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Revisiting archaeoacoustic methodology in the studies of acoustic vessels:application to Brittany and Serbia

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ABSTRACT

Ceramic vessels are found embedded in the walls of sacred edifices, built from the medieval to modern period across Europe and the Mediterranean. To better understand the acoustical, building, and religious ideas underneath this practice, the research results need to be mutually comparable. Therefore, this paper suggests a compliant approach that would enable such comparisons. Almost two decades of fieldwork experience led us to define the archaeoacoustic research methodology of acoustic vessels that includes: (1) data collection, (2) data analysis, and (3) a "multi-channeled" dialogue among scientific disciplines. These three phases mainly, but not exclusively, consider the fields of history of religion, archaeology, history of art and architecture, acoustics, and musicology. We draw upon the previously defined methodological requirements, that ensure avoiding anachronism and misinterpretation, and then translate them into practice. We tested the methodology on several case studies from two distinct regions in Europe - Catholic churches in Brittany (France, 15-17th c.) and Orthodox churches in Serbia (9-15th c.). Our findings showed that the proposed methodology is particularly important for results comparisons regarding archaeology and acoustics, while the results originating in the field of musicology, religion, and history of art and architecture could be comparable within culturally similar regions.

Keywords: archaeoacoustics, acoustic vessels, church architecture

1. INTRODUCTION

We recently presented our general approach to archaeoacoustic facts, limited to the societies with written record, based on two main principles: 1) to avoid any anachronism by contextualising as much as possible, and 2) to start from low-level hypotheses even if these may seem illusory today [1]. Analytical grid created this way was then, as we emphasize in this article, used in relation to our multidisciplinary research on ceramic acoustic vessels.

Within the framework of a Franco-Serbian research programme, we tested the methodology in two distant regions of Europe - Brittany and Serbia. For the comparison to be effective, it was necessary to develop a common methodology for the historical, archaeological, and anthropological aspect of this acoustic practice in building churches. Our research also included data collecting - geometric and acoustic measurements of both the vessels and the churches. Due to the pandemic, the last part of the program - acoustic measurement campaign in Serbia – could not be carried out yet. Therefore, in this article we focus on the French part of the study and limit the comparison with the Serbian churches only on the aspect of vessels placement.

2. METHODOLOGY DETERMINED BY THE LARGE STUDY CONDUCTED IN FRANCE

2.1 Two main principles

The first principle of our general archaeoacoustic approach is to avoid any anachronism. Here are three main recommendations to achieve that:

- Put aside current acoustic knowledge and document the history of (practical) acoustic knowledge at the time of building
- Give priority to written sources related to the particular church (i.e. architectural treatises, mentions of trades (masons, potters), abbey chronicles, etc.) [2].
- Study the texts themselves and the evolution of the acoustic vocabulary [3].

The second principle - to start from low-level hypotheses - is reflected in the following recommendations:

- Do not try to demonstrate any a priori theory, especially if it comes from recent knowledge. Numerous studies tended to show the absorption efficiency of acoustic vessels, but this is difficult to prove because there are too few vessels and they are often tuned to frequencies. In addition, their acoustic effectiveness does not explain the acoustic intention of builders. A low-level hypothesis would be, for example, to assume that the builders had acoustic intent, or that they chose the vessels in a certain way [4].

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- Diversify the sources of hypotheses; even something that is known to be false today should not be dismissed from the analysis if there are written records about it or archaeological facts that support a bizarre interpretation. For example, the historic texts always mention the amplification of voices regarding acoustic vessels. The acousticians dismiss the idea of amplification because it is usually not effective in large volume churches in which vessels are generally inserted. However, this hypothesis could be considered in the case of the undercroft of Noyon [5].

- Carry out studies at two levels: statistical data collection and monographic studies. Monographic studies are often carried out, but they do not allow generalisation and usually provide more questions than answers. Statistical studies provide an overview and a better understanding of cultural context [4].

- Accept unexpected results. The association of, for example, iconography and the vessels or the symbolism of the vessels' distribution in walls (i.e. triangle or cross formation) imply that the acoustic aspect, in the sense in which we understand it now, was not the only concern of the builders [5].

2.2 Interpretation of acoustic vessels practice

While it is clear that the vessels are related to the acoustics, there are three possible interpretations that we call by Latin terms to simplify and summarise:

- **VOX** represents the interpretation according to which the actors seek to act on the voices whatever the presupposed acoustic intention was (absorption, amplification, modification ...). There is a considerable amount of evidence to support this interpretation.

- **LOCUS** represents the interpretation that actors seek to affect the acoustics of the building. This is a bold assumption but one that is often favoured by acousticians despite a lack of effect. However, texts and some archaeological data show that this intention was present.

- **TRANSITUS** represents the interpretation that the vessels promote a link between speech and song on earth and the afterlife. Their association with iconography, their distribution in space and some texts show that this interpretation was at work.

These three interpretations are not exclusive, and they can coexist in the same place. Sometimes, one can hardly see any more than a symbolic interpretation to explain a device in a particular church.

2.3 The choice of acoustic vessels

The choice of pottery used for the acoustic purpose is particularly important. The analysis of our entire database (over 50 churches visited, over 1100 pots measured) implied that the acoustic vessels were often chosen by their resonance frequency. We observe 4 categories that cover almost the entirety of our corpus:

Type A: unimodal set with only one model of vessel;

Type B: continuous distribution of frequency, generally over one octave;

Type C: bimodal set with two main frequencies 'tuned' in fourths or fifths;

Type D: discontinuous distribution of frequencies over one octave (or less) either in the form of a third, fourth, fifth, octave or, rarely in smaller steps (of the order of a tone).

All these characteristics offer a relevant analysis grid for comparing other corpora, even if it is important to remain open to other possible interpretations or other configurations that could occur in each territory.

3. APPLICATION TO A COMPARATIVE STUDY

This section will present cultural and historic context of acoustic vessels practice emerging in the region of Brittany and Serbia. We will particularly consider the number of embedded vessels, their position in the church and arrangement, as well as the TRANSITUS interpretation.

3.1 Acoustic vessels in Brittany

The re-emergence of acoustic vessels started in central regions of Western Europe (Rhine and Rhone valleys) in the 10th century, and it is possibly related to the Carolingian renaissance. In peripheral regions, such as Brittany - the north-west region of France, this acoustic practice emerged later. The reasons for this might lie in the very favourable economic conditions of 15-17th c. Brittany (having one of the most important fleets in Europe and strong linen trade with the northern countries), when numerous parishes rebuilt their religious buildings. It could also be related to the development of polyphony [5]. This acoustic practice undoubtedly appeared at the time as a possible solution for general sound control.

The region of Brittany contains the significant number of churches with acoustic vessels [6]. There are 53 churches in our inventory and if we add eight churches with vessels from Loire-Atlantique (North) which is part of historical Brittany, we arrive at 61 churches out of a French census of more than 200 churches [7]. The peculiarity is that most of the buildings in Brittany were built from the 15th to the 17th century with vessels inserted during building, and for the older churches, for those that we were able to visit, the vessels were inserted subsequently.

The Brittany Corpus on which we worked is 19 churches (among the 61 listed) in comparison with the French ones (50 among the 200 listed). The Brittany Corpus churches are medium in size, between 1000 to 6000 m^3, while the whole French corpus is between 200 to 14000 m^3.

The relative number of parish churches is superior in the Brittany corpus than the French corpus (table I), and the pots are mainly positioned in the nave. In the whole corpus, we have remarked that the monastic churches have more often vessels in the liturgical choir above monk or nun seats [4], as seen in figure 1.

Another interesting parameter is the mean number of vessels inbuilt per church. In the French Corpus, the mean is 23 vessels per church, while in Brittany the number reaches 31. The highest number of vessels is found in the Abbaye des Anges in Landéda with 110 vessels and Ploaré close to Douarnenez with 108 estimated vessels (96 present). The last interesting point is the number of sophisticated systems of frequency choice (C and D) regarding simple ones (A and B), which is 18/32 (0.56) in the French corpus and 8/12 (0.66) in the Brittany ones (table II).

Figure 1 – West wall of the liturgical choir of the Abbey "Couvent des Ursulines" formely "Saint-François de Cuburien", Saint-Martin des Champs (close to Morlaix), 16th century (Photo credit: B. Bertholon)

Concerning the TRANSITUS interpretation, few churches have vessels organised with Christian symbolism. We only found 3 churches which pots in triangle organisation, most of churches have linear organisation.

In Brittany we found the highly refined multi-frequency system of acoustic vessels, large number of vessels per church located all over the place with a larger grouping in the choir. The delay in the development of acoustic vessels practice in Brittany might be the reason for more rational choices of vessels than in other parts of France.

3.2 Acoustic vessels in medieval Serbian churches

The boarders of medieval Serbia changed over time occu- pying a significantly larger territory than today, particularlytowards south and south-west. In this paper, we consider only the medieval churches that are under the jurisdiction of the Serbian Orthodox Church today. Acoustic vessels are found in fifteen of those churches, approximately seven vessels per church. Medieval Serbian churches were built in three architectural styles (Raška, Byzantine, and Morava style) that are corelated with political and cultural strivings of the time. It is interesting to notice that the most of churches with acoustic vessels (7/15) were built in Raška architectural style (12th-13th c.) during the period when Serbian medieval state and Serbian Orthodox Church was formed under the Nemanjić dynasty. Acoustic vessels were not found in the churches of Byzantine style, but they appear again in Morava architectural style (14th-15th c.). In most cases, they were secondarily used for acoustic purposes and predominantly positioned under the central dome, in spherical surfaces such as pendentives and dome drum. These vessels were pots, jugs and pitchers, with the hight from 20 to 50 cm. In each church the vessels were similar in shape, embedded horizontally, with mouth or pierced bottom oriented towards the church interior space [8]. The exception is the Trg church, in which the vessels were found inbuilt vertically, upside down, behind the finishing layer of a wall in naos [9].

Churches built in medieval Serbia had small volumes – approximately from 400 to 3000 m^3, and reverberation times from 1 to 3 seconds. Consequently, the number of acoustic vessels was relatively small. In some cases, only one vessel is found in each pendentive under a central dome (Figure 2). The largest number of 20 acoustic vessels was noted in the Mileševa Monastery. The exact number and the positions of originally embedded acoustic vessels in medieval Serbian churches are difficult to determine, because the churches were partly ruined and rebuilt during the turbulent history, and walls were often repainted, sometimes covering the vessels' openings with mortar. In several cases, the vessels were extracted from the walls during recent conservation works and then stored in museums (Trg, Komarane, Davidovica) [7].

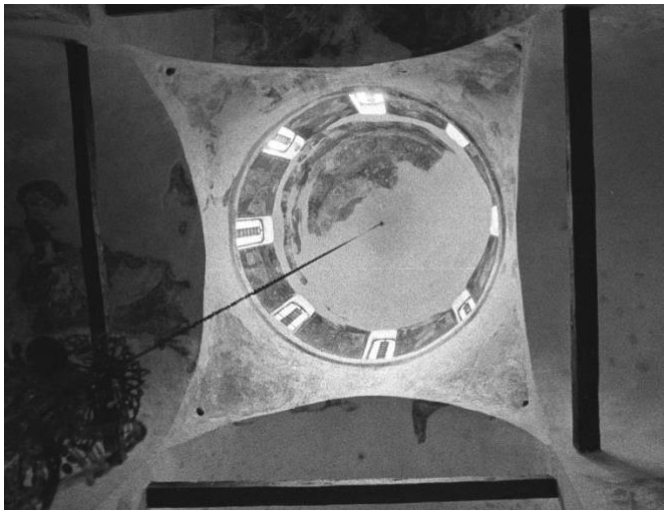

Figure 2 – central dome of Nova Pavlica monastic church (14th c.) with one acoustic vessel in each pendentive (Photo credits: Documentation of the Republic Institute for Protection of Cultural Monuments Belgrade)

In medieval Serbian church, Byzantine chanting tradition was adopted. This vocal and monophonic music has gradual melodic flow and rhythm that supports lyrics, thus providing each spoken word a quality of a song. The chanting was performed from chanting apses at northern and southern side of a central dome. It was important to

ensure both the understanding of the chants and readings, and to acquire spiritual experience enhanced by chanting.

Concerning the TRANSITUS interpretation, it is worth noting that acoustic vessels were usually placed in pendentives which were also the places for the frescoes of four evangelists. Acoustic vessels could be interpreted in line with the understanding that pendentives represent a transitional element between physical (earth) and spiritual (dome, heaven) worlds.

3.3 Comparative overview

Table 1 – Location of vessels in the liturgical space

		Monastic Parish	Liturgical choir or under the central dome	In the whole church (nave)
French corpus	M	11	12
	P	4	17
Brittany corpus	M	3	2
	P	2	9
Serbian corpus	M	12	2

Table 2 – Type of organisation regarding frequency (type A, B, C, D when it's possible to classify)

Corpus	A	B	C	D
French	10	4	10	8
Brittany	2	2	4	3

4. INSTEAD OF A CONCLUSION

The object of the paper is to test the previously proposed archaeoacoustic methodology on acoustic vessels found in two distant regions in Europe – Brittany and Serbia. If we apply this methodology in numerous countries, we will be able to outline the original idea and acoustic intention of the builders, and also explain the dispersion of this acoustic practice throughout Europe.

Comparing the whole French corpus to the one of Brittany, which is far from the probable re-emerging area, we have observed similarities but also some specificities. As the development of acoustic vessels practice was late in Brittany, the builders were more skilled and sophisticated in the technique, taking advantage of the experience from the close regions. They employed larger number of vessels that also covered a wider frequency range. The vessels had better organization in the probable intention to be more efficient.

Serbian and French corpus are significantly different. Acoustic vessels are mainly found in medieval monastic churches in Serbia, while in Brittany they were employed in both monastic and parish churches. Conversely to the French corpus where the vessels were embedded in the walls, the vessels in Serbia were generally placed in the area under the central dome. From the acoustical point of view, although the Serbian churches are not very large and the reverberation time is not long, it is expected that annoying acoustic effects occur under the dome and disturb the chanting, because of focalisation or delays. The system of acoustic vessels might be devised as a solution of these effects.

The application of the proposed archaeoacoustic methodology to acoustic vessels found in Brittany and Serbia contributes to our understanding of this acoustic practice in two aspects: 1. Its application in significantly different architectural spaces, 2. Its relation to the polyphony in the Western Europe and the monophony in the Eastern Europe.

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