

Portuguese Cistercian Churches - An acoustic legacy

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Abstract. The Cistercian Order (11th century) stands out as an apologist of the simplicity and austerity of the space. According to the Order of Cîteaux, only with an austere space, without any distractions, the true spiritual contemplation is achieved. This Order was an aggregator and consolidator pole during the Christian Reconquest. Thus, as it happens with other Religious Orders, Cîteaux has a vast heritage legacy. This heritage is witness, not only of the historical, but also social, political, and spiritual evolution. This legacy resumes the key principles to an austere liturgy, which requirements, in the beginning, are based on the simplicity of worship and of the connection between man and God. Later, these requirements allowed the development of the liturgy itself and its relation with the believers. Consequently, it can be concisely established an empirical approach between the Cistercian churches and the acoustics conditioning of these spaces. This outcome is fundamental in order to understand the connection between liturgy and the conception of the Cistercian churches as well as the constructed space and its history. So, an analysis of these principles is essential to establish the relation between acoustic and religious buildings design throughout history. It is also a mean of understanding the knowledge of acoustics principles that the Cistercian Order bequeathed to Portugal. This paper presents an empirical approach on Cistercian monastic churches acoustics. These spaces are the place where the greatest acoustic efforts are concentrated and it is also the space where the liturgy reaches greater importance. On the other hand, Portugal is a country which has an important Cistercian legacy over several periods of history. Consequently, the Portuguese Cistercian monastic churches are representative of the development of the liturgy, the design of spaces and of the acoustic requirements of their churches since the 12th century until the 21st century and it is of great importance to implement this study.

1. Introduction

Architecture results in a synthesis of cultural and historical principles. This fact is most representative in the case of religious architecture: it is a witness of the evolution of society, but also of the relation between man and liturgy. This results in a complex legacy, with both symbolic and cultural character. However, despite the complexity of the religious architecture, there is always intentionality. In Romanesque, for example, the use of the image was a mean to impress the believers, as well as to communicate with them, given the illiteracy in that historical context.



The use of image would be preserved until the Baroque, period where the decoration intensifies as response to the Counter-Reform [1]. The religious architecture responds also to other needs, not only with the image. The musical and oral creation are essential to the celebration of the *officium* [2]. Thus, it has an important acoustic dimension which has acquired great importance since the Council of Vatican II, as it implies an active participation of the assembly in the liturgy [3, 4]. It is therefore important to establish the connection between acoustics and liturgy, considering its historical evolution [5].

The relation between acoustics, liturgy, history and religious built heritage allows the establishment of an acoustic heritage with characteristics representing the religious history. The acoustic heritage complements the material heritage and completes the definition of the cultural context in which the building was built [6]. This issue is relevant in the study of the Order of Cîteaux, given the strong relation that it had with music and liturgy, as well as the design of Cistercian spaces [7].

2. Origin and historical evolution

The Order of Cîteaux (11th century) is a monastic Order ruled by the principles established by St. Benedict. It results of a reform in the Benedictine Order that demanded the return to the austerity of the first Desert Fathers through poverty, prayer, work and the isolation of the world [8].

The Cistercian Reform was an initiative of St. Robert of Molesme (1098), later consolidated by St. Alberic (1099) and St. Stephen Harding (1109). Harding introduces some of the most important legislation of the Order, namely the “Carta Caritatis” [9].

Initially the Order established a foundation in La Forgeotte, without success and later founded its first monastery in Cîteaux (1106), successfully. From the Abbey of Cîteaux appeared the first daughter-abbeys: La Ferté (1113), Pontigny (1114), Clairvaux (1115) and Morimond (1115) [8]. By this time the Order is consolidated, reaching its peak between 1129 and 1153, due to the efforts of St. Bernard of Clairvaux, which proclaims the Cistercian monasticism throughout Europe. On the other hand, the ideals of the Cistercian Order in medieval Europe, lead to an increase of the number of vocations and foundations of this Order.

At the time of St. Bernard’s death, the Order already had more than 343 monasteries in continental Europe and 55 in England [10]. The Order arrives to Portugal in the 12th century, around 1143-1144 [8]. In the 13th century the female branch in the Cistercian Order is introduced, as a result of its support by noble and royal women. The first monastery was built in Tart, Belgium [4, 8, 11].

In Portugal, as a result of the patronage of D. Teresa, D. Mafalda and D. Sancha, several feminine monasteries would be founded, as well as the affiliation of some previous Benedictine monasteries, as Arouca and Lorvão [11]. Cistercian Nuns lived in closure; this fact can be justified by both the fulfilment of post-Gregorian reform and ensuring compliance of the Cistercians ideals.

From the 13th century until the 16th century there is a period of decadence for the religious Order. This resulted from several factors, in particular, the lack of discipline of the monks and nuns, the Great Schism of Avignon and the rise of the Mendicant Orders. This decay was accentuated with the introduction of commendations that favoured the economic exploitation of the monasteries instead the monastic principles [11].

In the 17th century an antimonastic climate is established as a result of the Illuminist period, Rationalism and the French Revolution. The last one spread across Europe ideals in which religious Orders had no place, leading to the end of monasticism in many countries. The Napoleonic Wars

facilitated the dissemination of the French revolution principles in countries such as Portugal, Spain, Belgium, Italy and Germany.

The situation in Portugal was similar to the situation in the rest of Europe: there were structural problems in the Order, as well as the increasing loss of its autonomy and the financial ruin of Cistercian monastic abbeys. With the introduction of the ideals of the French Revolution in the country, the society would be fragmented in Liberals and Absolutists [12].

In 1834 the Religious Orders were extinct in Portugal. The Romanticism introduces the nostalgia of the medieval period. As a result, a few monastic buildings were restored. However, this restoration did not respect the pre-existence principles, but those based on picturesque images, so the results were sometimes fantasized [8].

3. Cistercian Architecture

The Order of Cîteaux (11th century) is a monastic Order ruled by the principles established by St Benedict. The typology of early Cistercian monasteries was adapted to social, cultural and historical contexts, so there are several layout readjustments of Cistercian Monasteries. The Monasteries are often stripped of ornamentation, and when existent it is austere. Later, with the increasing complexity in religious architecture, the monastery acquires greater ornamentation, however, austere if compared with other buildings of the same period of construction.

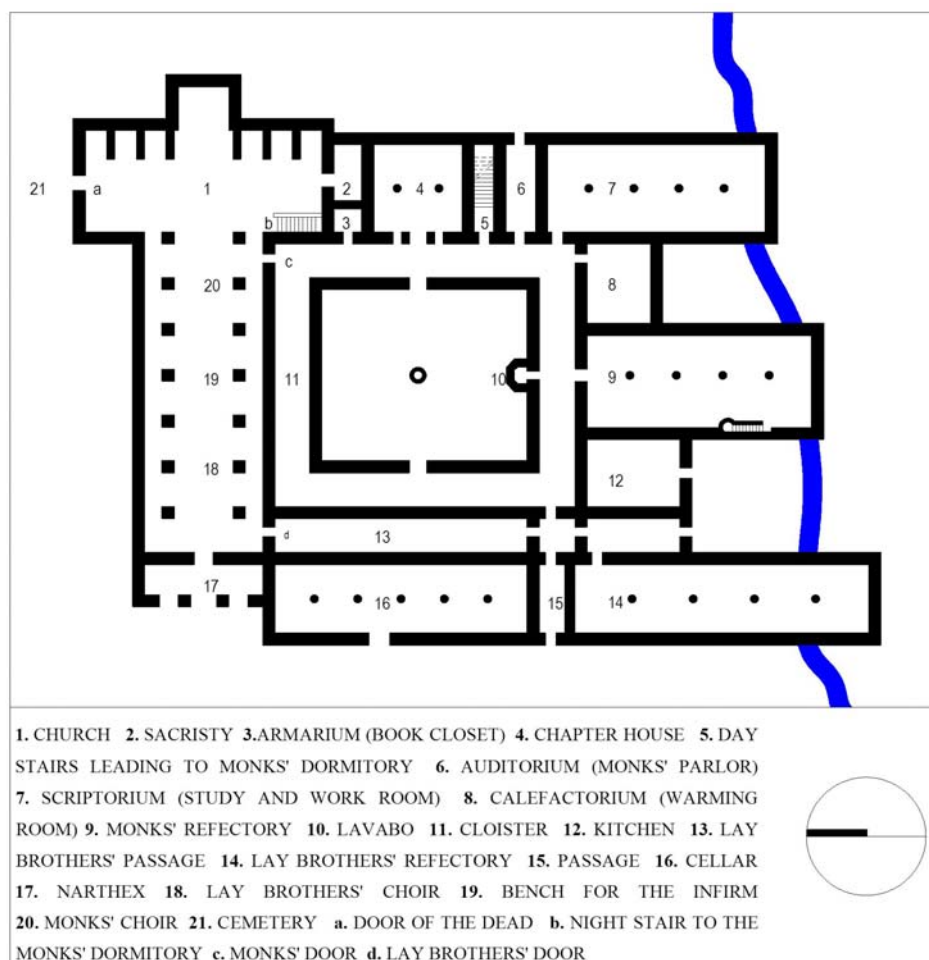


Figure 1. "Cistercian Plan", according to Ana M. T. Martins [13]

As a result of following the Rule of St. Benedict, the Cistercian monasteries are inserted away from large urban centres, granting the fulfilment of silence and absence of distractions [13]. Communion with nature was another important factor, to stimulate contemplation, justifying the choice of wild natural places to insert a Cistercian Monastery [14]. Thus, the foundation of the Cistercian monastery should be 32 km away from the nearest population and 40 km away from the nearest monastery, as stipulated in General Chapter [15]. These features would facilitate the choice of isolated valleys with fertile land, existence of wood and water [8].

The relation between spaces in Cistercian monasteries is similar to one another. Cultural and historical influence may change the original layout. However, there is still the use of proportions and the adequacy of construction materials to the place where the monasteries was founded [7].

The use of the module "*Ad Quadratum*" defines spatial dimensions, as it happens on the primitive Cistercian monastic Church, a Latin cross plan, with deep apse and three naves, cloister related through orthogonal planes (Figure 1) [8, 13].

There are four parts on the Cistercian Monastery plan: *Spiritus*, *Anima*, *Corpus* and *Domus Conversorum* [8]. The *Spiritus* corresponds to the Church, *Anima*, is the area of the monks' Chapter House and *scriptorium* as well as the monks' dormitory, the *Corpus* includes kitchen, refectory and the *calefactorium*, and the *Domus Conversorum*, was an exclusive area of the Lay Brothers, without connection to the monks' area [8]. The monastery of Alcobaça [13] or Fontenay represent a good example of this plan.

4. Acoustic Heritage: the church

The acoustic heritage results of soundscapes with relevance on the characterization of the cultural identity of a place. It is an element that characterizes the cultural identity of a place and allows featuring a social and historical context [16]. In the case of religious buildings, the acoustic heritage acquires a cultural dimension which results of the typology layout, form, the construction materials [6], but also of the liturgy [5].

The sound in enclosed space and the inherent propagation phenomena in it, affects the development of cult ceremonies. Music, as well as the speeches are conditioned by the same [6]. On the other hand, considering the context of the religious Orders is to assume the existence of a unique soundscape, since this is a Community [16].

Churches are buildings which, by their quality and symbolism are, in many cases, classified as world heritage sites. It is necessary to protect and safeguard their features. These come from the practice of the liturgy, but also cover cultural aspects and establish the notion of belonging to the communities served by these churches [17, 18]. On the other hand, a church creates an important territorial landmark. The sound of the bell, for example, can define geographical areas of the community by the familiarity it causes on a subject and with it, the notion of belonging to such community [19].

The liturgical character evolved and involved the adaptation of new demands to the intelligibility of speech and music. This factor implies changes on the way the space was used and its relation to the location of elements such as the Choir and the Organ [20].

Safeguarding this heritage, as well as the mobile and immobile related materials and spaces, is important, since it avoids the dispersion and profanation of cultural identity. On the other hand, the study of these characteristics may present proposals to improve some of its shortcomings, not forgetting the cultural and liturgical constraints inherent to the same [21].

In the specific case of the monastic churches, the sound field characterized the liturgy of the period in which the building was in use, but also the criteria that the Order itself imposed to the religious cult, as music style. An example can be found in the middle ages, with the use of Plain chant and later of Gregorian and Organ music in those churches [6], which involved a significantly different sound field than the one existing in the churches of later periods. The characterization of the acoustics of these spaces allows recovering cultural legacy [22].

4.1. Acoustic Heritage of the Cistercian Order

Acoustics in Cistercian spaces is characterized by a strong resonance, with high values of reverberation time. This resonance results of an austere decoration and the use of materials of the region, according to the principles established by the Rule of St. Benedict.

The churches of Morimondo and Chiaravalle Abbeys were analyzed by Anna and Ugo Magrini [23] establishing some common points between space and acoustics of these spaces. Another study of the acoustic heritage of the Cistercian Order was carried out by Genaro Gonzalez [6], in Spain. This study characterizes the acoustical heritage of two Cistercian monasteries, including the Church. In this study, the author refers the importance of understanding the introduction to liturgical aspects taking into consideration the assessment of this kind of spaces, which by its development are more complex than, for example, in an auditorium.

It was considered, in this sense, acoustic and cultural dimension as factors of influence. As regards, to analysing the acoustic dimension he considered factors inherent to the building itself. Its characterization, namely the distribution space, shape and dimensions, materials and surfaces that compose it; but also, characterization of the acoustic field in these spaces, such as sound phenomena, which influences the subjective assessment of sound, were under study. The cultural dimension in this type of building established a relation between sound and the use of space. This evaluation was conducted with resource of "Noise Rating curves" (NR) and "Preferred Noise Criterion" (NPC), which establishes a comfort idea based on sound pressure of the background noise, as well as its suitability to the role. An approach to the objective of sound field characterization was also made, through the determination of the Reverberation time (RT), the Bass Ratio (BR), the Early Decay time (EDT), the Definition (D50) and the Clarity of both word and music (C50 and C80). From the obtained data he could feature the Cistercian acoustic heritage in the analyzed monasteries. It was also possible to evaluate the suitability of acoustics for the roles played by those monasteries.

4.2. Acoustic Heritage of the Cistercian Order in Portugal

In Portugal, an acoustic study was carried out at the Cistercian monastic Church of St. Bento de Cástris, belonging to the cycle of Alcobaça [24]. In this study, high Reverberation Times (RT) were confirmed, including subsequent changes [24]. This feature suggests lack of intelligibility of speech, however, considering that the church was built in a period when the religious ceremony was essentially sung, a higher RT in this space is expectable (in later Cistercian's monasteries, wood carvings, decorations and even panelled ceilings [8] were used). As such, a greater intelligibility of speech can be intuited. These cases are in accordance to the evolution of the liturgy, where intelligibility acquires greater importance and justifies less reverberation [25]. The relation about musical activities, as well as speech, with RT [24] can be synthetize on Table 1.

The existence of reverberation, on the other hand, also suits the use of the organ in Church, which justifies its use as an instrument of choice for a significant period of history. The organ accompanied the plainchant, which due to its characteristics was more intelligible in reverberant spaces, if compared to other religious chants [2]. The combination of organ and choral chants facilitated the envelopment and the reverberance in the main nave of the Church [5].

Table 1. Reverberation Time according to type of music. Adapted from Lanzinha et al. [24]

Activities	Reverberation Time Recommended (s)
Choral Music	1,8-2,5
Congregational hymn	1,8-2,5
Organ music	2,0-3,5
Orchestral music	1,8-2,5
Contemporary Music	0,5-1,0
Speech/Theatre	0,7-1,8

This leads to the conclusion that in Cistercian spaces, reverberance and envelopment, as well as warmth and clarity were welcome. From an objective viewpoint, the presence of these parameters implies high RT values and suitability of some indexes, as C80, EDT and BR.

If we considered the monastic Cistercian churches in Portugal, it will be possible to draw some conclusions about the acoustic behavior these spaces could have. Santa Maria de Alcobaça answers some of the premises to the characterization in the Cistercian monastic Church acoustics in the primitive context. On the other hand, there are some churches that must have a distinct acoustic characterization. It happens due to the use of material such as wood, even in Tarouca's cycle, including the use of roof caissons [8], which provides lower RT. This difference is a result of the Baroque influence. The monastic church of Santa Maria de Cós is an example.

The exposure of the lathwork can also have effects on acoustic characterization. It may be referred, in this sense, Santa Maria de Fiães, Santa Maria do Ermelo, Santa Maria de Júnias and Santa Maria de Almoester. Despite the dome is not being used as a constructive element in the primitive Cistercian Church, there are examples in Portugal where it is present. Given the effect of the dome on acoustic characterization these churches are an interesting case study. These are S. Mamede de Lorvão, S. Cristóvão de Lafões and Santa Maria de Maceira Dão.

5. Further research and objectives

After a first approach to this theme it is proposed to make a characterization of the acoustics in the Cistercian monastic church in Portugal. The main objective is to verify the presence of empirical acoustic knowledge of this monastic Order in the country.

As it was previously referred, in Europe, a similar investigation has been made by researchers such as Anna and Ugo Magrini [24]; and Genaro Baixauli [6]. In Portugal, a similar study in the female monastic Church of S. Bento de Cástris [24, 25] was carried out and inserted in the ORFEUS Project, and it is our intention to continue this study in other Portuguese Cistercian monastic churches.

To achieve these goals, information was collected about the Cistercian Order, as well as its monasteries in Portuguese territory. A research in order to understand how to proceed on the acoustic study of churches was also carried out, since there are buildings with special acoustical requirements

6. Diagnostic of the existing churches and choice of sample

The status of conservation of the Portuguese monasteries churches is heterogeneous: there are good preserved examples, others in a status of reasonable preservation (with some modifications), poor preserved ones, as well as others in a ruin status. However, in the case of the monastic churches there are many examples in good state of conservation, some of which are still in use nowadays, as parish churches.

Based on the existing work of Ana M. T. Martins [8], a synthesis was made, considering both male and female monasteries.

The degree of modification on these monasteries, due to processes of restoration or rehabilitation, was also considered (Table 2 and Table 3).

Table 2. Conservation status of male Cistercian Monasteries in Portugal

Monastery	G O O D	Conservation State				P O O R
		Without modification	With few modifications	With some modifications	With many modifications	
Sta. Maria de Fiães			•			
Sta. Maria do Ermelo			•			
Sta. Maria do Bouro	•					
Sta. Maria da Estrela					•	
Sta. Maria de Júnias		•				
S. Pedro das Águias, o velho				•		
S. Pedro das Águias, o novo				•		
Sta. Maria de Salzedas				•		
Abadia Velha de Salzedas	•					
S. João de Tarouca			•			
Sta. Maria de Aguiar			•			
S. Cristóvão de Lafões			•			
Sta. Maria de Maceira Dão						•
S. Paulo de Almaziva					•	
Colégio Espírito Santo					•	
Sta. Maria de Seiça						•
Sta. Maria de Alcobaça	•					

Table 3. Conservation status of female Cistercian Monasteries in Portugal

Monastery	G O O D	Conservation State				P O O R
		Without modification	With few modifications	With some modifications	With many modifications	
S. Pedro e S. Paulo de Arouca	•					
N. Sra. da Purificação de Tabosa						•
S. Mamede de Lervão					•	
Sta. Maria de Celas				•		
Sta. Maria de Cós						•
S. Dinis de Odivelas			•			
N. Sra. Nazaré do Mocambo	•					
Sta. Maria de Almoester		•				
S. Bernardo de Portalegre		•				
S. Bento de Cástris				•		
N. Sra. da Conceição de Tavira						•

7. Results and discussion

Considering the previous study and analysis it is intended in further researches to study the following samples of Cistercian monastic churches in Portugal as presented in Table 4.

Table 4. Further researches on samples of Cistercian monastic churches in Portugal (male and female monasteries)

Cistercian monastic churches in Portugal	Monastery gender	Further research discussion and analysis
Sta. Maria de Alcobaça	M	- since it presents integrity and synthesizes the primitive Cistercian plan.
S. João de Tarouca	M	- has a plan near the primitive one, as well as the existence of choir and organ.
Sta. Maria de Fiães	M	- has the austerity that characterized the primitive ideals of the Order, as well as rural surroundings.
Sta Maria do Ermelo	M	- has the austerity that characterized the primitive ideals of the Order, as well as rural surroundings.
Sta. Maria do Bouro	M	- has rural surroundings and use of false wooden vault in the nave.
S. Cristóvão de Lafões	M	- has a centred typology, as well as resource to a dome.
S. Pedro e S. Paulo de Arouca	F	- still has the Choir and Organ.
S. Mamede de Lorvão	F	- still has the Choir and a two sided face Organ.
Sta. Maria de Almoester	F	- combines a simple nave with a vaulted altar and Choir.
S. Bernardo de Portalegre	F	- has two Choirs, a Low Choir and a High Choir, one above the other and both opposite to the altar.
S. Bento de Cástris	F	- has lack of studies about this space.
Sta. Maria de Celas	F	- has a centred plan and a dome in the church, as well as choir with a wooden ceiling.

On this sample of churches, it is intended to determine the acoustic behaviour. It will be achieved by the on-site collection of data according to the ISO 3382 and in some cases by the use of virtual simulation. It will be determined, in these processes, objective acoustic parameters in order to understand acoustic suitability to the demands of these churches in the past and nowadays. The objective parameters to determine are the Reverberation Time (RT), the Early Decay Time (EDT), the Central Time (TS), the Clarity of word and music (C50 and C80), the Definition (D50), the Strength (G) and the Bass Ratio (BR). It is also intended to determine the Speech Transmission Index (STI), since it allows understanding of the level of intelligibility without the need of auditors. Since one of the principles of the Order was silence and the foundation in isolated places, it is also intended to evaluate the Noise Rating in order to determine which churches still respect this premise and how it suits the religious needs of the Order.

After the gathering of data, conclusions regarding the acoustic legacy of the Order in Portugal and its relation with regional influences will be established. The data collection will be carried out with recourse to inventory, in order to facilitate the subsequent crossing of data and establish conclusions.

8. Conclusions

In the Portuguese context, there is a diversity of Cistercian monastic churches, so its characterization allows acknowledgement of the interaction between the Cistercian liturgy and regionalism present in the country, resulting in a great diversity of soundscapes.

This is also a Country which currently has the necessary conditions for the study and inventory of the Cistercian acoustic legacy. Some of these examples allow an approximation to the primitive ideals of the Order, as well as other examples which result from the interaction between Cistercian principles, history, regionalism and culture.

The preservation of these principles is essential in order to safeguard a portion of memory that is part of the cultural identity of the Country. On the other hand, the characterization of acoustics in Cistercian monastic churches in Portugal allows the comparison with other studies carried out at a European level, allowing completion of the research and knowledge about the performance of the spaces of this Order in Europe.

Acknowledgments

This work has the financial support of the Project Lab2PT - Landscapes, Heritage and Territory laboratory - AUR/04509 and FCT through national funds and when applicable of the FEDER co-financing, in the aim of the new partnership agreement PT2020 and COMPETE2020 - POCI 01 0145 FEDER 007528.

This work is also financed by FEDER funds, under the new PT2020 partnership agreement and by national funds FCT/MEC – Foundation for Science and Technology under the UID/HIS/00057/2013 – POCI-01-0145-FEDER-007702 project.

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