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From Tangible to Intangible Heritage inside Italian Historical Opera Houses

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Abstract: Historical opera houses in Italy have been the place for the development of a relevant part of the National musical tradition and their design is paired with a peculiar acoustical fingerprint. Due to its relevance this can be regarded as an intangible heritage embedded in the tangible heritage constituted by the theatre building itself. In particular the presence of fairly deep lateral enclosures opened to the main hall volume, called the "boxes," is of paramount importance for the implications it had on the listening experience perceived by the public. For instance, the positions in the box recess had a much less favourable sound field compared to the frontal ones located at the box opening towards the hall. In this work the need for the box design is briefly recalled from an historical perspective and then the sound field in the boxes is described as the combination of several sound reflections from specific interior surfaces. It is seen how the related listening experience can vary in a remarkable manner while moving from boxes at different tiers. This characteristic greatly differentiates historical opera houses from modern ones, where one of the most valuable attribute is a limited change in acoustics over large audiences. The acoustical environment of historical halls and inside boxes in particular was important in building up the ear of the Italian opera goers, thus a close consideration of the peculiarities of the intangible heritage is necessary in case of restorations and cannot be overlooked.

Keywords: acoustical heritage; historical theatres; theatre restoration; listening experience

1. Introduction

A cultural heritage is intended as a tangible or intangible witness of civilization [1] and this definition, when applied to the acoustics of architectural spaces, gave rise to the term "acoustical heritage" [2] meaning that the sound experience is an essential part of the heritage's historical fruition that shall be addressed in the context of conservation. An analogous approach was proposed for Italian historical opera houses (HOS) [3] and some specific tools for safeguarding were developed [4]. What makes acoustics so important in the HOS is the interplay of architecture, music and social behaviour. In fact, the development of opera as an artistic form and the fruition of the houses from the early days in XVII century until the late XIX century, beside technical, architectural and acoustical improvements, were first of all reflecting the structure and the spirit of the contemporary society. The most evident proof of that resides in the audience arrangement of the opera houses, which was initially established as a framework resembling the classes of the society, with the Royal or Duke box taken as a reference and the rest of the locations ordered according to decreasing prestige or census. Thus, the peculiar invention of the boxes provided the architectural tool to accomplish such ordering concepts, which were then coded in the traditional design and survived a long time even if they were not entirely functional from the acoustical point of view. In fact, despite the long quarrels in the field of theatre architecture which span from the baroque to the neoclassical period and later on [5,6] and that concerned for instance the hall plan shape and the interior materials, the key design concept based

on the audience arrangement in tiers of piled boxes was never seriously put into question in Italy (apart minor issues regarding the closing or opening of the front balustrade).

In the end one can say that in the Country the theatre with boxes was for centuries the synonym of the performance space and that the theatre structure was in turn a representation or a metaphor of the society. That is why the tangible heritage of the historical theatre building hosts a peculiar cell, the box, which can be regarded as of outmost importance for the development of the intangible heritage of theatre acoustics. In this work the motivations for the box design will be recalled and placed in the context of the theatre development. The impact of the boxes design on the acoustics will be described in relation to the specific location of the listener and the original interlink of location, acoustics and social prestige of the box's proprietary will be discussed. Finally, some of the still-to-be-researched characteristics will be discussed.

This work is first aimed at providing theatre building stakeholders and conservation specialists with the basic concepts of HOS acoustics. Secondly, both historical and acoustical backgrounds are merged into a single perspective and, by so doing, a novel outline of the interlink of tangible and intangible heritage in HOS is presented. This information is valuable since it explains why interventions on the theatre building that are unaware of the peculiar role of acoustics may seriously affect the intangible heritage. However, it has to be remarked that the focus of the paper is not an in-depth analysis of HOS acoustics or a detailed examination of their historical development. The interested reader is directed to existing specialized literature which is referenced to in the work.

2. Why Boxes?

The arrangement of the public into separate boxes is at the basis of the theatre concept as a social event. In fact, if not directly erected by funds coming from royal, prince or local elites, the building of a theatre between the XVII and XIX centuries was only possible by subscription of private quotes, with nobles, aristocrats and later on mostly upper and middle class members providing the capitals to start up the construction. Within this mechanism, the box was a private property, sometimes rented and the theatre itself was similar to a condominium or, in other words, was a place for sharing leisure and "social" life and not just a place to attend performances [7]. During most of the late XVII and XVIII centuries the opera itself is part of a more general entertainment taking place for those in the box, where playing cards, chatting, cooking and many other less elegant activities are not only allowed but just normal. For instance, the box opening where provided with curtains to grant privacy and it was not unusual, during the golden age of "belcanto" in the first half of the XVIII century, that only the "aria" written for and performed by the outstanding singer was regarded as worth listening, so that the other on-going businesses were interrupted. This is to say that life in the box was an extension of the private house and only after a long time the bourgeois style of attending operas become more and more focused on the artistic side and this happened in particular when opera itself shifted from mythology or themes dealing with antiquity to more accessible, engaging and socially involved topics. This metamorphosis started already in the XVIII century but was more and more effective during the XIX century and especially in Italy the theatre venue and its boxes, became one of the most important places for social and political claims which were also interlinked to the growing National movements [8]. For instance, some of the Verdi works were pioneering the female rights for equality or the ideals of the Nation independence, so that the opera theatre itself was turned into a mass event rather than a pastime mostly limited to the upper classes. In the meantime, every town and most of villages built their own opera houses and, by the early XX century, more than 1000 similar theatres were active all over the Country. Thus, the theatre civil message was able to reach and being shared across the whole territory. Unfortunately, in the social process above, acoustics was not the main driver of the change. From the very beginning of the story in the second half of XVII century it had been already pointed out that the acoustical environment in the box was rather puzzling and often inadequate unless the listener was on the front opening. Anyhow, despite bad acoustics in the box recess as later demonstrated by direct measurements [9], the front box positions had visibility and

sufficient sound, together with great involvement in the performance due to the relative proximity of the stage. This was an argument that supported keeping the status quo, since acoustics could be rated as appropriate for those in the box who were really interested in the show. Together with this motivation, also the social structure of the property and the peculiar mix of private and public relationships that took place in the box finally prevented in Italy the tearing down of the box walls and the change of paradigm in the theatre design although this necessity was strongly suggested by the illuminists theories [10]. On the contrary, firstly solutions with very limited lateral box walls and then completely open galleries were adopted in France and Germany with the threefold aim of a more democratic and moral participation and, last but not least, a more acoustically effective sound propagation for those in the rear positions.

3. The Build-Up of the Acoustical Response in the Hall and the Specific Role of the Surfaces

The acoustics of the HOS were recently reviewed [11] and new acoustical data of HOS have been accumulated [12]. In particular in ref. [11] a detailed and quantitative analysis based on published measured data and listening experiments is employed to set the acoustics of HOS in relation to modern theatres and to discuss the differences of the perceived sound between stalls and boxes inside typical HOS. To the present aims it is relevant to fully understand the interlink between the layout of the main hall space with its acoustical response. This can be done by setting sound sources and receivers in some relevant positions, respectively in the pit and on stage for the source and in the stalls and in the boxes for the receiver and examining the resulting pattern of reflections. To start with, in Figure 1 one can see how the sound in the stalls can be generated by a stage source and in Figure 2 by a source placed in the orchestra pit. Efficacy of reflections is quantified by line, dash and dots respectively for full reflections, for partial reflections on surfaces of limited extension and for scattered reflections. Arrows' colour refer to the lateral (red), ceiling (blue) and proscenium arch (green) surfaces.

The same reflections that are traced in the upper theatre sketch are reported on a time scale in the lower pane, where the measured binaural impulse responses[1] are shown. The stage source provides strong reflections coming from the lower side walls and concentration of sound at back stalls positions due to concave reflections from behind often occurs. Reflections from box fronts are limited by the partial box opening and by scattering of decorative details. In Figure 1, one can see that some of the stage source sound is missed in the stage-house, which is a volume coupled to the main hall, while the ceiling and the proscenium arch contributions are able to distribute sound effectively in the stalls. Sound from the pit towards the stalls (Figure 2) suffers from diffraction on the pit rail and the lateral contributions are still incomplete. Again, an important role is attributed to ceiling and proscenium arch. A similar exercise can be done for the positions in the boxes (frontal position only) and is reported in Figure 3 (stage source) and Figure 4 (pit source). Only the ceiling can provide a full reflection while lateral contributions are variable depending on box opening and on the fine details of the surfaces involved. In particular, the presence of reliefs and decorations makes this contributions partly of scattered type. The reflections from the proscenium arch may not cover all of the box positions while they are very useful for creating acoustical contact between musicians in the pit and the singers on stage. The description of the pattern of reflections for listeners gets further complicated when the source is in the pit, since part of the boxes has a direct sightline whereas others still experience pit rail shading (back and lower tiers in particular). The different contribution of surfaces and materials to the position-specific sound detailed above finds a counterpart in the acoustical indicators and particularly in the subjective perception whose main characteristics are outlined below.

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[1] The binaural impulse responses are the best acoustical data to represent the sound inputs to the left and right ears of a listener. They are shown in pairs with the left channel above and the right channel below. Binaural data are obtained by means of a so-called "dummy head", which is an anthropometric sound probe having two microphones close to the entrance or inside the left and right ear canals.

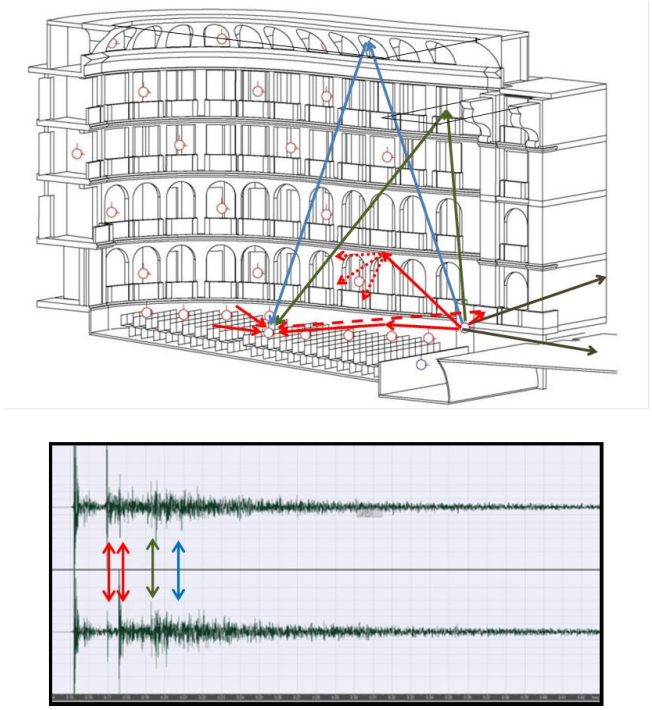

Figure 1. The sound field for a receiver in the stalls when the source is on stage. On the top pane is the geometrical tracing of the reflections from different surfaces. Full line is for effective reflection, dash line is for partially effective reflection and dotted line is for scattered reflection with energy spread to all directions. The bottom pane represents the respective measured binaural impulse response and the time course of the reflections traced before is highlighted colour by colour.

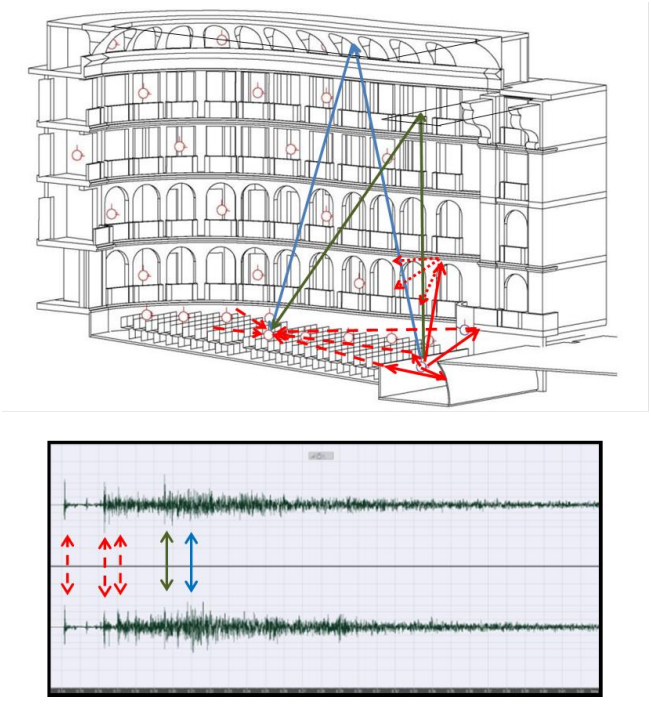

Figure 2. The sound field for a receiver in the stalls when the source is in the orchestra pit. Inside historical opera houses the pit was later added if it was not present in the original design. Note that the direct sound from the source in the pit is screened by the pit rail. Line layouts as in Figure 1, refer to text for details.

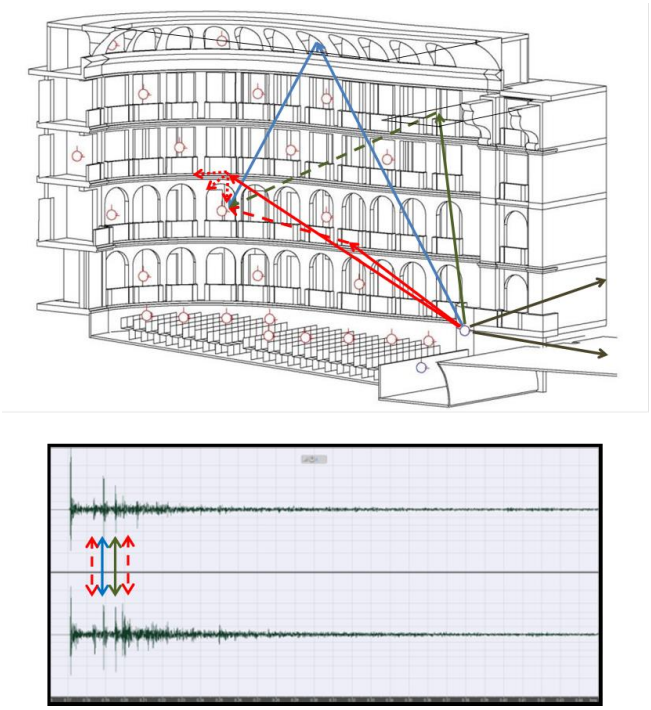

Figure 3. A stage source and the pattern of reflections for a receiver in the boxes. Line layouts as in previous figures.

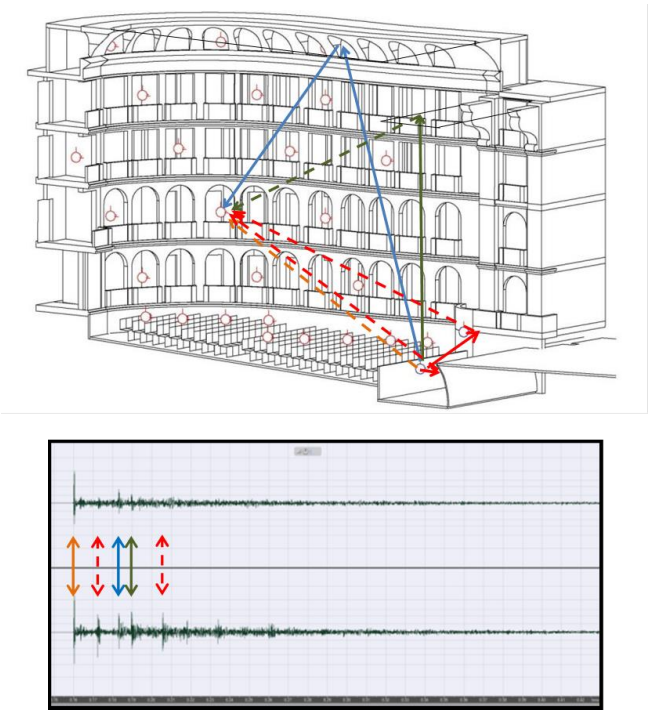

Figure 4. A pit source and the pattern of reflections for a receiver in the boxes. The visibility of the pit source depends on the box location and is best at front upper boxes. This occurrence is one of the main factors governing the balance of pit and stage sources. Line layouts as in previous figures.

4. Listening in the Royal and Proscenium Boxes

The previous analysis can be used to describe the listening experience in the different types of boxes. At first one shall recall that originally two types of boxes were outstanding: the so-called Royal or Duke box and the proscenium boxes. The Royal box was placed exactly at the apex of the plan shape above the entrance and often extended over two or more levels. Needless to say, this box was in the centremost position in order for the audience to have this primary reference in sight. Thus, the Royal box was also a place to look at and this was indeed part of the show. As it will be clear from what follows, the location of the Royal box at sufficient height and usually in the second tier was favourable also for acoustics. Moreover, the larger opening towards the main hall allowed for a more effective coverage of the ceiling reflection in the front and back positions producing an increased the sound level and finally the increased interior volume gave to this space a much more uniform and rich sound compared to the narrower boxes on both sides. The tradition of the Royal box with its usually outstanding acoustics with respect to the conventional boxes was kept in larger and smaller historical opera houses so that many of them during more than 200 years were built with such feature. Another quite special group of boxes are those located at the sides of the proscenium arch. From the very beginning, being closest to the stage meant on the one side the best involvement in the performance but, not less important, ensured to be fully visible to all the rest of the public. Since a similar feedback from the rest of the audience has always been part of the theatre experience by the high-society goers, one can understand why the proscenium boxes were yearned for, especially from those willing to establish their position in the society. They wished to be part of the show and nothing was better than being practically on the stage and hence having a remarkable benefit in the listening due to this proximity. Seen from the point of view of the acoustical design, the nature of the proscenium boxes was conflicting with the requirements of good stage acoustics for performers and of an effective sound propagation from the stage towards the audience. In fact, the presence of apertures with cavities summing up usually to 40 - 50% of the lateral areas depletes the reflection pattern of very important contributions which preferably could project the singer voice in the distance and could assist her/his voice in the difficult competition with the sound from the orchestra. Furthermore, also the mutual listening of stage and pit suffers from a limited availability of effective reflection surfaces in the forestage area and merging vocal and orchestra scores may become a tricky task for the conductor when singer and orchestra hardly listen one another.

The consideration of the forestage importance was addressed from the beginning of the modern theatre architecture and the need for side reflections from almost plane surfaces to support the singer was also a common design requirement. Interventions on proscenium boxes in particular were recently outlined as one of the few possible ways of improving the acoustics in the case of refurbishments [13]. A complementary strategy that was historically pursued in order to optimize the visual contact and the acoustical communication between singers and audience was the extension of proscenium as much as possible into the main auditorium [14]. Later on, with the advent of bigger halls and increasingly "technological" scenery, the stage tower was enlarged and the singer kept rearward. This had some acoustical drawbacks stemming from the longer distance with respect to the audience and from the less efficient reflection provided by the side surfaces. So, compared to the former "permeated" design style between stage and audience, the areas around the forestage would have been even more important in the evolved context, in order to better project the stage sound into the hall. Unfortunately, the traditional layout of the proscenium boxes, which had limited side reflecting surfaces coinciding only with the box fronts, was kept largely unaltered to satisfy the non-acoustical expectations of the theatre promoters that had the property of the proscenium boxes.

5. Listening in the Tiers of Boxes

The core of the present analysis deals with listening in the large number of boxes that are piled up in several tiers and surround the stalls. In part 3 it was explained that, especially in the boxes, thanks to the complex local contribution of reflections, the acoustical characteristics experienced by the listeners vary a lot depending on a multitude of factors as for instance the visibility of the orchestra pit sources. In fact a free sightline to the pit is surely realized for the upper tiers whereas it may be not granted in the first level. Obviously the prevalence or not of the pit sound, depending mainly on pit geometry and especially on the barrier effect of the pit rail, model the timbre response at the different box tiers. Moreover the central or lateral location of the box is associated for the latter with a somewhat unbalanced right and left exposition to the sound field, also due to the usual lack of strong lateral sound because of the largely open lateral surfaces consisting in the box fronts on the sides. But the benefit of a close and compact design, obtained with horseshoe plan (or bell and semi-elliptic just to note some of the more diffused) and the piling up of boxes, counterbalances most of those limits and makes the box positions at the opening facing the main hall quite suitable to discern singing and music in the opera performance. Some benefit from the control of upper reflections favouring the orchestra was recalled out to explain this occurrence too [15]. Furthermore, differently from the acoustics of concert halls—where the highest spatial sound is one of the main targets of the acoustical design—in the opera house, the role of the spatial impression has to be revised in view of the simultaneous presence and emission of two sources, orchestra and singer, each having peculiar sound power, frequency response, directivity and location in the hall volume. Recent studies indicated that, different to what one would expect, under these circumstances the increase of inter-aural cross-correlation[2] provided by the singer source might be used by the listener to focus the singer and hence better separate her/him from the competing orchestral background [18]. This would contrast with the knowledge of an overriding requirement for low inter-aural cross-correlation for musical sources when playing singularly [19]. This fact may partly explain why the front box positions, by just maximizing direct sound and few reflections (proscenium arch and stalls ceiling in particular) can be preferred by some listeners to most of the stalls locations where, on the contrary, the view is surely more natural and the sound strength is often a little higher. Listening attributes do change when moving from one box to another so that the subjective preference can be assessed experimentally [20]. In particular the examination of the objective acoustics data tells that the best balance between pit and stage can be achieved only at a certain height (typically at second or third tier) because of the pit rail shading and this is manifested primarily by smoother frequency response of the pit source [11]. The resulting perception of the orchestra sound can be more natural and not lacking high frequency sound as it happens when pit rail shading is most effective. On the other hand, when one goes higher and higher in the level, there is usually a prevalence of orchestra sound since the source becomes entirely visible and only better singers can compete with it by means of a strong and focused voice emission.

6. The Gallery

This part of the Italian historical opera houses, called "loggione" (that is "big lodge"), is worth mentioning per se for several reasons. The area surmounts the boxes and, differently from the lower levels, it is completely open. Historically speaking this place was originally left for lower-class goers, without box privacy and, in the early opera days, most people there were simply the attendants of the aristocrats in the boxes underneath. Acoustically speaking the sound circulation is greatly enhanced in the gallery [19] and, what is more important, the vicinity of the ceiling ensures a strong reflection

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[2] This quantity is termed IACC, is defined in [16] and is bound in the interval [0;1]. It is a measure of the similarity of the signal at the two ears which is thought to be related to the spatial impression intended as both the "apparent source width" and "envelopment" [17]. In the historical opera house this quantifier can be measured and evaluated from binaural impulse responses taken at the listener position for a given sound source location.

especially of the orchestral sound, which is generally quite neat and strong despite the farthest distance. So, the grounds for the singers are not the most favourable for making him/herself heard because the competitor, the orchestra, is at its best in the *loggione*. That is why the limits of a less powerful singer or one unable to project his/her voice properly are immediately spotted in this area. Together with the rest of the hall locations, the gallery has thus highly contributed to shape the way listeners approach opera and music in general, since opera houses are regularly used in Italy to host symphonic concerts too. This is to say that the acoustical heritage of opera houses has an impact on and is a reference for the acoustical expectations of the public related to the spaces where music is performed. This was apparent when newer concert halls were opened in the recent past. Receiving the new and much more reverberant acoustics was in fact difficult in the beginning since it implied a severe change in the way music was appreciated in public venues (see [21] for a comparative account of the acoustics of the Teatro Regio in Parma with that of the recent Paganini concert hall in the same town).

7. The Box as a Secondary Sound Source

The concern for the structural integrity of the historical opera houses, where often wooden structures were preferred to stiffer masonry with brick elements, can be directly linked to the vibration efficiency and to the resulting acoustical radiation. Despite the little published research on the role that lightweight vibrating structures perform in the historical opera houses, tradition and selection of survived best cases have indicated this point as an essential requisite for the overall quality. Seen in an historical perspective, the debate between masonry and wood has had a long history and the building of the Teatro Comunale di Bologna (1763) was one of the most serious quarrels on this topic, which is reported in [5] and is here worth recalling. On one side was the designer Antonio Galli Bibiena, who supported bell shape plan and bricks and on the other side the theoretician Francesco Algarotti, whose traditional view in favour of wood was at that time still prevailing. The discussion was mainly focused on what nowadays we would refer to as sound absorption but, although just drafting the basic physical mechanisms, the judgements driven by the educated ears were already able to associate a peculiar character to the acoustics of the theatre depending on the prevailing material. Bibiena said: "the theatre is more brilliant when made of stone" whereas his critics at the Accademia Clementina replied firmly: "the wood makes the sound more sweet to hear, whereas stone would make it harsh and raw." Considering this quarrel 250 years later and being well-aware of the complexity of the theatre as an acoustical system, we are still faced with difficulties in giving a solid scientific substrate to the acoustical qualities outlined by the pretenders. What we know today is that sound absorption, geometry and diffusion are one side of the coin, whereas the least explored side lays in the sound radiation by the structural elements once they are invested by the emitted sound and crossed by the travelling vibrations. The problem becomes immediately extremely complicated to handle quantitatively and this is probably one of the motivations that keep this side rather obscure. In pioneering works on the contribution of structural vibrations to the sound of the historical opera houses [22,23], the authors tried to rank the contributions of different surfaces and the task in [22] was that of preserving the same vibrational performance after some necessary renovations were implemented. More recently [24] a similar approach was reviewed to test the radiation of box parts (balustrade, lateral walls, ceiling) during sound production with a dodecahedron on stage in the renovated Teatro Zandonai in Rovereto (North Italy), whose structure is entirely made of wood. As a first result it was found that the balustrade is able to vibrate and re-radiate effectively up to nearly 3kHz, which is highly significant in the context of the singing voice since the most relevant formant frequencies appear to be covered for the most part. Second, the sound is radiated effectively from the side box walls and slight less from the box ceiling [25]. Of course, these results prompt the question of the audibility of re-radiated sound and of its contribution to the overall acoustic quality in the boxes for closer listeners and in the stalls for more distant ones. Unfortunately, these questions are at present still largely unexplored quantitatively and will require both theoretical developments and careful experimental and listening works.

8. Conclusions

This work intended to present a perspective which is often overlooked in the analysis of opera houses and in particular of the historical ones in Italy. The concept inspiring the arrangement of the audience and in particular the invention of boxes was a compromise between socio-economic rules and technical or acoustics motivations. This solution was so robust and so well adhering to the complex nature of the fruition that it was maintained with minor changes for more than 250 years, even when the rest of Europe had already abandoned it. For this reason, acoustics could develop only partly, although some shortcomings due for instance to the limited sound circulation in the rear box positions and to lack of reflections from the sides of the stage or to the risk of focusing in the back of the stalls (presented objectively in [9,20]) were reported already in the debates on theatre architecture since XVIII century. Even though, the intangible acoustical heritage developed inside such spaces has shaped the way music is enjoyed in the Country and today historical opera houses are still the most important National places for music, opera and prose production in the public system. In practice, the intangible heritage of HOS acoustics backs the wider intangible heritage of Italian musical tradition. What really matters nowadays is building restoration and in this event the origins and the development of the theatre concept, together with its acoustics cannot be ignored. Preserving the tangible heritage shall imply safeguarding the acoustics as well, despite some of the above limits being smoothed by a careful design. Even so, it is questionable that the overall dry character which builds up the peculiarity of the historical opera houses is altered to an unacceptable extent since a part of the legacy of music fruition and history will also be compromised.

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References

1. Vecco, M. A definition of Cultural Heritage: From the tangible to the intangible. *J. Cult. Herit.* **2010**, *11*, 321–324. [CrossRef]
2. Dordevic, Z. Intangigle tangibility: Acoustical heritage in architecture. *Struct. Integr. Life* **2016**, *16*, 59–66.
3. Fausti, F.; Pompoli, R.; Prodi, N. Acoustics of opera houses: A cultural heritage. *J. Soc. Am.* **1999**, *105*, 929. [CrossRef]
4. Pompoli, R.; Prodi, N. Guidelines for acoustical measurements inside historical opera houses: Procedures and validation. *J. Sound Vib.* **2002**, *232*, 281–301. [CrossRef]
5. Barbieri, P. The acoustics of Italian opera houses and auditoriums (ca. 1450–1900). *Recercare* **1998**, *10*, 263–328.
6. Barbieri, P.; Tronchin, L. L'acustica teatrale nel neoclassicismo italiano. Con una ricostruzione virtuale del 'teatro ideale' di Francesco Milizia (1773) (Theatre acoustics in the Italian neoclassical period. With a virtual reconstruction of the 'ideal theatre' of Francesco Milizia (1773)). In *Giordano Riccati Illuminista Veneto ed Europeo*; Fondazione Giorgio Cini—Studi di Musica Veneta; Olschki: Firenze, Italy, 2012; Volume 30, pp. 133–163.
7. Bianconi, L.; Pestelli, G. (Eds.) *Storia Dell'opera Italiana (History of Italian Opera)*; EDT: Torino, Italy, 1988; Volume 5.
8. Sorba, C. *L'Italia del Melodramma Nell'età del Risorgimento (Italy of Melodramma in the Risorgimento Period)*; Il Mulino: Bologna, Italy, 2001.
9. Ianniello, C. A note on historical theaters for opera. *Riv. Ital. Acust.* **2002**, *26*, 45–62. (In Italian)
10. Milizia, F. *Trattato Completo, Formale e Materiale del Teatro (Treatise on Theatre)*; Stamperia Pasquali: Venezia, Italy, 1773.
11. Prodi, N.; Pompoli, R.; Martellotta, F.; Sato, S. Acoustics of Italian historical opera houses. *J. Acoust. Soc. Am.* **2015**, *138*, 769–781. [CrossRef] [PubMed]
12. Garai, M.; Morandi, F.; D'Orazio, D.; De Cesaris, S.; Loreti, L. Acoustic measurements in eleven Italian opera houses: Correlations between room criteria and considerations on the local evolution of a typology. *Build. Environ.* **2015**, *94*, 900–912. [CrossRef]

13. Sumarac-Pavlovic, D.; Mijic, M.; Masovic, D. The influence of proscenium boxes on acoustic response in historical opera halls (L). *J. Acoust. Soc. Am.* **2015**, *138*, 1533–1536. [CrossRef] [PubMed]
14. Forsyth, M. The relationship between music and architecture in historical theatres. In *Teatro Storici: Dal Restauro allo Spettacolo*; Nardini: Fiesole, Italy, 1997. (In Italian)
15. Barron, M. Acoustics of opera houses. In Proceedings of the 2nd International Conference of Acoustics and Spaces for Music CIARM95, Ferrara, Italy, 19–21 May 1995.
16. International Organization for Standardization. *ISO 3382-1:2009 Acoustics—Measurement of Room Acoustic Parameters—Part 1: Performance Spaces*; International Organization for Standardization: Geneva, Switzerland, 2009.
17. Ando, Y. *Opera House Acoustics Based on Subjective Preference Theory*; Springer: Tokyo, Japan, 2015; Chapter 5.
18. Sato, S.; Wang, S.; Zhao, Y.; Wu, S.; Sun, H.; Prodi, N.; Visentin, C.; Pompoli, R. Effects of Acoustic and Visual Stimuli on Subjective Preferences for Different Seating Positions in an Italian Style Theater. *Acta-Acust. United Acust.* **2012**, *98*, 749–759. [CrossRef]
19. Beranek, L. *Concert Halls and Opera Houses*, 2nd ed.; Springer: New York, NY, USA, 2004; Chapter 4.
20. Sakai, H.; Prodi, N.; Pompoli, R.; Ando, Y. Temporal and spatial acoustical factors for listeners in boxes in an historical opera theatre. *J. Sound Vib.* **2002**, *258*, 527–547. [CrossRef]
21. Auditorium Paganini e Teatro Regio. Available online: http://pcfarina.eng.unipr.it/Public/Presentations/confrontoauditoriumregio.pdf (accessed on 30 January 2019).
22. Pisani, R.; Duretto, F. Il restauro ed i problemi di acustica dei teatri storici (The restoration and the acoustics problems in historical theatres). In Proceedings of the XXVII National Conference of the Italian Acoustics association (AIA), Genova, Italy, 26–28 May 1999.
23. Iannace, G.; Ianniello, C.; Maffei, L.; Romano, R. The acoustics of the Court Theater in the Reggia di Caserta. In Proceedings of the 17th International Congress on Acoustics, Rome, Italy, 2–7 September 2001.
24. Prodi, N.; Santoni, A.; Rossetti, A. *Misurazioni Acustiche nel Teatro Zandonai di Rovereto dopo il Restauro (Acoustical Measurements in the Teatro Zandonai after the Restoration Works)*; Technical Report; Engineering Department, University of Ferrara: Ferrara, Italy, 2014.
25. Prodi, N.; Pompoli, R. Acoustics in the restoration of Italian historical opera houses: A review. *J. Cult. Herit.* **2016**, *21*, 915–921. [CrossRef]