

Acoustics of Vanvitelli's place

Gino Iannace

Università della Campania Luigi Vanvitelli, 81031 Aversa, Italy

Abstract

Luigi Vanvitelli was an architect who lived in the 18th century and designed numerous palaces, the most important of which was the Royal Palace of Caserta. This article presents the acoustic characteristics of this building. The palace was built in the 18th century as the residence of the King of Naples. The palace contains numerous rooms used for various purposes of court life. This article reports the acoustic properties of the rooms, which were studied according to the ISO 3382 standard. The average values for reverberation time (T30), clarity (C80), definition (D50), and speech transmission index (STI) are reported. Acoustic issues are also discussed, as knowledge of acoustics during the period in which the palace was built was virtually nonexistent. The materials used for the construction of the palace were marble and plaster. These materials, being acoustically reflective, generate long reverberation times.

Keywords

Vanvitelli, architect, acoustics measurements, Royal Palace, ISO 3382

1. Introduction

Architectural acoustics is a modern science. Although its earliest rudiments date back to Greek and Roman times, the first studies on the acoustics of enclosed spaces were conducted by C.W. Sabine in the late 19th century. Sabine's research and studies were collected in a book, *Collected Papers*, which still serves as a basic text for early studies. This book collects the experiments and acoustics of the most famous spaces of the era. Sabine's research began with a request to improve listening conditions in the auditorium of the Fogg Art Museum. This room, due to its size and reflective materials, had poor speech intelligibility. Through a series of measurements and the addition of cushions of known dimensions, speech intelligibility was increased and a new parameter, reverberation time, was defined. It is defined as the time interval required for sound to decay. This article aims to analyze the acoustic characteristics of various rooms within the Royal Palace of Caserta. The acoustics of the following rooms have been studied, considering their architectural characteristics. In ancient Greece and the Roman Empire, numerous theaters were built. The purpose of their construction was to provide a place to gather people to attend performances. In ancient Greece, open-air theaters or small roofed rooms "Odeon" were built. In the Roman Empire, the Greek tradition of building large theatres, covered (Odeon), and large buildings for gladiatorial shows (Amphitheater) was introduced. Every city in the empire, large or small, had these buildings for performances. The construction of theaters followed simple rules set forth in Vitruvius's book. During the Renaissance, numerous studies were conducted on the caustics of theaters. Athanasius Kircher also explored how the geometric shape of enclosed spaces and noted that the curved roof of a room influenced the propagation of sound. One of the most interesting studies focused on the elliptical shape of ceilings and how this geometry could enhance the propagation of sound. During the Renaissance, architects designed buildings, churches, and theaters based on experience and analogy with spaces known for their good acoustics. Furthermore, in the 17th century, numerous

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* Corresponding author.

✉ Gino.IANNACE@unicampania.it (G. Iannace)

ORCID 0000-0003-3182-3934 (G. Iannace)



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studies on theater acoustics were conducted. During that period, it was noted that the propagation of sound was analogous to the propagation of light, and for enclosed spaces, the propagation of sound and light was studied using ray theory. These observations laid the foundation for geometric acoustics, which was later applied to the design of theaters and churches. This paper aims to analyze the acoustic characteristics of several rooms: Court Theatre; Elliptical Vault; Palatine Chapel; Throne Rooms. Various campaigns of acoustic measurements were carried out in each of these rooms using an omnidirectional sound source emitting a Maximum Length Sequence (MLS) signal [1-5].

2. The Royal Palace of Caserta

In 1750, King Charles of Bourbon purchased land in the town of Caserta, near the Tifatini Mountains, at north of Naples. The aim was to build a new royal palace. The reason was that the palace of Portici was subject to seismic shocks and eruptions of Mount Vesuvius, and for the tranquility and safety of the court, it was decided to build a new palace far from Vesuvius. This new building was to serve as the administrative and ministerial center of the Kingdom of Naples. The project was designed by Luigi Vanvitelli, an architect of Dutch origin who had created architectural projects for the City State. Vanvitelli, a profound expert in classical architecture and Vitruvius's treatise. From this knowledge, he developed an original vision, which he applied in the construction of the Royal Palace of Caserta. The architecture of the Palace is a reflection of Vanvitelli's neoclassical culture. And the building would later be considered a practical example of the neoclassical style. The foundation stone of the Palace was laid on 20 January 1752. The plan of the Palace is rectangular, with sides of 247 m and 190 m, and a total perimeter of 874 m, the height of the building is 41 m. The entire surface is divided into four parts along, creating four equal courtyards. The palace contains approximately 1200 rooms and 1742 windows. Based on Vanvitelli's original vision, the palace was intended to be a multifunctional structure, which included not only the royal residence, but also living quarters, administrative offices, a chapel and a theatre. The access to the palace from Naples was designed as a grand avenue. Figure 1 shows Luigi Vanvitelli's drawings of the Royal Palace of Caserta: the front view and the main elevation. The Royal Palace remained the property of the Bourbon kings from 1752 to 1860, after which it passed to the House of Savoy. In 1919, the entire property was transferred to the Italian government.



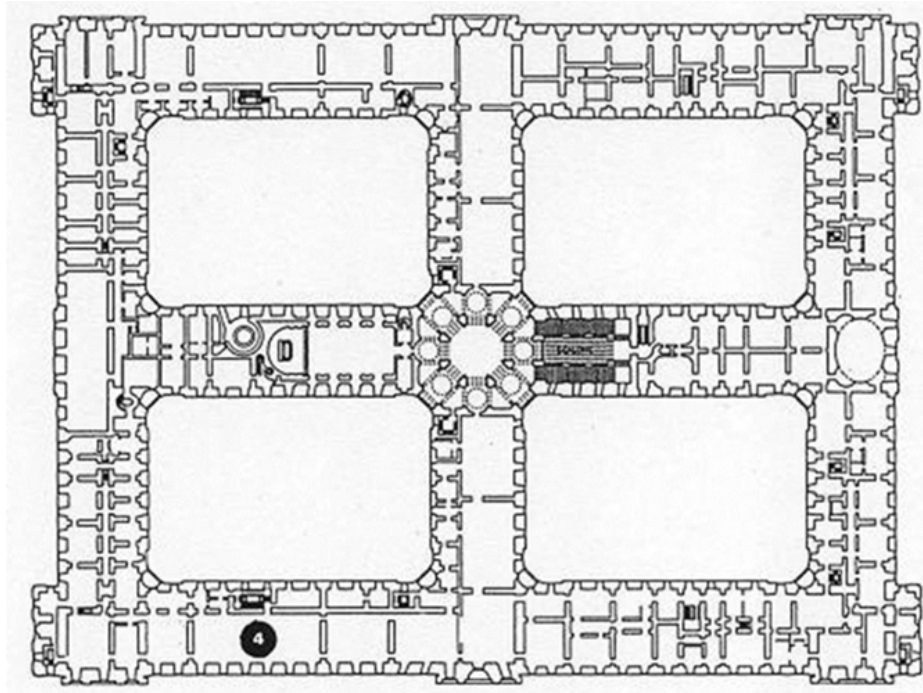


Figure 1: Drawings of the Reggia of Caserta: frontal view; principal elevation with the rooms.

In the 18th century, many nobles enjoyed privileges not only in the political and economic spheres, but also in the cultural sphere, as they were the main patrons of the arts. The nobles financed artists such as painters, sculptors, and even musicians. But during the 18th century, music began to be performed in places other than the nobles' palaces. Music began to be performed outside of palaces; the first theaters open to the public appeared, and performers paid by the public began to perform. This period contributed to the development of public theaters, where people of all social classes could attend performances simply by purchasing a ticket. In addition to theaters, music was also performed in chapels, where choirs supported religious services. Since the 16th century, the term "cappella" had been used to indicate a group of voices and instruments that performed at religious and secular events. In chapels, Latin replaced the vernacular, and the biblical message was emphasized through choral music. Chapel musicians served their Prince or Court. This political context led to a shift in the role of the "maestro di cappella," who initially focused primarily on sacred music but also had to adapt to the secular performances favored by aristocrats. In the 17th century, important figures from the chapel arrived at the Royal Palace of Caserta, including Alessandro and Domenico Scarlatti, Paisiello, and Cimarosa, who helped spread the music and artistic expression directly linked to the Bourbon court. The Bourbon family's commitment to music is evident in the establishment of the Teatro San Carlo in 1737 and the construction of the Court Theatre within the Royal Palace of Caserta. This theatre was not included in Vanvitelli's original project but was added at the suggestion of King Charles of Bourbon. The Court Theatre was dedicated to official events, such as the ball performed at the wedding of King Ferdinand IV and Maria Carolina of Austria in 1769 [6-10].

3. Acoustic Measurements

Several acoustic measurement campaigns were conducted in the Royal Palace. The equipment used consisted of a dodecahedron sound source, which generated a Maximum Length Sequence (MLS) signal. This signal was recorded by a microphone. The impulse response (IR) was then processed to obtain the acoustic parameters. The acoustic measurements were conducted according to the ISO 3382-1 standard.

The acoustic parameters analyzed include EDT, T30, C80, D50, and STI. These parameters were defined to characterize how sound is perceived in a room. A brief definition of each parameter is provided below:

- Early Decay Time (EDT): This refers to the time it takes for the acoustic pressure level to decrease by 10 dB after the sound source is turned off.
- Reverberation Time (T30): Defined in seconds, this is the time needed for the sound pressure level to decrease by 30 dB. It is a critical parameter used to characterize the acoustic properties of a room, providing insights into sound reflections, absorption, and the overall auditory environment.
- Clarity Index (C80): Expressed in decibels, this is the ratio between the energy that reaches the receiver within the first 80 milliseconds and the later energy that arrives after that. It is one of the criteria used to evaluate the suitability of a hall for musical performances.
- Definition (D50): This is a factor calculated based on the energy arriving within the first 50 milliseconds and the total energy of the sound source until its dissipation. It is used to assess the clarity and intelligibility of speech in a room or space.
- Speech Transmission Index (STI): This parameter is used to assess how much a voice signal is distorted by unwanted echoes, excessive reverberation, and/or high levels of background noise. STI values range from 0 to 1, indicating very poor and ideal speech intelligibility, respectively.

Each room or theatre, depending on its intended use, requires specific acoustic parameters, such as optimal reverberation time, clarity, and definition. Rooms intended for speech require short reverberation times, while those intended for music require longer reverberation times, as reverberation enriches the music with reflections and enhances the sense of audience participation. Therefore, a room designed for music may not be suitable for speech unless appropriate acoustic corrections are made. Table 1 presents indicative values for the acoustic parameters in different musical listening conditions and speech intelligibility settings.

Table 1. Acoustic indicative parameters for the different listening conditions.

Parameters	EDT (s)	T30 (s)	C80 (dB)	D50
Optimal values for musical performances	$1.8 < \text{EDT} < 2.0$	$1.6 < \text{T30} < 2.2$	$-2 < \text{C80} < 2$	< 0.5
Optimal values for speech performances	1.0	$0.8 < \text{T30} < 1.2$		> 0.5

The main acoustic parameters were analyzed in octave bands as a function of frequency, ranging from 125 Hz to 4 kHz. The results were averaged across all measurement points, and the standard deviation values are also presented in the frequency function graphs. If the standard deviation values are close to the mean value, it indicates that there are minimal variations in the measured parameters between points. Conversely, if the standard deviation values differ significantly from the mean value, it suggests large variations between the measurement points. The acoustic parameters were measured in an empty room, with no audience present, and with negligible background noise, always below 35 dBA [11-15].

3.1. Court Theatre

The small and exquisite Court Theatre, located on the west side of the palace, was not part of the original project. Vanvitelli began designing this new room in 1756, three years after the start of the construction of the Royal Palace of Caserta, as requested by King Charles. The Court Theatre, which closely resembles the San Carlo Theatre in Naples, opened in 1769 during the Carnival, in the presence of King Ferdinando and Maria Carolina. It represents the only room fully completed by Vanvitelli. The Court Theatre has three entrances: one reserved for the king, providing direct access to the royal balcony, and two side entrances for the guests. The layout is typical of a horse-shoe shape, with 42 boxes arranged over five levels, decorated with statues and floral motifs, each distinct from the others. The dimensions of the theatre are 25 m in length, 12 m in width, and an average

height of 15 m, with a volume of 4700 m³. The theatre does not have an orchestra pit. The royal balcony is three levels high, surmounted by a large crown and Baroque drapery made of pasted paper. The vault is subdivided into different segments, accentuated by edges and supported by alabaster pillars and columns. The Burbon family used the theatre primarily for Baroque opera performances, while today it serves as a venue for conferences and musical shows. Figure 2 illustrates the theatre's horseshoe-shaped layout. Figure 3 shows an interior view of the Court Theatre. Figure 4 presents the average values of the acoustic parameters and the standard deviation. If the standard deviation is large, the measured values are scattered; conversely, if the standard deviation is small, the measured values are concentrated near the mean of measured values. The average STI value of 0.60.

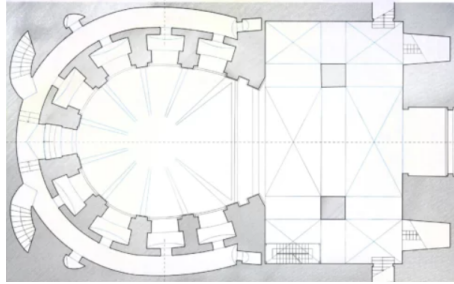


Figure 2: Court Theatre: horseshoe-shaped plant.



Figure 3: Internal view of the Court Theatre.

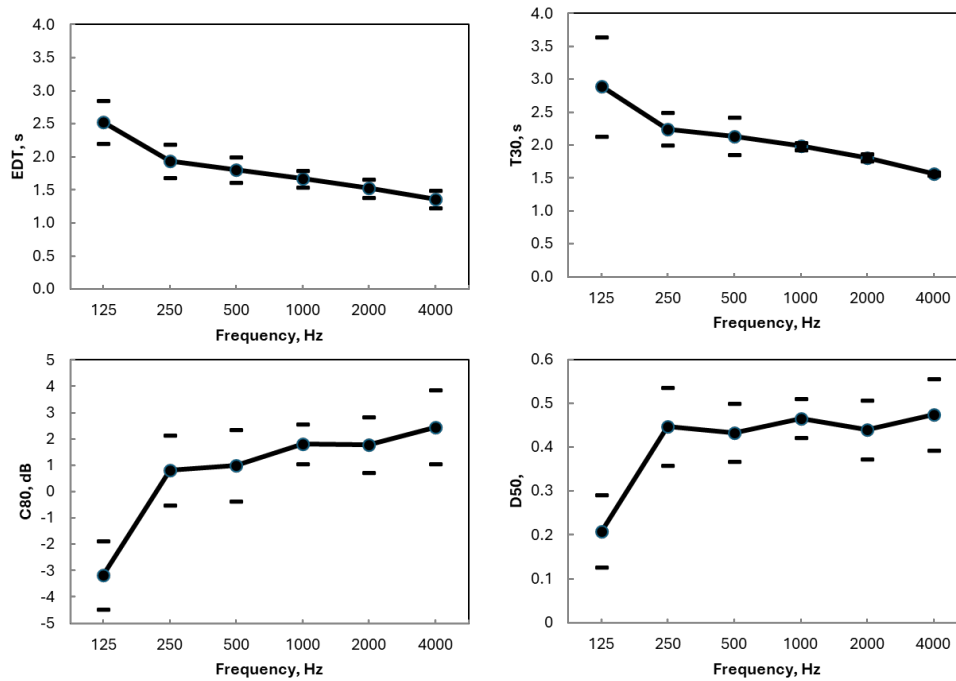


Figure 4: Average values of the acoustic parameters and the values of the standard deviation

3.2 Palatine Chapel

The Palatine Chapel is located on the first floor and was inaugurated on Christmas Day in 1784. Geometrically, it is inspired by the Chapel of the Palace of Versailles, with its rectangular hall and semicircular apse. Above the main entrance is the royal tribune. Both sides are characterized by two galleries, with double-height Corinthian columns supporting a barrel-vaulted ceiling adorned with golden coffered motifs. The chapel's walls are lined with polychrome marbles. The ceiling is barrel-vaulted and made of wood with large reliefs; this geometry helps to diffuse the incident sound. Figure 5 shows the interior view, while Figure 6 illustrates the floor plan with the main dimensions. The chapel is used to host musical concerts, including opera performances. The surface area of the palatine Chapel is about 1000 m², and its volume is 22,860 m³. Figure 7 presents the average values of the acoustic parameters and the standard deviation, with an average STI value of 0.25. The acoustic characteristics of the palatine Chapel include a reverberation time of 5 s at mid-frequencies. Considering the geometry and materials of the chapel, it can be said that the values of EDT and T30 measured in unoccupied conditions are relatively low for a volume of 22,000 m³. The large windows on the side walls and the wooden ceiling contribute to the absorption of reflected sound, reducing the reverberation time. The side galleries and reflective materials create a diffuse sound field throughout space, resulting in small standard deviations for the EDT and T30 values. However, the values for D50 and C80 show large standard deviations, with significant variation across the different measurement points. The average value of C80 is equal to -5 dB, which means that the chapel does not have good musical listening conditions; similarly, the average value of D50 is equal to 0.2, which means that the chapel does not have good speech listening conditions [16-25].



Figure 5: Internal view of the Chapel.

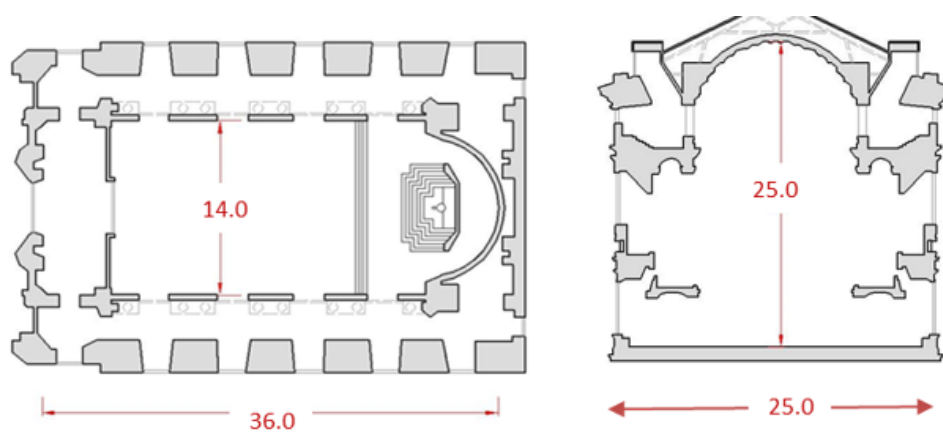


Figure 6: Plant of the Chapel with main dimensions.

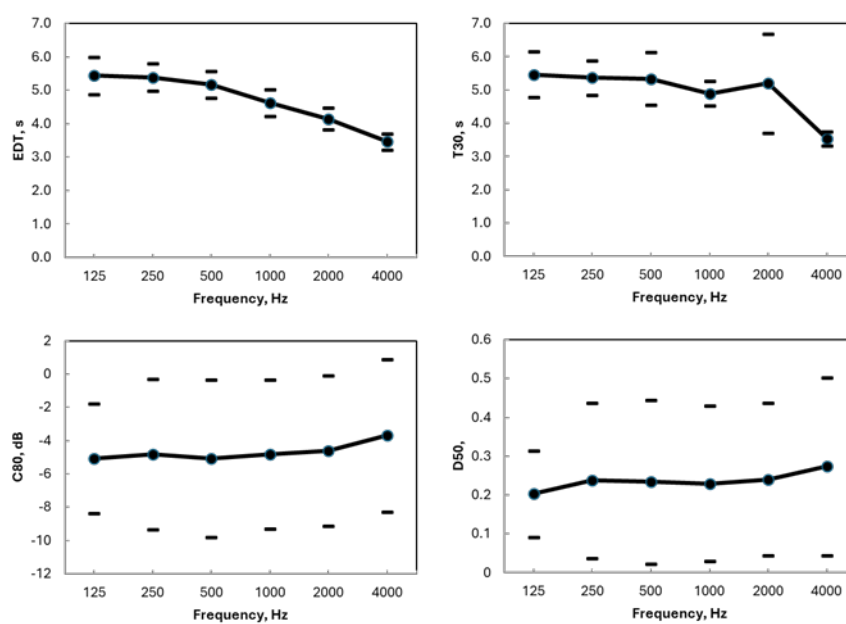


Figure 7: Average values of the acoustic parameters and the values of the standard deviation

3.3 Double Elliptical Vault

During the Renaissance period, circular and vaulted structures were built and used for aesthetic and structural purposes in places of worship, monumental buildings, and courtyards. In vaulted environments, sound reflection focuses on the central area due to the convergence of multiple reflections, generating unique acoustic experiences for visitors exposed to these phenomena. In the central area, beneath the highest point of the vault, repeated echoes occur. Echoes are defined as the delayed repetition of sounds. Focusing effects can result in high sound pressure levels, echoes, and tonal coloration. Concave surfaces create a convergence of sound energy, amplifying sound near the focal point (compared to a flat surface) while attenuating sound in other areas (far from the focal point). Despite their complexity and the acoustic risks associated with irregular sound distribution, fluctuating echoes, and tonal coloration, focusing effects can often lead to positive acoustic outcomes. These phenomena are frequently excluded from the acoustic design of halls, though, in some cases, they enhance the acoustic experience. The monumental staircase is one of the most complex structures in the Reggia of Caserta. It consists of a central ramp of steps that parallel each other after the first landing, which has a width of 5 m, continuing to the upper vestibule. The staircase is connected to a long corridor leading to the entrance of the palace. The total area of the staircase covers 600 m², with a height of 42 m. The elliptical hole has main axes measuring 10.9 m and 14.6 m. From the first level of the vault, it is possible to view the second vault. The double elliptical vault creates an impressive effect, such that, originally, musicians were placed around the void and would perform as the king and his guests ascended the stairs during ceremonies. A similar acoustic effect was realized in the dome of St. Paul's Cathedral in London, designed by Sir Christopher Wren, and in the dome of Les Invalides in Paris, designed by Jules Hardouin-Mansart in 1680. When constructing the staircase and the double elliptical vault, Vanvitelli was unaware of the acoustic properties related to large volumes. Acoustic measurements of the monumental staircase were conducted by placing the sound source at the top of the elliptical vault, while the microphone was moved across the steps, as shown in Figure 8 presents the average values of the acoustic parameters and the standard deviation, with an average STI value of 0.20. The average T30 value is approximately 6 s, which is long enough for the large volume and the presence of acoustically reflective materials. The standard deviation values are high at low frequencies, while at medium to high frequencies, the standard deviation values are negligible. The greatest differences between measurement points occur at low frequencies. The average C80 value is -10 dB, which is a result of the relatively long T30. Both the C80 and D50 values show high standard deviations, with notable differences between the measured points. The results highlight that the reverberation tail is very long, as shown in Figure 9. The need to design the double vault arose from structural reasons. If the vault had been built at a height of 30 m, the lateral forces on the walls would have been too strong to be absorbed by the thickness of the walls. However, by using the double elliptical vault, these forces are contained by the oval ring of the oculus. Vanvitelli was able to find a compromise between the structural requirements and the scenic effect, anticipating the concept of stereophonic music, where the sound seems to come from a hidden source and immerses the audience in a spatial sound experience. Vanvitelli's decision to build a dome with a double elliptical vault was driven by both structural needs and stenographic considerations. The cornice running along the vault provided a place for music maestros during receptions. As the royal procession ascended the wide staircase and stood in the vestibule on the first floor, they could hear the music without being able to see where it was coming from. The decision to place the musicians in the vault created a significant scenic and artistic effect [26-37].



Figure 8: Double elliptical vault.

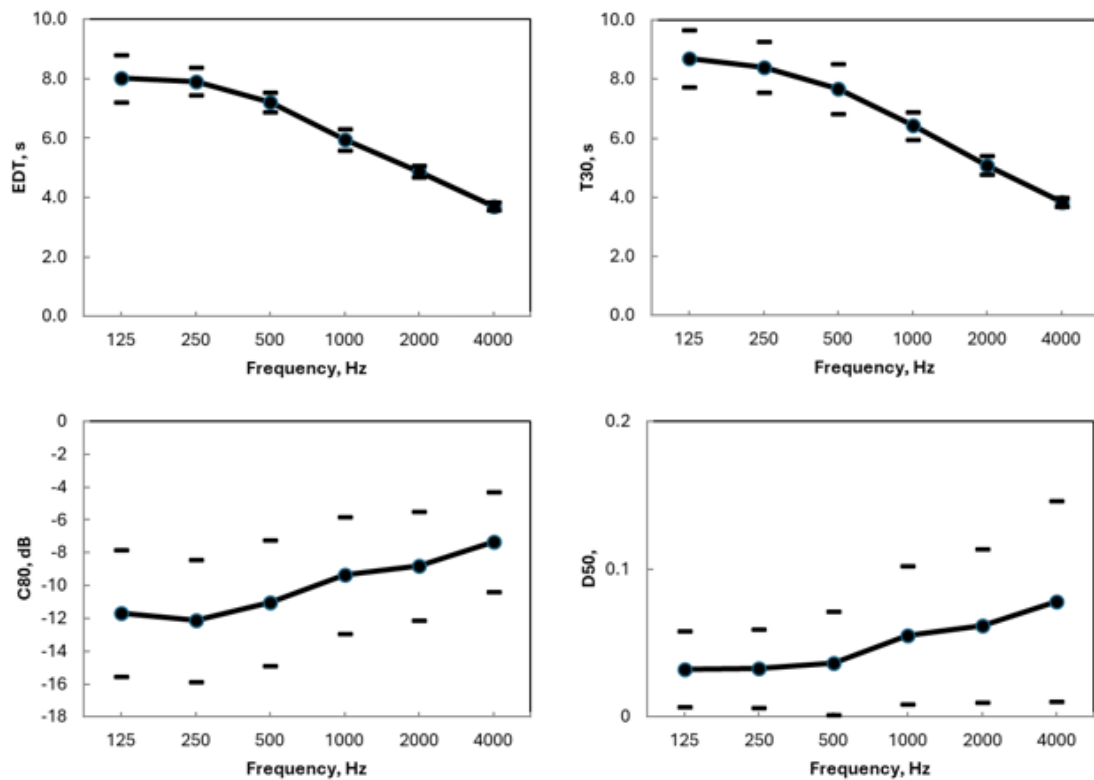


Figure 9: Average values of the acoustic parameters and the values of the standard deviation

4. Conclusions

When the Royal Palace was built in the 18th century, there was no formal knowledge of acoustics; only the treatises of the Roman architect Vitruvius were known. If a room had good acoustic characteristics, it was due to the experience of the designer, who, in conjunction with the design of other rooms, guided the construction of the building, as well as the use of embellishments such as fabrics, paintings, or papier-mâché. This paper presents the acoustic characteristics of the most important rooms of the Royal Palace of Caserta. The Royal Palace, constructed in the 18th century as a residence for the King of Naples, features several notable rooms, including the courtyard, the elliptical vault,

and the theatre. The acoustic characteristics of these rooms were studied in accordance with ISO 3382-1. For each room, the average values of reverberation time (T30), clarity (C80), definition (D50), and STI were reported. Particular attention was given to the elliptical vault, where musicians were positioned, and to the theatre, which was used for the entertainment of the Court. The acoustic challenges of these rooms were highlighted, especially considering that when the palace was built, there was no in-depth knowledge of acoustics. Since the classical world was highly influential at the time, Vitruvius' theories were applied, and much of the design relied on experience and the observation of natural phenomena. Some scholars attempted to draw analogies between the propagation of sound and light, attempting to adapt the principles of geometric optics to acoustics. Additionally, the building materials—marble and plaster—contributed to the rooms' long reverberation times.

Declaration on Generative AI

The author(s) have not employed any Generative AI tools.

References

- [1] G. Guarini, *Civil Architecture*; Il Polifilo: Milan, Italy, 1968. (In Italian)
- [2] M. Villani, *La più nobile parte*. In *L'architettura delle Cupole a Roma 1580–1670*; Gangemi Editore: Rome, Italy, 2009.
- [3] T. Cox, *Sonic Wonderland: A Scientific Odyssey of Sound*; Bodley Head: Oxford, UK, 2014.
- [4] M.P. Vitruvio, *De Architectura*; Giulio Einaudi: Turin, Italy, 1997.
- [5] A. Kircher, *Phonurgia Nova*; Rudolph Dreher: Kempten, Germany, 1673.
- [6] L. Tronchin, The 'Phonurgia Nova' of Athanasius Kircher: The Marvellous sound world of 17th century. *Proc. Mtgs. Acoust.* 2008, 4, 015002. <https://doi.org/10.1121/1.2992053>.
- [7] W. Sabine, *Collected Papers on Acoustics*; Harvard University Press: Cambridge, MA, USA, 1922.
- [8] *Guide to the Royal Palace of Caserta*. Available online: <https://reggiadicaserta.cultura.gov.it/> (accessed on 8 March 2025). (In Italian)
- [9] D. Howard, L. Moretti, (Eds.) *Architettura e Musica nella Venezia del Rinascimento*; Mondadori: Milan, Italy, 2006.
- [10] ISO 3382-1; *Acoustics-Measurement of Room Acoustic Parameters—Part 1: Performance Space*. ISO: Geneva, Switzerland, 2009.
- [11] M. Barron, *Auditorium Acoustics and Architectural Design*; E. & F.N. Spon: London, UK, 1993.
- [12] N.W. Adelman-Larsen, Possible Acoustic Design Goals in very large Venues hosting Live Music Concerts. *Audit. Acoust. IOA 2015*, 37 Pt 3, 308–316. <https://doi.org/10.2514/1.16170>.
- [13] L. Marshall, *Architectural Acoustics*, 2nd ed.; Academic Press: Cambridge, MA, USA, 2014.
- [14] L.L. Beranek, Concert Halls and Opera Houses: Music, Acoustics, and Architecture. *J. Acoust. Soc. Am.* 2005, 117, 987–988. <https://doi.org/10.1121/1.1861061>.
- [15] M. Barron, Objective assessment of concert hall acoustics. *Proc. Inst. Acoust.* 2006, 28 Pt 2, 70–78.
- [16] L. Cremer, H.A. Müller, *Principles and Applications of Room Acoustics*; Schultz, T.J., Translator; Applied Science: London, UK, 1982; Volume 1.
- [17] S. Di Loreto, M. Cantarini, S. Squartini, V. Lori, F. Serpilli, C. Di Perna, Assessment of speech intelligibility in scholar classrooms by measurements and prediction methods. *Build. Acoust.* 2023, 30, 165–202. <https://doi.org/10.1177/1351010X231158190>.
- [18] L.L. Beranek, *Concert Halls and Opera Houses: Music, Acoustics and Architecture*; Springer: New York, NY, USA, 1996.
- [19] T. Hidaka, L.L. Beranek, Objective and subjective evaluations of twenty-three opera houses in Europe, Japan, and the Americas. *J. Acoust. Soc. Am.* 2000, 107, 368–383.
- [20] T. Hidaka, N. Nishihara, Objective evaluation of chamber-music halls in Europe and Japan. *J. Acoust. Soc. Am.* 2004, 35, 357–372.

- [21] F. Merli, A. Bevilacqua, L. Tronchin, The “Real Teatro di Corte” of “Reggia di Caserta”. Spatial sound propagation. In Proceedings of the 2021 Immersive and 3D Audio: From Architecture to Automotive (I3DA), Bologna, Italy, 8–10 September 2021; pp. 1–5. <https://doi.org/10.1109/I3DA48870.2021.9610842>.
- [22] A. Bevilacqua, F. Merli, L. Tronchin, Verdi theatre of Salerno: A deepening acoustic research. In Proceedings of the 2021 Immersive and 3D Audio: From Architecture to Automotive (I3DA), Bologna, Italy, 8–10 September 2021; pp. 1–5. <https://doi.org/10.1109/I3DA48870.2021.9610925>.
- [23] M. Cairoli, The Architectural Acoustic Design for a Circus: The case study of Rigas Cirks. Appl. Acoust. 2021, 173, 107726. <https://doi.org/10.1016/j.apacoust.2020.107726>.
- [24] M. Cairoli, The architectural acoustic design for a multipurpose auditorium: Le Serre Hall in the Villa Erba Convention Center. Appl. Acoust. 2021, 173, 107695.
- [25] M. Cairoli, G. Iannace, A Single Acoustic Quantity Index as Part of an Early-Stage Digitalized Procedure for the Restoration of Baroque Theatres to Be Used as Multipurpose Spaces. Heritage 2024, 7, 6749–6771. <https://doi.org/10.3390/heritage7120312>.
- [26] F. Saidane, O. Benzineb, S. Chergui, G. Ciaburro, G. Iannace, Acoustic properties of two emblematic theaters in Algeria: The case of the National Theater of Algiers TNA and the Regional Theater of Bejaia TRB. Build. Acoust. 2024, 31, 289–306. <https://doi.org/10.1177/1351010X241245359>.
- [27] F. Merli, A. Bevilacqua, L. Tronchin, Acoustic response of the Goldoni theater of Bagnacavallo. In Proceedings of the 2021 Immersive and 3D Audio: From Architecture to Automotive (I3DA), Bologna, Italy, 8–10 September 2021; pp. 1–5. <https://doi.org/10.1109/I3DA48870.2021.9610884>.
- [28] A. Bevilacqua, S. Sukaj, G. Ciaburro, G. Iannace, I. Lombardi, A. Trematerra, How a quartet of theatres plays under an acoustic perspective: A comparison between horseshoe shaped plans in Campania. Build. Acoust. 2022, 29, 317–329. <https://doi.org/10.1177/1351010X221080769>.
- [29] S. Sukaj, G. Amadasi, I. Lombardi, A. Trematerra, Acoustic evaluation of some churches located in south of Italy. In Proceedings of the 2023 Immersive and 3D Audio: From Architecture to Automotive (I3DA), Bologna, Italy, 5–7 September 2023; pp. 1–6. <https://doi.org/10.1109/I3DA57090.2023.10289491>.
- [30] F. Merli, A. Bevilacqua, L. Tronchin, The acoustic study of the palatine chapel inside the Reggia of Caserta. In Proceedings of the 2021 Immersive and 3D Audio: From Architecture to Automotive (I3DA), Bologna, Italy, 8–10 September 2021; pp. 1–4. <https://doi.org/10.1109/I3DA48870.2021.9610961>.
- [31] U. Berardi, G. Iannace, C. Ianniello, Acoustic Intervention in a Cultural Heritage: The Chapel of the Royal Palace in Caserta, Italy. Buildings 2016, 6, 1. <https://doi.org/10.3390/buildings6010001>.
- [32] U. Berardi, G. Iannace, A. Trematerra, The Acoustics of the Double Elliptical Vault of the Royal Palace of Caserta (Italy). Buildings 2017, 7, 18. <https://doi.org/10.3390/buildings7010018>.
- [33] A. Bevilacqua, A. Farina, G. Iannace, J. Ferrari, Acoustic Investigations of Two Barrel-Vaulted Halls: Sisto V in Naples and Aula Magna at the University of Parma. Appl. Sci. 2025, 15, 5127. <https://doi.org/10.3390/app15095127>
- [34] G. Iannace, I. Lombardi, E. Scarano, A. Trematerra, Discover the Acoustics of Vanvitelli Architecture in the Royal Palace of Caserta. Heritage 2025, 8, 142. <https://doi.org/10.3390/heritage8040142>
- [35] M. Cairoli, G. Iannace, A Single Acoustic Quantity Index as Part of an Early-Stage Digitalized Procedure for the Restoration of Baroque Theatres to Be Used as Multipurpose Spaces. Heritage 2024, 7, 6749–6771. <https://doi.org/10.3390/heritage7120312>
- [36] A. Bevilacqua, G. Iannace, E. Navarra, N. Manzo, L. Gomez-Agustina, New Acoustic Design for the Piscina Mirabilis Located nearby the Port of Misenum. Heritage 2024, 7, 4423–4439. <https://doi.org/10.3390/heritage7080208>
- [37] A. Bevilacqua, G. Amadasi, G. Iannace, A. Trematerra, Acoustic Simulations Applied to the Garden of Rufolo’s Villa in Ravello: Comparison between Different Scenarios. Appl. Sci. 2024, 14, 1223. <https://doi.org/10.3390/app14031223>