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Editorial

Historical Acoustics: Relationships between People and Sound over Time

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The Special Issue "*Historical Acoustics: Relationships between People and Sound over Time*" was the inaugural collection of the recently established journal "Acoustics (MDPI)", so it felt appropriate to give it a focus to history, places and events of historical relevance, seeking to explore the origins of acoustics, and examining the relationships that have evolved over the centuries between people and auditory phenomena. Sounds have, indeed, accompanied human civilizations since the beginning of time, helping them to make sense of the world and to shape their cultures. While the establishment of "acoustics" as the science of the "production, transmission and effects of sound" in our contemporary understanding could be located approximately two-hundred years ago, scientific acoustical studies date back to the 6th century BCE, with the ancient Greek philosophers, and were developed later on by Roman architects and engineers. In fact, the interest human communities have expressed towards acoustical phenomena goes back much further than that, regarding which recent research outcomes from the emerging field of archaeoacoustics (investigating the auditory and acoustic environment of prehistoric sites and monuments) have been very fruitful. Societies and cultures have been more or less aware of the importance of "sound" and the science underpinning it, and acoustics have always played a central role for our lives and evolution.

Submissions were invited for research dealing with, for instance, acoustic characterization of prehistorical and historical spaces and buildings, acoustics of worship spaces (e.g., temples, mosques, churches, etc.) and ancient theatres, auralization of soundscapes of the past, soundscape of heritage sites and sound as cultural heritage, and literature reviews about acoustic treaties. Considering the relatively broad spectrum that an arbitrary definition such as "historical acoustics" could cover, the contributions gathered in this Special Issue seem to cluster around a few main themes.

The acoustics of historical worship buildings was a theme common to several contributions. Sü Gül [1] investigated the acoustic environments of the Hagia Sophia and the Süleymaniye mosque by carrying out measurements of room acoustics parameters and comparing the results with previous measurement datasets retrieved from the literature. The work included acoustical simulations to compare unoccupied and occupied conditions and to inform the discussion of the original materials. Other contributions related to the theme of worship spaces dealt with Christian churches. Alonso et al. [2] analysed the acoustic evolution of the choirs of several Spanish cathedrals by means of both on-site measurements and simulation models, which confirmed that room acoustics conditions typically provide suitable intelligibility of sung text. Đorđević et al. [3] studied the sound field of the Orthodox medieval church of Lazarica (Serbia); also, in this case, room acoustics measurements were used to calibrate a computer model and perform an acoustic simulation of the church to investigate the effects of the space occupancy, the central dome and the presence of the iconostasis on a number of reverberation- and speech-related parameters. Álvarez-Morales et al. [4] studied the Gothic York Minster cathedral; the authors used measured and simulated room impulse responses to better understand how its architectural features contribute to its highly reverberant acoustic field

and reflected on the implications these had on the evolution of the site from a meeting place of the cathedral's Chapter to its contemporary use for a variety of cultural events.

Several contributions addressed the theme of the acoustics of sites of archaeological interest, with these cases typically dealing with open-air sites. Till [5] reported on the acoustics of three UNESCO World Heritage Sites (the La Garma cave complex in Spain, Stonehenge stone circle in the UK, and the Paphos Theatre in Cyprus), covering a time span of almost 40,000 years. The author reflects on the evolving acoustics of ritual sites in human civilizations, highlighting the role of sound in defining the character of such spaces. The acoustics of ancient Greek theatres is a broad research topic, per se; in his paper, Barkas [6] collates data from twenty ancient theatres in Greece and shows the positive effect of the scenery in contemporary performances of ancient drama to improve the acoustic comfort, concluding that, in spite of considerable alterations (e.g., historical changes, accumulated damage, etc.), most of those theatres are still fit for purpose (i.e., they are theatrically and acoustically functional). Boren [7] used acoustic simulation to confirm historical records of Julius Caesar giving a speech to 14,000 soldiers after the battle of Dyrrachium and another one to 22,000 soldiers before the battle of Pharsalus during the Roman Civil War. Results seem to indicate that, under reasonable background noise conditions, Caesar could, indeed, have been heard plainly by 14,000 soldiers in the speech at Dyrrachium; on the other hand, even in favourable environmental conditions, it is realistic to estimate that Caesar could not have been heard by more than some 700 soldiers in the case of Pharsalus. Likewise, Witt and Primeau [8] used acoustic modelling tools to investigate an Ancestral Puebloans site in Downtown Chaco in the United States that served as an open-air performance space for both political theatre and sacred ritual, focusing, in particular, on the inter-audibility between various locations within the performance space of this site.

The acoustics group of the University of Bologna proposed two contributions on the acoustics of historical opera houses. In the first paper, D'Orazio and Nannini [9] reviewed publications about theatre design written by pre-Sabinian Italian scholars (treatises, essays, etc.), pointing out elements of consistency among some 19th century minor Italian opera houses, to explore to what extent acoustics-related scientific and empirical knowledge would have been part of the construction practice during the golden age of the Italian opera. In the second paper, D'Orazio et al. [10] focuses on the Alighieri theatre in Ravenna, designed by the Meduna brothers and, through acoustic measurements and simulations, the authors compare the current condition with the original one, before the proscenium of the stage was removed in order to open an orchestra pit during a refurbishment in the late 1920s.

Finally, Jordan [11] brought forward the topic of soundscapes as cultural intangible heritage. The author applied both qualitative and quantitative methods to a case study at the Berlin Wall Memorial in Germany, investigating both the past and present soundscape of the site (as understood and perceived), with the support of binaural recordings, psychoacoustic analysis, and soundscape surveys based on standardized soundscape protocols.

A common methodological trait for most of the research that deals with "historical acoustics" is the presence of both acoustic measurements and acoustic simulations in the investigated cases. For the measurements, the researchers' work should always be commended, for the considerable challenges they face in implementing standardized measurement protocols in locations that often present serious accessibility and operability issues. For the acoustic simulations, it is interesting to observe that, while acoustic software was originally conceived (mainly) for the design of spaces that are yet to be built, it is also a powerful tool to investigate acoustic environments that no longer exist (or at least not in pristine condition).

The works gathered in this Special Issue show a vibrant research activity around the "acoustics of the past", which should be the foundation layer to inspire the discipline's future paths. During these months of interaction with authors, reviewers and editors, we realized that there is an increasing interest in these themes and, for this reason, the Journal agreed to establish a permanent topic collection on "Historical Acoustics", to which we invite all interested authors to contribute.

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