

INTANGIBLE TANGIBILITY: ACOUSTICAL HERITAGE IN ARCHITECTURE NEMATERIJALNA MATERIJALNOST: AKUSTIČKO NASLEĐE U ARHITEKTURI

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Abstract

Archaeoacoustics or archaeology of sound is a multidisciplinary field of research, focused on acoustics of historical places and argumentation of 'the continuity of creating the sound field from prehistoric caves, megalithic structures, ancient theatres and odea, Christian catacombs, all the way to the medieval and renaissance sacral architecture and public edifices'. Its overall goal is to expand our comprehension of cultural history, especially the historical endeavour of builders to control the acoustical properties of sacral and performing places. Although the shift in heritage discourse happened from the 1972 to 2003 UNESCO Conventions, and has enabled the more holistic approach to heritage research, the aspect of sound in built environment is not properly treated as acoustical heritage of humanity. This paper addresses the issue of acoustical heritage recognition, as an inseparable intangible aspect of architectural patrimony. The goal is to indicate the relevance of acoustical research of historical places for the understandings of the history of architecture, and thus argue the need for conservation and safeguarding decisions that correspond to the archaeoacoustical research findings. Therefore, the key recommendations of the relevant UNESCO Conventions are interpreted and discussed.

INTRODUCTION

One of the aspects of our understanding of history of architecture originates in the field of sound. The direct connection of sound and architecture is covered by the discipline of architectural acoustics. Archaeoacoustic multidisciplinary teams nowadays research the history of acoustics of historical places and edifices. The need for recognizing archaeoacoustics as a relevant source of gaining scientific knowledge, made me pose a question on how is acoustic heritage seen from the standings of heritage conservation professionals and roof documents of UNESCO that consider the heritage of human creation and thought. Although the significant shift in heritage discourse happened from 1972 to 2003 UNESCO Conventions, the conservators are constantly confronted to the question how tangible is the tangible heritage, /1/. The aspect of sound in architecture is falling in this gap. Therefore, this paper addresses the issue of recognizing the acoustic heritage, as an inseparable intangible aspect of architectural patrimony,

Ključne reči

- nematerijalno kulturno nasleđe
- istorija arhitekture
- arheoakustika

Izvod

Arheoakustika ili arheologija zvuka jeste multidisciplinarna oblast u okviru koje se istražuje akustika istorijskih prostora i argumentuje „kontinuitet stvaranja zvučnog polja od praistorijskih pećina, megalitskih struktura, antičkih pozorišta i odeona, hrišćanskih katakombi, sve do srednjovekovne i renesansne sakralne arhitekture i javnih objekata“. Njen sveobuhvatni cilj je da proširi naše razumevanje kulturne istorije čovečanstva, a posebno pitanja graditeljskih nastojanja da kontrolišu akustičke osobenosti sakralnih i izvođačkih prostora. Iako se ostvario značajan napredak u oblasti zaštite nasleđa od UNESCO Konvencije iz 1972. do Konvencije iz 2003. godine i omogućio više holistički pristup istraživanju nasleđa, aspekt zvuka u izgrađenoj sredini nije adekvatno tretiran kao akustičko nasleđe čovečanstva. Iz tog razloga, ovaj rad se bavi pitanjem priznavanja akustičkog nasleđa, kao neodvojivog nematerijalnog sloja arhitektonske baštine. Cilj rada je da ukaže na značaj akustičkog nasleđa istorijski prostora za razumevanje istorije arhitekture, te tako argumentuje potrebu za konzervacijom i zaštitom koje su u skladu sa arheoakustičkim nalazima. Shodno tome, u radu su diskutovane ključne preporuke relevantnih UNESCO konvencija.

with the main goal to indicate the need for acoustical research of historical places and according conservation and safeguarding decisions.

In order to support the historical relevance of sound research as element of the overall architectural experience, in the first part of the paper I argue why the findings of archaeoacoustical research should be, as any historical document, included in the system of meaning and thus become *spiritually transparent*, /2/. The second part of the paper considers the dominant archaeoacoustical research questions and methodologies, as well as the outlines of corresponding archaeoacoustical findings. The third part refers on the UNESCO Conventions and interpretation of their position on the acoustical heritage. Finally, the discussion points out the relevance of archaeoacoustical research for the conservation of architecture and safeguarding the traditional practices, as well as its potential to expand the understandings of cultural heritage in its entirety.

THE RELEVANCE OF SOUND IN TANGIBLE HERITAGE RESEARCH

A traditionally dominant approach to studying and presenting the historical achievements of architectural creativity is rooted in the range of visual. This negligence of other senses in experiencing various historical places is also unjustified on the level of physics. The fine sensitivity of complex auditory circuit in human beings could be expressed in the ratio of frequencies: the sensitivity of human eye to light is 1:2,¹ but the sensitivity of human ear is 1:1000 (20-20.000 Hz). In addition, ratio of the weakest and the strongest sound which a human can perceive is more than 120 dB, but for the light, this ratio is 90 dB. In other words, the sense of the hearing mechanism is a very powerful receiver and processor of information from the external environment. Nevertheless, it is not that simple. People cannot register all produced sound, because sense of hearing has an auditory range: on the frequency of 20 Hz auditory range is close to 70 dB, but on the middle frequencies like 1000 Hz, sound level of 70 dB is fairly loud because the auditory range for this particular frequency is only 5 dB. Therefore, the sound of the same objective intensity could be barely audible on one frequency, but suitably loud on the other, /3/. This non-linearity of the human sense of hearing is closely related to the human perception of sound. The subtle nature of sound has an essential importance for human beings: (1) on the sensory level it causes the vibrations of the whole human body, (2) it involves the deepest levels of conscious and (3) it also influences perception of the environment and orientation in space. The researches on prenatal periods indicated significant interrelation of sound and space, and the perception associated with it. The first sounds invoke the sense of movement in the consciousness, such as climbing, lowering, crossing, disappearing, etc. Since it is shown that from the last trimester of pregnancy, the fetus can recognize music from the outside world, the level of sound is considered more primitive in our consciousness than the level of speech, /4/.

‘The acoustic ecology of a space is part of what turns a space into a place (...) Spaces are physical locations, but a consciousness of sound, the act of listening to a space, begins to turn it into a place.’ /5/

The sound is more important in some specific places. Acoustics had a significant role in the architectural design in which the great number of people supposed to be listening; such are prehistorical temples, cromlechs, ancient theatres and odea, as well as the sacral architecture of all historical periods. Silent architectural remains led to the conclusion that ‘*the time is collapsed for the archaeological observer*’, /6/. It is reasonable to assume that one of the paths leading towards the restoration of *the collapsed time* lies in the field of archaeoacoustics. Sound ‘*can appear to fill spaces, create atmospheres and have an intense emotive power*’, /7/. Therefore, our perception of sound substantially influences the vividness of our experience and comprehension of architecture in general – because ‘*without acoustics, archaeology is deaf*’ and ‘*without archaeology, acoustics is blind*’, /8/.

Since the prehistorical period, humans tended to create the way to conquer their own nature, including the unconscious level of the psyche. Thus, the rituals, symbolism, and the words developed, /9/. In all of them sound had a crucial role in establishing a connection with *Invisible, Other dimensions* and *Spiritual world*, /4/, because it alleviated the concentration for reaching the deeper state of consciousness. In other words, for prehistorical human, as well as for people of the Middle Ages, physical space was understood in its totality – as an objectification of the *spiritual space*, /10/. The acoustics of spaces is also cultural evidence of the historical periods, which likewise reveals technological knowledge, beliefs, religious practices and overall expectations of an architectural space. The acoustical field strongly influences our perception of a place, religious practice, and public performance. Acoustical quality of a space strengthens the architectural experience. Therefore, the relation of sound and space is of elementary importance for understanding the cultural history of humanity. In this border area, where the spiritualization of matter and the materialization of spirit is taking place, sound was used to open the door of the spiritual world. The sound fields of places are a middle transferor, which has a final and nonetheless important influence on how we perceive the sound, weather spoken, sang, or played. Researching the acoustics of such places, not only that could make our perception of history and archaeological sites aural, but also could lead us to the treasury of the new information. *Audio recordings* inbuilt in the architecture and soundscape of open-air sites provide us a possibility of deeper insight in the connections between spiritual and physical worlds - that fine line between Heaven and Earth.

ARCHAEOACOUSTICAL RESEARCH

Although the first conceptions of production, transmission and perception of sound were developed in Pythagorean School, the first quantification of subjective experience of sound waited until the very end of the 19th century for the work of Wallace Clement Sabine. He was the first one to mathematically define a *time of reverberation* - the acoustical parameter that quantifies subjective perception of sound. That way, he initiated the new field of architectural acoustics. Further development aroused the interest among researchers on tracing the history of aural architecture, so a focused research of the past through the sound started in the last two decades of the 20th century, /11-13/, when the possibility to transform the image of the, until then, entirely silent archaeology was finally realized. Nowadays these researches are compiled in the multidisciplinary field of archaeoacoustics.ⁱⁱ On the international multidisciplinary conference on archaeoacoustics, /14/, overall endeavour of archaeoacoustical research is pointed out: *to argument the continuity of creating the sound field from prehistorical caves, megalithic structures, ancient theatres and odea, Christian catacombs, all the way to the medieval and renaissance sacral architecture and public edifices*, /15/.

Main research questions of the archaeoacoustical studies of prehistorical sites are focused on locating and content of the cave art, as well as the purpose of the prehistorical sites

– caves, tombs, cromlechs, and temples. Prehistorical caves are considered as the uterus of acoustical culture, the places where the sound effects were initially recognized and used, because they enabled the prehistorical humans to realize the possibilities of symbolic architecture and by the committed art to sacrifice aesthetics of perfection in order to unite with the holy forces, /9/. Therefore, one of the archaeoacoustical hypothesis is that the location, as well as themes of cave art and petroglyphs could be explained by acoustical properties of the places, /11, 12, 16/. It is argued that the painted locations - the narrow passages and hardly accessible galleries - were carefully chosen far from the cave entrances in order to contribute the overall feeling of divine presence, /2/, which is enhanced with certain acoustic effects - resonance, echo, and flatter echo - that contributed the creation of auditory illusions. Reznikoff moreover advocates the vocal approach to the acoustical studies of caves for two reasons: (1) the easiest and possibly the only way for prehistorical human to determine length of the cave was by using his voice and listening the acoustical effects that followed; (2) the shamanistic practice was primarily vocal. Therefore, Reznikoff used the mumbling of male voice from C₁ to G₃ for evaluating *the answer of the cave*. It was considered good if the following requirements were fulfilled: (1) initial sound was stronger for more than 10 dB, (2) sound lasted longer than 3 seconds, (3) the resonance and the vibration could be heard further than 25 m, and (4) the echo occurred at least five times, /16/. The study showed that 80% of all cave paintings are located close to the place of resonance and their density is proportional with the intensity and richness of the resonance, /11, 16/.

Due to belief that various characteristics of prehistoric ritual places – such as the distinct acoustic effects as a clear echo - influenced the (unconscious) mind of the ritual practitioner to open for receiving the desired information, /17/, especially if percussion instruments like shamanistic drum, gong or bell were played, /18/. Those sacred places were subjected to the psychoacoustic research in order to illuminate role of the sound and its spatial effects in prehistoric rituals and *communication with the depicted animals, Earth, Invisible*, /9/. The acoustical research showed that rousing of the cave resonance impelled vibration of the whole body to adjust with oscillations of the gallery. Also, the defined and clear echo in the caves provided the impression that the painted characters talk and the production of the stone tools by hitting stone to stone, provided reflections of sound that are often referred to as a distant echo of the single strike of hooves or a thundering reverberation associated with equine stampede, /12/.

Acoustical parameters are measured on the prehistoric sites in order to argue that certain megalithic structures - *the greatest riddle of human prehistory* according to Eliade - have acoustic properties that significantly support their initial purpose, /13, 19-21/. For example, it is believed that the megalithic temples of Malta – used as ritual spaces, storage of common goods and healthcare centres, /22/, were designed to emphasize senses of smell and hearing. Hal Saflieni Hipogeum is an underground cemetery complex with 54 connected rooms cut into the rock and 11 entrances.

The openings in the walls and in the floor, found in the oracle chamber, produced specific acoustic effects: if it was talked in the low voice in the small niche positioned in the chamber, the voice could be clearly heard in all the parts of the structure, /23/. That way the static architecture vividly contributed to dramatic rituals of recreating the approach to the timeless world of ancestors, /24/. The acoustic research on Easter Aquarhies site showed the positional hierarchy, meaning that reflections of sound are directed towards the centre of a stone circle, so the clear sound is designed to reach only the participants of the ritual, but to stay vague and intelligible to everyone out of the stone circle, /13/. Similar psychoacoustical effects were noted on the Stonehenge, where the resonant frequency is 10 Hz, same as alpha waves of a human brain. Although it is below the audibility threshold, frequencies from one to 14 Hz humans receive as a rhythm. Thus, 2 Hz is two beats in a second or 120 in a minute. Low frequency resonance or a standing wave could be aroused with the strong wind or when the great number of participants played small percussion instruments on the site. For this reason, archaeoacoustical findings back up the thesis that Stonehenge had a purpose to support ritual music, /20/.

The various archaeoacoustical projects were developed with the focus on the geometry of different types of architectural edificesⁱⁱⁱ from the period of Antiquity onward, in order to question their relatedness with the music composed at the time and development of religious practices.^{iv} Since the mid VI century B.C. the independent architectural space of the theatre was formed and the acoustics had a salient significance in it. Marcus Pollio Vitruvius wrote about the importance of geometry and recommended how to build a theatre where the audible quality will be as excellent as visibility:

‘The curved cross-aisles should be constructed in proportionate relation, it is thought, to the height of the theatre, but not higher than the footway if the passage is broad. If they are loftier, they will throw back the voice and drive it away from the upper portion, thus preventing the case-endings of words from reaching with distinct meaning the ears of those who are in the uppermost seats above the cross-aisles. In short, it should be so contrived that a line drawn from the lowest to the highest seat will touch the top edges and angles of all the seats. Thus the voice will meet with no obstruction.’ /27/

According to Vitruvius - what could be well seen could be equally well heard. Archaeoacoustical research showed that the geometry parameters which influenced acoustics of ancient theatres are: (1) height and depth of the proscenium, (2) height and slope of the optional roof, (3) the radius of orchestra and (4) slope of the auditorium, /28/. Perhaps the most popular for its acoustical properties, the theatre in Epidaurus from the III century B.C. has a steep slope of the auditorium which is getting even larger with the distance from the stage. Unlike the Greek, the Roman theatre augmented the steepness of the auditorium slope once or twice, while the proscenium got lower and deeper. Beside the direct sound, the audience also got at least two reflections of sound that significantly strengthen the intensity and

the clearness of speech. Those sound reflections from the stage building were under 50 ms, which is even today the accepted limitation for sustaining speech intelligibility. Orchestra – the architectural element considered as the most original acoustical idea of Greek theatre - secured the slight distance of the auditorium from the stage in order to gain the secondary reflections of sound with a short delay. Therefore, it was suggested that due to the experience, ancient architects were aware of this limit and controlled the geometry of the theatre accordingly, /28/. The significant change in theatre design came with Romans: the portico was designed in the same level as the roof of the stage, thus the reflective surface contributed that audience in the last rows clearly hear voices of actors from the stage; orchestra became a half circle with four steps intended for seating, so the reflection properties were lost, /29/. The comparative research of Greek and Roman Theatre showed that the reverberation time in Greek theatre significantly depends on the presence of the audience. On the contrary, the presence of the audience in the closed construction of the Roman theatre does not influence notably on the sound field, but the late reflections are scattered above the audience between the scene wall and the portico colonnade, /30/. Choir singing contributed the further range of audibility, as well as the masks that actors used for voice amplification, /28, 29, 31/.

The acoustic research of odea – roofed ancient theatres – also proved the possible knowledge of Roman builders on how to control the reverberation. The reverberation time was longer in the transversal halls than in the longitudinal ones despite the larger volume of the latter, /32/. It was also regulated with the heavy draperies descending from the ceilings, /33/. Since the odea from the final phase of development had significantly improved acoustic and optic properties, the range of the happenings increased, /32/.

Writing about the theatre's acoustic in the fifth book of the *Ten books on Architecture*, Vitruvius also recommended acoustical vessels and their positions in the defined critical points in order to neutralize the late reflections of sound. He called them *speakers*, strongly convinced they contribute improvement of the sound field in theatres. *'In accordance with the foregoing investigations on mathematical principles, let bronze vessels be made, proportionate to the size of the theatre, and let them be so fashioned that, when touched, they may produce with one another the notes of the fourth, the fifth, and so on up to the double octave.'* /27/

Although the technology of acoustical vessels could be found in sacral architecture all over the world from the Middle Ages until the Modern Period, their effectiveness is questioned throughout history, /31, 34-37/. Nevertheless, numerous artefacts are indicating a certain acoustic tradition based on the Vitruvius' recommendations. Acoustic vessels are usually inbuilt in massive walls of sacral architecture, positioned on equitable distances high in the walls, usually in choir or the central nave, in various numbers and positioning patterns. They were rarely custom built for acoustical use. Usually, they were customary vessels for water, approximately 15 to 50 cm in height, with radius of openings 3 to 15 cm. The frequency range of the so far researched vessels is from 16 to 280 Hz, and none of the churches have ceramic vessels with the range of two octaves as Vitruvius had recommended, /31, 37, 38/.

The variety of archaeoacoustical questions could be approached with the measurements on the archaeological site or by creating and investigating the virtual three-dimensional model in the suitable software. Computer modelling is opening the possibilities to research the correspondence of architectural geometry and its acoustic properties, applied materials, number of people in the audience, position of the



Figure 1. Holy Trinity church in Resava monastery is the endowment of despot Stefan Lazarević, erected between 1407-1418. Its soundscape and acoustics of the interior space are characteristic for the Moravian building style of medieval Sebia. Photo of the exterior (left) shows the church inside the fortification walls. Photo of the interior (right) shows the view on the south apse, decorated with frescoes, two pillars with corner colonettes in the front and the central chandelier hanging under the central dome. Photo credits: author.

vocalists and instrumentalists, specific shapes of furniture, plaster decorations, etc.

ACOUSTICAL HERITAGE OF HISTORICAL PLACES IN UNESCO'S CONVENTIONS

Adopting the Convention for the Safeguarding of Intangible Heritage in 2003, /39/, UNESCO established a new heritage discourse. It is considered as a sister legal document, /41/, to the 1972 Convention Concerning the Protection of the Natural and Cultural Heritage, /40/, which is often criticized as a *Western and academic approach* to heritage, /42, 43/, primarily focused on the great monuments and masterpieces. In contrast to that, the 2003 Convention revealed a significant shift in comprehending the cultural heritage - from *static and monumental* to *dynamic and living*, favouring *transformation over authenticity and renewal over conservation*. Although it also emphasized the interrelatedness of tangible and intangible heritage, the broad holistic approach was unaccomplished, due to *'an institutional compartmentalization and polarization where tangible stands for dead or monumental civilizations and intangible for living cultures'*, /44/. In other words, the shift in discourse was made from the territorial approach of object protection towards the ethnographical approach of safeguarding *'processes as a device for identity and cultural production'*, /42/, and the 2003 Convention was expected to become *the standard-setting instrument* for the safeguarding of living cultural heritage, /45/.

Acoustic heritage of historical places, as the intangible layer of architecture, falls in the discrepancy of those two adopted approaches to heritage, because of the difficulty where to place it and how to treat it in the research, interpretation, and conservation of architectural patrimony. *'Intangible cultural heritage means the practices, representations, expressions, knowledge, skills – as well as the instruments, objects, artefacts and cultural spaces associated therewith – that communities, groups and in some cases individuals recognize as part of their cultural heritage'*, /39/. Since the ceremonies and all sorts of performing (rituals, theatre, public speaking, etc.) are closely related to the characteristics of places, the architectural and environmental acoustics are highly important as it directly influences the quality of the *living heritage* presentation and thus becomes its inseparable part.

'...ancient music may be inseparable from dance and ritual, or an archaeological site itself may act like a musical instrument, generating sounds as a result of its own acoustical properties. It may introduce such a characteristic quality to any other sounds made at or in the site that this become the dominant sonic presence. Acoustics are clearly an important part of sonic context...' /5/.

Beside the recommendations for safeguarding the oral traditions, performing arts and social practices, the 2003 Convention acknowledges the intangible cultural heritage also as *'the knowledge and the practices concerning nature and the universe'*, and *'the traditional craftsmanship'*, /39/. The essential idea of the 2003 Convention is that if the intangible heritage is safeguarded, then the tradition is kept alive and sustainable in the community, /45/. Although

sacral edifices and auditoriums are not anymore built the way they used to be, the authentic acoustical tradition of each historical period could be safeguarded as a part of the human knowledge, skills, and building practices of the time. State Parties to 2003 Convention 'committed themselves to endeavour to ensure the *'recognition of, respect for, and enhancement of the intangible cultural heritage in society'*, as well as to *'promote education for the protection of natural spaces and places of memory whose existence is necessary for expressing the intangible cultural heritage'*, /39/. The value of the place is emphasized in the context of intangible heritage safeguarding. One of such values is certainly the acoustical one, which significantly contributes the identity of a place – important element of defining the intangible cultural heritage. *'This intangible cultural heritage (...) is constantly recreated by communities and groups in response to their environment, their interaction with nature and their history, and provides them with a sense of identity and continuity'*, /39/. In other words, heritage conservation should not be only concerned of the environment where arts or the living traditional practices are taking place, but also take into account the intangible layer which 'colours' the experience of culture in many different ways, including aurally. For example, 2009 entry on the *Representative List* is *The Candombe and its socio-cultural space: a community practice*. The Candombe – the procession of drummers in the old part of Montevideo on Sundays and holidays – is the example of acoustical importance for experiencing the cultural practice. Acoustic resonance of the streets of Montevideo contributes and thus becomes a part a Candombe procession, which is also closely related to the city, the specific neighbourhoods, and Montevideo's Afro-descendent community, /46/. Here it is necessary to reflect on the work of R.M. Schafer, who developed the concept of *soundscape* as a pattern of sound that defines and distinguishes places from one to another. The essential standing of his work in acoustical ecology was that the sound contributes to a sense of place as equally as the visual features, so Schafer argued that the acoustical environment should be listened to as if it was a musical composition, /47/. These environmental and architectural acoustic properties have the key role in *developing a sense of place* just like the architecture or the ceremonies it supports, /48/.

'Just as many (tangible) places owe their importance to intangible values, so too many aspects of intangible heritage are grounded in specific places and cannot survive without them.' /46/

DISCUSSION: ARCHAEOACOUSTICAL RESEARCH IN HERITAGE CONSERVATION

Each significant historical place has specific cultural values among which are acoustic ones, tightly connected with the material aspect of heritage – the built and natural environment. It is important to note the close relation between the decisions on architectural conservation and their effects on the corresponding architectural acoustics. The findings of archaeoacoustical research – the documentation, research, and assessment of the acoustics of a place - should be equally treated as any other criteria for making an

informed decision on heritage conservation. For the places where the religious practices or any other ceremonies are still performed, it is highly important not to make changes in the room acoustics in order to safeguard the original architectural experience. The archaeoacoustical research of sacral architecture pointed out the changes in acoustic field caused by the architectural conservation adjustments on materials and geometry. For example, if the frescos in the medieval Orthodox church are severely damaged and the decision of the conservator is to use lime mortar with large granules in order to sustain 'the medieval look', then the acoustics is effected due to the usage of not authentic material which absorbs more sound energy than the fine flat surfaces of the fresco-mortar. These issues of inadequate architectural conservation, which is threatening the authentic acoustic field, permanently disables further archaeoacoustical research on the site. However, it could be prevented if absorption properties of the material used in the conservation correspond to the authentic material.

The other question of acoustical heritage concerns the tradition of acoustic vessels. If acoustic vessels used in sacral architecture of medieval period are kept as exhibited artefacts in the museums, the tradition of the continuous recreation of an acoustical field is disabled. One cannot experience the acoustical effects from one or several acoustical vessels in the museum, because they are isolated from the original built context. Since the function of the UNESCO 2003 Convention, /39/, is also a research, inventorying, studying the nature of cultural transmission and sustainability, /45/, acoustical heritage should fairly be regarded as the specialized knowledge transmission in the building domain. Consequently, it is important to determine and further research the acoustical traditions in architectural and historical places. By adequate safeguarding of the acoustic heritage it would be possible to aurally experience the past in the present moment, and thus recreate a historically deeply rooted culture.

The UNESCO 2003 Convention is criticized for failing to link the safeguarding of intangible heritage to the protection of places, where the tangible and intangible values actually meet, /46/. This also implies to the question of safeguarding the acoustical heritage. The Representative List of the Intangible Cultural Heritage of Humanity, with the summary of 314 elements in 2014, does not include any inscription which considers the acoustical heritage of historical places. Even though acoustical heritage issues seem to fall in the gap between tangible and intangible heritage safeguarding approach, they could be also treated as a connecting thread between those two. The first sign of this shift would be the inscription and recognition of acoustical heritage in the Representative List. That way, it would be proven that the safeguarding of cultural heritage does not only include the most colourful or interesting, but each manifestation that contributes to the understanding of how spaces are used and comprehended. By sustaining 'the attachments that connect people to places and give them meaning', /46/, we also maintain the original inherited environment for the further research of culture in order to eventually fulfil the complex mosaic of cultural heritage. Never-

theless, the UNESCO 2003 Convention introduced a significant shift in the heritage discourse to which now tends to safeguard spiritual values, knowledge, and understandings of life, nature and the cosmos. It also suggested the regional and international cooperation on the intangible heritage research and safeguarding (article 86, 105). Accordingly, it is needed to broaden the multidisciplinary teams of researchers and conservators, and actively involve the acousticians in the assessment of the authentic inherited acoustical values of historical places in order to bring us closer to the holistic approach to heritage – erasing boundaries among tangible, intangible and natural heritage. *'Ecological thinking is characterized by holism and awareness of interconnections. It recognizes that the management of complex systems demands attention not to one variable but to many, and that there will always be uncertainty about how changes in individual variables affect the whole.'* /49/

In other words, acoustical documents should be regarded as any other viable historical document, because they primarily suggest the state of knowledge of the builders, which lacks in written documents. Therefore, it is important that the heritage of architectural acoustics should be recognized and safeguarded, not only as an aesthetic value, but also as the source for extracting knowledge and understandings of the past practices. The UNESCO 2003 Convention enables the recognition of acoustic heritage of historic places as a part of the integral protection, but additional effort is needed to create its appropriate place in the entire system of conservation and safeguarding the cultural heritage of humanity. That way, the specific 'sonic colour' of architecture would be preserved, thus contributing to the overall experience of architectural and musical heritage in the particular place.

CONCLUDING REMARKS

Formation of scientific disciplines, such as archaeoacoustics, reflects the awareness of the harm influence of the differentiation of sciences and thus the whole knowledge of humanity. Revival of the multidisciplinary approach emphasizes the strong need for the integration of sciences, because the great science needs *'the main instruments of the great art: emotion, intuition, sense for beauty, (...) creative energy which does not know the disciplinary differentiation'*, /50/. The contemporary development of digital technologies accelerated the progress of archaeoacoustical research in the last two decades. This young scientific discipline has a great potential for expanding our knowledge and comprehension of cultural history, especially the historical endeavour of builders to control the acoustical properties of sacral places and the overall history of acoustic science – understandings of production, transmission and reception of sound.

The paper emphasized this potential of archaeoacoustical research and the need for the acknowledgement of the acoustic findings of historical places as a valid historical document. The acoustical heritage - as the intangible complementary aspect of architecture - should be identified as such and safeguarded adequately. Further research and recognition of acoustical heritage of historical places will

contribute the understandings of the influence of acoustical effects on the performance and acoustical knowledge of the builders throughout history. I argued that each historical building or a room where acoustics was important during any historical period deserves a proper archaeoacoustical research. These findings should be considered in the complex and multi-layered conservation process, especially if the building still has a significant need for adequate acoustical properties (for example, a church that is still in use, a shrine, or a theatre). Therefore, it is important that archaeoacoustical questions come into the sight of heritage researchers as additional tool for historical understandings of architectural projects and prehistoric sites, as well as the significant guideline for safeguarding and adequate conservation for the cultural heritage of humanity. This is now possible, because UNESCO 2003 Convention widened the focus of 1972 Convention and thus shifted the heritage discourse. It enabled the recognition of acoustical heritage of historical places as a field where tangible and intangible intertwine, and where it is necessary to provide a multidisciplinary holistic approach to heritage research, conservation and safeguarding.

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ⁱ The visible range of the electromagnetic spectrum has wavelengths from 380 to 780 nm or frequency of 4×10^{14} to 7.9×10^{14} Hz. The ratio of lowest and highest frequency is thus around 1:2.

ⁱⁱ 'Archaeology of sound' is also frequently used term in the same meaning.

ⁱⁱⁱ For example, ERATO project, /25/, was dealing with the evaluation of acoustic heritage of ancient theatres and odea; within the ATLAS project, /26/, it was researched the acoustical support for the theatres of antiquity; CHARISMA project considered the historical preservation of the acoustical heritage of Byzantine churches and Ottoman mosques in Istanbul.

^{iv} The largest number of researches of acoustical properties of ancient theatres and odea were presented in 2011 at the conf. The Acoustics of Ancient Theatres in Patras, Greece.

^v Until May 2014 total number of 161 State Parties ratified the 2003 Convention.



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