Case study

Archaeoacoustics of intangible cultural heritage: The sound of the *Maior Ecclesia* of Cluny

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A B S T R A C T

Some major historical heritage which has disappeared over time can currently be recovered in part thanks to computer modeling tools and virtual reality technologies. Incorporating sensory experience using immaterial reconstruction constitutes a new form of knowledge and a major methodological change in the field of cultural heritage. Archaeoacoustics are used to introduce phenomenology as a new method for the analysis of historical heritage, allowing evaluation of the sound quality of a space based on subjective perception by using auralization techniques which allow cognitive and physical elements to be reproduced and combined. This study assess and recover the acoustics of a now extinct major religious space: the *Maior Ecclesia* in Cluny, recognised as European heritage. Its long reverberation times produced a grandiose acoustic experience of Gregorian chant, heightening spirituality. Its extensive choir served as a place of spatial reference, because of its location in the temple and its major role in the liturgy. It could be defined as an *ecclesiola in ecclesia* with an identity of its own. The sound of the Gregorian chant of the monks was perceived clearly and powerfully within this space. However, the high reverberance perceived in the rest of the spaces of the church transformed the chant into an unintelligible, inaudible signal.

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1. Research aims

The main aim of this study is the assessment and recovery of the lost intangible heritage of church acoustics through the acoustic reconstruction of religious spaces of the past, which no longer exist. Auralization techniques are used to explore the importance of sensory experience and the spatial dimension of sound, establishing a relationship between the spatial configuration of the church and how this complements the music. To do this the acoustic characteristics of the now non-existent major Romanesque religious space, the *Maior Ecclesia* of Cluny, are assessed. The acoustic reconstruction includes two audio archives based on auralizations.

2. Introduction

The application of new technologies to cultural heritage has led to important methodological changes in the conservation, protection, enhancement and appreciation of monuments. This new approach is stated in the objectives of the International Council on Monuments and Sites (ICOMOS) [1] which aims to restore meaning and preserve the memory of historic buildings, promoting the application of technology in the assessment of monuments, particularly interesting in the recovery of archaeological heritage.

Experiential archaeology [2] makes "being there" possible. With this aim in mind, numerous studies focused on visual reconstruction [3], illuminating cultural heritage sites [4] or 3D architectural reconstructions [5], using image-based 3D modeling to record archaeological landscapes [6], excavations [7] and monuments [8]. However, all facets of cultural heritage must be researched, incorporating sensory experiences through intangible reconstruction [9], the virtual recreation of heritage settings where intangible values are elements to be protected [10]. The New Technologies for Cultural and Scientific Heritage of the European Commission report [11] states that virtual reality (VR) will provide "an impressive, immersive, interactive and involving product" and will give a "sense of personal presence of the user in its environment". Thus, the application of VR technologies to cultural heritage [12] has become a powerful tool for archaeological reconstruction.

Within this context, archaeoacoustics [13] arose as a new discipline, capable of enriching the intangible heritage of the past by applying "sensual technology" to a diverse range of monuments, from megalithic structures [14], searching for acoustic

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significance [15], or the effect on the emotional sphere of human consciousness [16] to recovering the sound of the past in spaces of worship. Research in these worship spaces has followed different approaches: the analysis of the relationship between architecture and acoustics in their current condition [17]; the suitability of the acoustics for the Liturgy of the Word [18]; acoustic reconstructions of disappeared religious spaces [19]; the acoustic analysis of the relationship between church spaces and the liturgical function of extinct [20] or currently transformed configurations [21]; assessing subjective characteristics and the study of intentionality behind the acoustics of existing church spaces [22]; the anechoic recordings of ancient music to be used in church auralization [23]; or applying sensory theory to the liturgy [24].

3. Case study: the Maior Ecclesia of Cluny

Cluny Abbey played a crucial role in the Middle Ages, from its foundation in the year 910 until the late 12th century. Seen as the soul of the Middle Ages because of its major religious, political, and cultural importance in the period and its major role in the unity of the Christian West, it was awarded the European Heritage Label by the European Commission. The Benedictine Abbey of Cluny prompted a profound renewal of monastic life, based on the ceremonial splendour of the liturgical celebration of the Mass and the Divine Office. This is why three churches were built in Cluny between the 10th and 12th centuries, each larger than the preceding one. The last of these buildings, the *Maior Ecclesia*, was built in 1130 and destroyed in 1790. Its large dimensions meant that the celebration of the liturgy took on unprecedented splendour, and it was a major cultural monument, key to the understanding of Romanesque architecture [25], the first European artistic style.

The *Maior Ecclesia* of Cluny imposed the new model of Romanesque basilica, larger than early Christian basilica, predominantly vertical, and paying greater attention to the transept, symbolically opening the space upwards. The floor plan was a Latin cross with two transepts, a central nave over 30 metres high with a barrel vault, flanked by side naves either side, with rib vaults, and an ambulatory from which chapels radiated (Fig. 1) in a solid stone structure with few decorative elements.

The formal scheme responded to monastic needs with a shallow chancel and a main altar for celebration, and a wide choir in the central nave for chanting divine office. In early Christian basilicas the choir in the chancel interacted with the *schola cantorum*, for chanters and minor clergy, situated in the central nave. In the 11th and 12th centuries the choir in the *schola cantorum* merged with the choir in the chancel. Due to the growth of monastic communities they no longer fitted in the chancel and were moved to an enclosed choral structure in the central nave, the choir, which in the case of the *Maior Ecclesia* of Cluny could accommodate approximately 470 monks [26].

The documentary source for the reconstruction of the church is based on the pioneering archaeological work of K.J. Conant [27], the subsequent reconstruction of Cluny [28] and the virtual reconstruction of the environment using a virtual immersion digital model to reconstruct the architecture of Cluny within the Gunzo interdisciplinary project [29,30]. However, a recreation of the sound of the
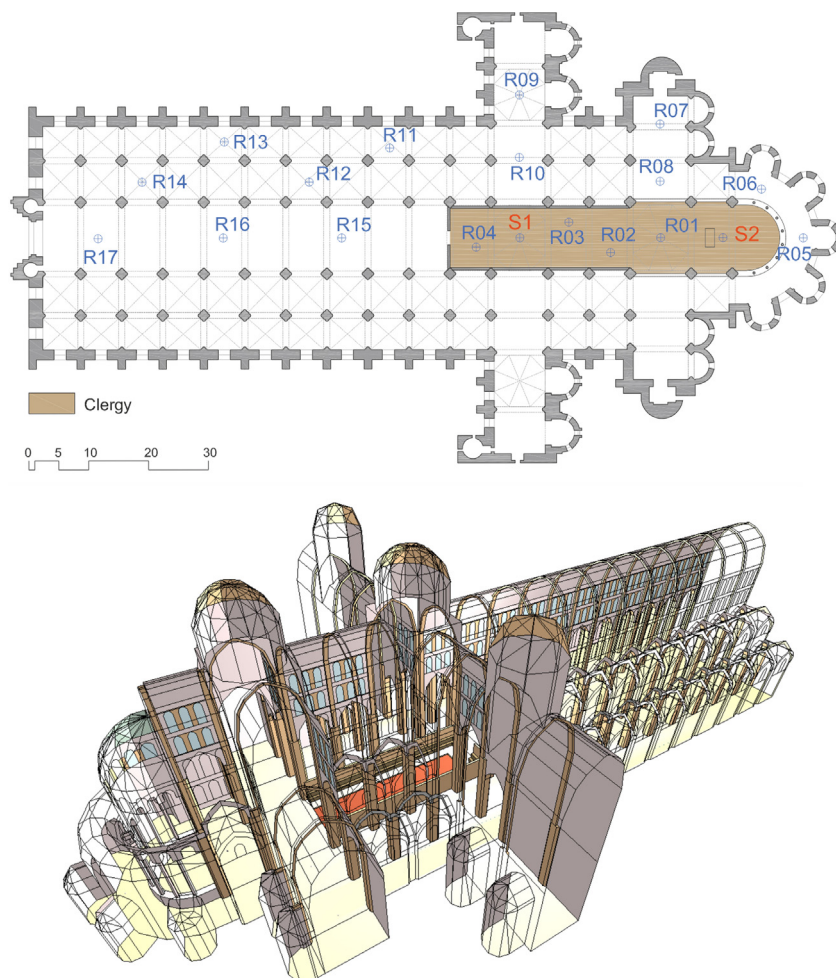

Fig. 1. Top: floorplan of the *Maior Ecclesia* of Cluny. Clergy zone and distribution of sound sources and receivers. Bottom: acoustic 3D model.