Towards a New Approach in the Study of Ancient Greek Music: The Virtual Reconstruction of an Aulos "Early Type" from Sicily

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The ancient site of Selinunte (Sicily) is recognised today as one of the most important archaeological sites of the Greek period in Italy. From its foundation as a colony around the second half of the VII c. through to the middle of the III c. BCE, Selinunte enjoyed a prosperous existence as reflected in its notable sanctuaries, and temples. In 2006, the Institute of Fine Arts at New York University began a research project on the acropolis under the direction of Prof. C. Marconi and in collaboration with the Archaeological Park of Selinunte. The project consists of a new, systematic and interdisciplinary study of the archaeology and architecture of the main urban sanctuary, beginning with its southern sector. In the years between 2006 and 2012, the survey also consisted of the investigation of the 'South Building'. This structure is notable for its prominent position within the sacred space. From the time of its discovery (1876), its scale has attracted scholarly attention, and the 'South Building' has played a significant role in discussions about the spatial articulation and cults of the main urban sanctuary. The investigation included a systematic programme of documenting the buildings in the area and its digital reconstruction.

Several elements suggest the identification of the 'South Building' as an impressive theatral viewing area with particular acoustic qualities (Marconi and Scahill, 2015). This building belong to a group of theatral structures found in various regions of the Greek world. Many of these structures were not proper "theatres", but rather primitive rows of seats (meaning non-canonical theatres, with linear and non-circular *theatra* and/or *orchestra*): they existed as "a place from where one could watch", which is in fact the original meaning of the word *theatron*.

The quality of the stones was carefully selected in relation to their placement in the cultic theatres, based on structural, aesthetic, and, acoustic considerations. The acoustics of the linear *theatra* in the Greek world have never been analysed (Blesser and Salter, 2011): no study has focused on the acoustics of these theatres in order to understand how and why these spaces were chosen for performance. It is a category of buildings brought to the attention of scholarship by Anti (1947), but first investigated in relation to religious contexts by Nielsen (2002) in her study on cultic theatres in the ancient world; by Marconi (2013) in his study on the theatral structure of Selinunte; and by Hollinshead (2015) in her study on the steps as components of monumental construction at Greek sites as early as the VI c. BCE.

At Selinunte, the cultic theatre was built to accommodate spectators of performances associated primarily with Temple R, probably a temple of Demeter. One of the main striking finds among the votive depositions was the discovery of two parts of a bone *aulos*, which can be dated to 570 BCE (Marconi, 2014). This discovery is very significant, particularly with regard to the performance associated with the activity of Temple R (Marconi, 2013). The discovery shows the importance of music in this context which already existed in the Early Archaic period, that is, since its foundation.

In 2013, the Marie Curie Actions programme (IOF) funded the TELESTES project (622974): the main aim of this project was the reconstruction of musical development at Selinunte on the basis of material culture and written sources. It also included the study of the *aulos* from Temple R using a CT scan, an improved method for the visualisation and analysis of the instruments (Bellia, 2015). However, this survey still lacked an appropriate connection between the acoustics of the cultic theatre and musical activity related to the building. Thanks to the present project, auralisation techniques are used to explore the spatial dimension of sound in this cultic theatre, establishing a relationship between the spatial configuration of this structure and how this complements music. These data will help us to understand the aural perception of ancient peoples and the type of sound experiences they were exposed to.

This research is the first study on the virtual reconstruction of the acoustics of cultic theatres of the Greek world. Despite their relevance to the field of ancient music, no study has focused on the acoustics of these theatres in order to understand how and why these spaces were chosen for performance. Within this context, archaeoacoustics is being used as a new method for the analysis of historical heritage, enabling the evaluation of the sound quality of a space (Scarre and Graeme, 2006) by using auralisation techniques which allow cognitive and physical elements to be reproduced and combined (Eneix, 2014).

This project offers an innovative research method in the study of ancient Greek music, not only in its contextualisation of archaeological evidence, but

also by making connections between digital and acoustic techniques. It is also hoped that the results will provide some foundations from which to create interpretative reconstructions of what the cultic theatres might have sounded like, using digital and acoustic technology. Moreover, this study will contribute towards overcoming the traditional methods in measuring ancient instruments, opening up a new disciplinary framework for the *interaction between 3D reconstruction of instruments, their respective sounds*, and the spaces of musical performances.

In order to analyse the acoustic characteristics of the cultic theatre of Selinunte, an acoustic survey will be carried out using an impulsive sound source located in two positions on the steps, and in the "orchestra". Measurements will be recorded using an impulsive sound source. This process will make it possible to obtain a virtual acoustic reconstruction of this space, including the incorporation of acoustic characteristics as another important aspect of its intangible heritage. The software used will be CATT-Acoustic, v. 9.0 c.

The digitisation process of the *aulos* is divided into two main tasks, namely the 3D scanning phase and the post-processing phase. The tools we plan to develop are divided into those involving the use of computational methods for processing the 3D models, and those involving the development of interactive tools aimed at engaging in the exploration of the instruments. The software used will be GEOMAGIC DESIGN X, with AVIZO, v. 9.0. Following the digital model will translated into artificial copies, using polymer as a material. We aim to obtain and to assess the auralisation of the acoustical properties of these 3D models.

In addition, the work will address the study of written sources as well as visual and archaeological documentation related to music performed in the cultic theatres of the ancient Greek world from the Archaic through to the Classical periods. The study will be conducted in order to understand the reasons that led ancient cultures to create these spaces, as well as reconstruct how they experienced them.

Expected results

Firstly, this research will provide the first acoustic model for the study of acoustical properties of cultic theatres in the ancient Greek world. The study will assess and recover the acoustics of the Selinunte theatre.

Secondly, the research will develop specific tools suitable for processing the resulting 3D models. It is also hoped that the results will provide some foundations from which to create experimental interpretative 3D reconstructions integrating acoustic models. The results will establish a new framework, which future researchers can use to advance their knowledge of the application of 3D technology for the documentation of instruments.

Finally, this project will offer an innovative research method in the study of ancient Greek music. This research aims to create a field of comparative studies of archaeomusicological research.

In conclusion, this research will develop a new theoretical basis, which will contribute to the establishment of a methodology at the crossroads of archaeomusicology, architecture, and acoustics and digital technologies. In addition, this study is part of a programme intended to valorise ancient cultural and musical heritage in the Mediterranean with cross-disciplinary approaches to human culture and technology, in order to unveil new meanings and create new research fields within the digital humanities and heritage science.

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