. But the house suffers from the fault of traditional baroque theatres that sightlines at the sides and particularly at upper side levels are very poor.

The baroque theatre, based on the horseshoe plan form, dominated theatre design for 200 years till the twentieth century. Its success as a form had as much to do with social custom as any theatrical virtues: seeing and being seen was a primary concern in these houses. This may explain why so little was done to implement simple remedies to the baroque theatre's greatest failing, that of poor sightlines from the side boxes. Acoustically the baroque theatre and its descendants have proved remarkably appropriate for opera and little distinction was drawn in design between theatre and opera use, except for the obvious inclusion of an orchestra pit, because not just the music but also the words were very audible and balanced [3].

1.2. Opera houses during the twentieth century [2]

The most intense building program of opera houses during the twentieth century was undertaken in Germany in the 1950s and 1960s to rectify war damage. The majority of these were modern houses rather than reconstructions of the baroque theatres which preceded them. The new auditorium forms can be loosely grouped into those which are descendants of the baroque form and those deriving their main inspiration from the "Bayreuth solution" realized in 1876 (the theatre design was suggested by Wagner with amphitheatrical seating). Most of modern houses have open galleries opposite the stage. The manner in which these galleries extend down the sides of the auditorium provides a further opportunity for subdivision. Either continuous gallery sides are used or elements are segmented along the walls, to the extent in some houses of having small seating sections cascading from the rear towards the stage.

Plan design originates from the proscenium opening. Proscenium width for grand opera is typically 14 m, but larger sizes up to 18 m are also found. Smaller widths of 10 m or below are common in more intimate houses as in the Sassi di Verbania. The orientation of wall surfaces' configurations take on different plan shapes that in most of the cases are remember a shoebox or a fan space.

1.3. The Opera House acoustic behavior [3]

Both a baroque theatre and a modern Opera House design have many constrains.

The stage must be deep, the fly tower above the stage has to be about one and a half times the height of the proscenium opening above the top of the arch.

The orchestra is placed in the pit below the stage and the level between the singer and the musicians has to be balanced. The conductor, to be visible to both the orchestra and the vocalists, has to stand with his head just at stage level.

In opera houses singers need an area where they receive adequate reflected energy returning from the room.

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