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Spatial Design Praxis Using the Sound Sketching Environment Tool “Esquis’Sons”

Petros FLAMPOURIS¹,
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Abstract. Open-air amphitheaters are one of the most characteristic manifestations of Ancient Greek architecture. From an architectural renovation perspective, the legal framework results in minimal re-constructions of archaeological sites emphasizing on minimum interventions and low footprint impact. Contrary to the established treaty, this document addresses the rehabilitation of the selected site based on the use of the sound sketch software Esquis’Sons (Marchal, 2015) that allows you to sketch and hear sound scenes generated from a 3D digital model. By making a study based on in-situ recordings and using them in the sound sketch tool, one virtually builds a sound environment “in the making.” Multiple sound scenarios are then tested and used as feedback for spatial decision making.

Keywords. Sound Sketch, Esquis’Sons, Ambiance, Soundscape, In-Situ, Virtual, 3D Model

Introduction

Since the formation of the first charters where conservation and restoration techniques were presented, the approaching ethos to similar archaeological and historical sites was mainly restoration of the ‘least interference’. Meanwhile, a vast amount of research has been carried out on the ancient theatre (CORDIS | European Commission, 2020, The Acoustics Of Ancient Theatres 2011) regarding the historic and revival aspects of the architectural and acoustical theatre heritage. The methodological approach of this research is to approach the site based on sound attributes and media, adopting the sketching tool Esquis’Sons in this treaty in order to try to express and predict the sound ambiance of the site before and after the rehabilitation. An attempt is made to apply Esquis’Sons in a semi-Urban environment with heavy historical character. This method will help emphasize and predict sound ambiances to control and produce spatial.

Theater’s Architectural Description and Environmental Context

The study was carried out in an Ancient Greek theatre of Ancient Dimitriada (294-292 BCE) at the city of Volos in the region of Thessaly, Greece. The largest part of the diazoma and kilon’s marbles are missing. From the scene and the proscenium structures, only a stone footprint exists. From the ruins, we make the assumption that the size of the theatre was 9 klimakes and 8 kerkides, and the orchestra was shaped like a horseshoe with a radius of 12.10m, built from rigid soil. The kilon is 18m height. A few pieces of the kerkides remain, made of marble and Limestone.

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In relation to the urban fabric the archaeological site is situated 4km from the city of Volos, next to a road with medium traffic which is busy during rush hours. The Greek theatre is related to the geography of the site, built on the natural slope of a hill. The general site is surrounded mainly by fields. There are construction sites around the area and no residential buildings (fig. 1a).

Sound Sketching for Design

Acoustic study (reverberation durations, speech intelligibility criteria) has been performed by in-situ measuring and by room acoustic software. The results show that the amphitheater might regain its properties if the structure is reconstructed with marble or stone (seats, stage, orchestra). Even though the theater is built on a small hill, the existing site does not offer the same potential: the acoustic space is open and it cannot be considered as an enclosed space “isolated” from “outside” sounds. Contrary, the theater is “filled” with sounds of the shows that create “sound effects” (mask, mixing, metamorphosis) (Augoyard et al., 2011)³ with the sounds of the environment (sounds of nature, bells from neighboring villages, animals, noise of vehicles)⁴. The sound environment, the articulations and effects lead us to use Esquis’Sons to sketch out modifications in order to propose an architectural intervention implying the addition of small spatial objects which will not effect in terms of reduction of traffic noise but which can significantly modify the ordinary “listening” of these.

Esquis’Sons App Principles

The Esquis’Sons application is a tool for space designers that allows us to simulate sound ambiances. It thus offers the possibility to mobilize sound as a design material during the sketching of spaces. It is an immersion tool that uses sound tracks to be listened to in relation to geometrical parameters extracted from a CAD software. The idea is to introduce “sound” into the spatial project by allowing the user to “bypass” the complexity of acoustic modeling. Thus it is able to account for the propagation of sounds and the effects resulting from the constructed shapes (distance, elevation, mask, etc.).

Positioning sound as a sketching tool means taking the gamble of considering sound as a material of the architectural project. The inclusion of sound in the formulation of spatial interrogations makes it possible to question the morphological, material and functional stakes of a spatial project, all of which are likely to affect the propagation and composition of sound in space and time. Esquis’Sons asks questions about the organization and distribution of activities and uses that produce a sound environment. It is a way of questioning the general orientations (density, functions, locations) of a project beyond its visual representations.

We decided which scale to test for each scene, chose the focus of scenes and the degree of the architectural intervention. Then, we integrated and tested the interventions with the tool: we declared the 3D environment in Grasshopper and constructed the sound scene in Esquis’Sons (distance of listening points from sources and spatial objects, source(s) distance from ground and spatial objects, amount of each source, reflection and shadows from spatial objects and background noise). Once the space-sound model is built, we adjust the parameters based on the sound feedback obtained

3. See definition of mask, metamorphosis, mixing sound effects in Augoyard, J.F. and Torgue H. (Eds), *Sonic Experience : a guide to everyday sounds*, p.67-71, pp71-77, p.78.

4. See at: <https://soundcloud.com/petros-flab/90sec-scape>

from Esquis’Sons: adjusting materials (absorbance and reverberation) and adjusting geometries. Finally, a degree of qualitative realism is sought in the sound-spatial scene by working on new elements by the appearance and disappearance of behavioral - sound phenomena by introducing signals and sound markers, rhythmologies, and sound effects and by relocation of sound sources and listening points, uses around the scene.

Assigning Spatial Environment

We created the landscape by undressing the contour lines and the road on the south of the site. The theater area was modeled based on the ruins studied during the site survey. All the geometry elements created in Rhinoceros have been assigned to the applications Esquis’Sons through grasshopper. Dedicated opacity and absorbance in Esquis’Sons were adjusted individually.

Assigning Sound Samples

Related to background sources, all simulations share the background sounds common in sample and position. Four sound sources, oriented on the site emulate the expected sound qualities of the area. We declare on NW and SW an urban sample, on NW a construction site sample, on SE a church bell, on N a leaf rustle, breeze, cicadas and birds sample was used and we introduce a sample of noise traffic on E. Relating to the localized sources depending the modeled scene there was a variation regarding the assigned sounds. A concoction of samples of rustle of leaves, birds, theatrical play, chat, café ambiance, footsteps, kids, cycle path ambiance and busking were used.

Scale and Scene Focus

The interventions were studied on two levels regarding the scale focus. The first, which we call the “Global” level, is the relation between the site and its surrounding environment. It focuses on background sounds, spatial volumes, distances of the projected sound and the surrounding uses of the suburbia. The second level can be related to the scale of “the body in movement” (Chelkoff, 2003) and concerns the relation between smaller geometries and the user perception and actions, reflecting on the ambiance relation within the architectural space and the individual user.

Scenarios, Sound Sketches and Spatial Form Generation

Seven different scenarios of spatial interventions were developed. Each intervention had its own spatial approach for fulfilling the site rehabilitation brief. As a proof of the case studies, one rehabilitation scheme is presented and assessed below. At the following presented scenario 6⁵ (fig. 1b) the introduced spatial objects were: entrance, theater, koi, stage, sound barrier, museum, workshop, audiovisual pavilions, café, small theater, Pop-up pavilions, cycling path and supporting uses structures.

5. Scenario 6 was selected due to the interesting sound results emerged from the sound sketches. The interventions adopted in this scheme were more profound interventions, such as, leisure uses, parking slots, supporting theaters and bike routes, and supporting structures, but also treatment-related such as the sound barrier and side wall reflectors for the theater area;

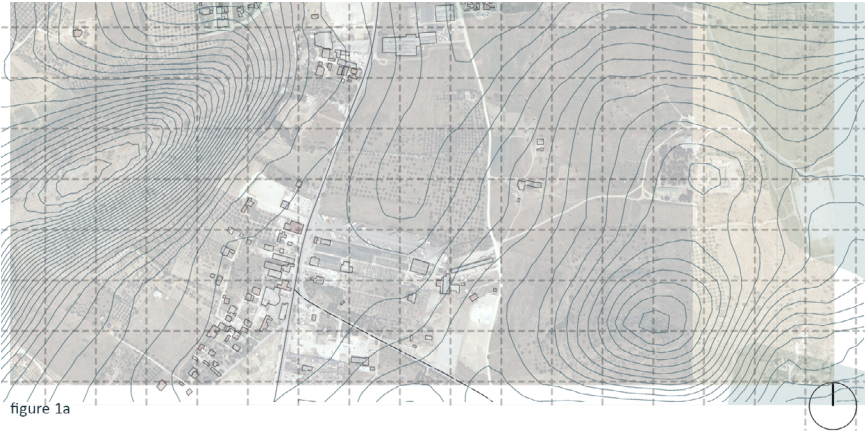


figure 1a

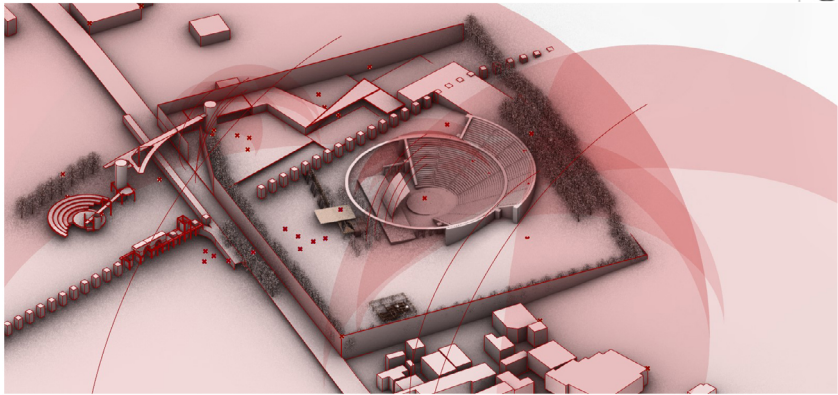


figure 1b

Figure 1. a) The theatre is related to the geography of the site, built on the natural slope of a hill. The general site is surrounded mainly by fields. There are construction sites around the area and no residential buildings. b) One of the selected interventional scheme, approached in a global and individual scale. Includes background and localized sound and can be studied in both level at the same time. The sketch includes 10 sound scenes on individual scale.

Evaluation Criteria of the Sound

Esquis'Sons is creating live and virtual a sound environment based on the spatial models edited with the 3D software (Rhinceros). It's built on sound loop mixing system that takes into account the position of the sources, the position of the listeners and the dimension and materiality of the built space in between. It helped by assigning different positions as listening points to hear 'live' the same sound scene from 2 different positions chosen by the designer in order to check, by sound, the results of its design. The comparison between the 2 sound tracks of the same sound scene is qualitative because it is based on comparative listening. The interventions evaluated below are validated using the following criteria for their produced qualities:

- **Clarity of sources:** capacities of the sound tracks to understand the sounds their source and their meanings;
- **Distance in between sources:** capacities of the sound track to reveal relative positions of the sources heard;
- **Materiality of space:** capacities of the sound track to reveal materiality of the space;

- **Narrativity of the sound track, sound effects:** potential to produce sound effects;
- **Ambiances (back plan/indices):** sound game in between sound that feeds the back plan and sounds witnesses of emerging events(ambiance description as a whole).

Evaluation of Scenario 6

Scene 1, Entrance

Audio

Clarity: A Large site, exposed to multiple sound incidents, bad clarity on foreground sounds

Distance: Multiple sound indices, a mixture of source distance on foreground and background

Materiality: road asphalt, soil, paving, trees, built structures

Narrativity: An open space, for public uses, of a warm dry environment

Ambiances: Background: Open space exposed to traffic with natural components.

Indices: People’s chatter, kids playing implying a space of public use

Effect: Mixing Effect, Masking effect, Reverberation

Scene 2, Theater

Audio

Clarity: A Large site, exposed to multiple sound incidents, lack of clarity

Distance: Multiple sound indices, a mixture of source distance on foreground and background.

Materiality: soil, paving, trees, stone

Narrativity: warm summer weather

Ambiances: Background: Open space exposed to traffic with natural components.

Indices: People’s chatter, kids playing implying a space of public use

Effect: Mixing Effect, Masking effect, Emergence effect, Reverberation

Scene 3, Sound Barrier

Audio

Clarity: multiple sound incidents, bad clarity on foreground and background sounds

Distance: Multiple sound indices, a mixture of source distance on foreground and background

Materiality: soil, paving, trees, building structures

Narrativity: warm weather, social, leisure

Ambiances: Background: Open space with natural components and people chatter.

Indices: kids playing, bell, traffic

Effect: Mixing Effect, Masking effect, Emergence effect, Reverberation

Scene 4, Theater/Bridge area

Audio

Clarity: multiple sound incidents, good clarity on the foreground and bad on the background sounds

Distance: Multiple sound indices, a mixture of source distance on foreground and background

Materiality: road asphalt, soil, paving, trees,

Narrativity: An open space, for public uses, of a warm dry environment, relaxation, coziness

Ambiances: Background: Open space exposed to traffic with natural components.

Indices: People’s chatter, music

Effect: Mixing Effect, Masking effect, Emergence effect, Reverberation

Discussion

The exploratory and iterative dimension of the tool has allowed us to make an interactive study to test design hypotheses. Our choice to focus on two main scales gave us the advantage of predicting different sound idiosyncrasies. By working on a global scale that included several scenes, we were able to show that one can influence the other on a larger scale. Our work also shows that different spatial typologies can be developed and studied through sound feedback by adding and removing, directly

mixing and modifying the modeled scene.

In every sketch:

- Geometries were investigated by altering their width, height, length positions and orientation.
- Characteristics were investigated by altering the absorbance coefficient of the environment and the opacity.
- Sources were investigated with their position, volume, size, amount and with a random factor integrated inside the Esquis’Sons tool.
- Listening points were investigated with their positions, directions and height.
- Loops were investigated with their context, length, neutrality, sound mark information.
- We also used the visualization components from Esquis’Sons in order to understand the diffusion and the propagation of sound.

The manipulation of components and the direct sound feedback provided a layer of sound, constituting spatial composition multifactorial, reinforcing the decision making and the appropriation of the introduced geometries by testing them through the listening positions and the modeled spaces.

Although we tested treatment-related interventions, it is interesting to note that we focused on the sounds of social interaction and not only at the quantitative aspects of acoustics. We may not be able to prejudge the ambiance of the space because of its multifunctionality, the unexpected cues that occur there and the complex arrangements that weave its constitution (Thibaud, 2018). However, it is possible to envisage a project composed of spatial schemes whose expected uses include some of its expected ambiances and qualities.

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