

# Site-specific composition for the Pisa Baptistery

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**Abstract.** This paper outlines a site-specific composition project realised at the Pisa Baptistery in April 2017. This baptistery, located in the Piazza dei Miracoli in Pisa, Italy, is known for its exceptional acoustics, in particular its long reverberation time that can reach up to fourteen seconds.

A composition entitled *Voci della Terra e del Cielo (Voices of Earth and Sky)* was designed specifically for this site, exploring the aesthetic peculiarities of its acoustics. The composition was performed by two local musicians: a tenor and a soprano. The aim of this project was to digitally record the composition and implement it in a project that consists of displaying soundscapes in gallery exhibitions of mixed-media art.

Compositional ideas and experiments concerning this piece are presented and the following results and findings are discussed.

# **Site-specific composition for the Pisa Baptistery**

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The aural architecture of the Pisa Baptistery makes it an interesting space for exploring sound and for composing sonic experiences that can only exist at this site. The Baptistery is well known for its long reverberation time, which can reach up to fourteen seconds. This inspired me to engage my current research at the University of Liverpool with an overseas project in Pisa. A key aspect of my research consists of the creation of ‘musical paintings’, a new type of mixed media comprised of multichannel acoustic panels designed for gallery exhibition. Integrating the Baptistery’s soundscape into this type of media would certainly enrich this collection. The project development consisted of three stages: firstly, it aimed to produce a composition corresponding to the site’s acoustic characteristics; secondly, a recording was scheduled to take place in site and lastly, the audio recording was prepared in the format of a musical painting to be displayed in galleries.

The Baptistery is a major tourist destination; it is the largest Baptistery in Italy and a world heritage site protected by UNESCO. Due to the high number of tourists visiting the site daily, it was necessary to take into consideration the lack of private access for executing the project. The local institution that protects and promotes the Baptistery, along with other monuments at the Piazza del Duomo, is the Opera della Primaziale Pisana (OPA Pisa). The institution agreed to offer one hour out of visiting hours to record the proposed composition. To further simplify this project, local musicians were chosen to participate, a tenor, Ettore Martinelli, and a soprano, Silvia Pepe, both students of the renowned soprano Patrizia Morandini. The composition produced for the site was performed and recorded on the 20<sup>th</sup> of April 2017.

## **Compositional approaches based on the site's characteristics**

Although the Baptistery presents peculiar acoustic characteristics, music is not usually performed in the site. Classical or religious repertoires would certainly lose their clarity amidst the rich blend of reflected sounds. Its only musical practice is an acoustic demonstration for visitors, where attendants sing briefly, usually for about one minute. In relation to new music, an electroacoustic composition entitled *Siderisvox* was performed at the Baptistery in 2006, as part of an acoustics research on the site (Tarabella, 2006). This research, conducted by Leonello Tarabella at the *Laboratori di Analisi dei Segnali ed Immagini e del computerART*, a project of the *Istituto di Scienza e Tecnologie dell'Informazione* (I.S.T.I. A.Faedo - Ricerca CNR), was also fundamental for designing *Voci della Terra e del Cielo* (*Voices of Earth and Sky*), the composition to be presented here.

The I.S.T.I. A.Faedo research (Tarabella, 2006) at the Pisa Baptistery has demonstrated a few procedures used to measure its acoustics and results. The first procedure shows that its response time to an impulse is around 14 seconds. This impulse was generated through a pistol shot, and a Fourier transform analysis has shown that the frequency which remains for longest is around 400 Hz. The second procedure consisted of measuring the response time through generated sine waves. This provided more detailed information and a chart was developed to facilitate the data visualisation. It was noted that the frequency of longest duration is precisely around 430 Hz, making this the main resonance of the Pisa Baptistery. A further study on the site showed that the ground and superior levels receive different responses, with the superior level being the one that preserves more reverberation peaks.

Taking these factors into consideration, some initial ideas were considered for the new composition:

- a) To create chords through reverberation.

- b) To experiment with the resonant frequency.
- c) To experiment with frequencies of long reverberation time.

Idea 'a', to create chords through reverberation, has been intentionally used by the Pisa Baptistery's attendants, who provide a short singing demonstration every 30 minutes for visitors. Generally, just one of the attendants sings individual notes of a sequence of four triads, respectively in the functions of subdominant, tonic, dominant and tonic. The interaction between the solo singer and the long reverberation may convey a polyphonic effect. Murray Schafer explains this effect as:

Reverberation and echo give the illusion of permanence to sounds and also the impression of acoustic authority. Thus they convert the sequential tones of melody into simultaneously heard chords of harmony (Schafer, 1977, p. 219).

Polyphony through reverberation is approached at the introduction of *Voci della Terra e del Cielo*. A sequence of chords is constructed from measure 13 (figure 1). The first chord is a "G major" with an added fourth. This chord is repeated until the bass note moves to "G#", developing into "Ab major" with an augmented fourth. Next, the bass note moves up another semitone, finally concluding in an "F major".

The image shows a musical score for two voices, Soprano (S) and Tenor (T), spanning measures 15 to 29. The score is written in 4/4 time. The Soprano part begins at measure 15 with a series of notes and rests, marked with dynamics like *f* and *mf*. The Tenor part begins at measure 18. A circled letter 'A' is placed above the Soprano staff at measure 23, indicating a specific chord. The score includes various dynamic markings such as *f*, *mf*, *p*, and *sfz*, as well as the instruction *messa di voce* in the Tenor part at measures 23-24.

Figure 1: Measure 15-29 - Polyphonic Chords

A pentatonic based chord, “E minor” with the addition of a 4<sup>th</sup> and a minor 7<sup>th</sup>, is explored in section B, from measure 56 (figure 2), with the intention of creating a texture of adjacent notes, in this case “G”, “A” and “B”. A brief return to the introductory chord scheme is encountered on measure 76. In section C (figure 3), other structures formed by the intervals of fourths, fifths and octaves are written for the soprano part.

The image shows a musical score for two voices, Soprano (S) and Tenor (T), spanning measures 56 to 61. The score is written in 4/4 time. The Soprano part begins at measure 56 with a series of notes and rests, marked with dynamics like *mf* and *f*. The Tenor part begins at measure 56 with a series of notes and rests, marked with dynamics like *mf* and *f*. The score includes various dynamic markings such as *mf*, *f*, and *mf*, as well as the instruction *messa di voce* in the Tenor part at measures 56-57.

Figure 2: Section B, Measure 56-61: Pentatonic chords

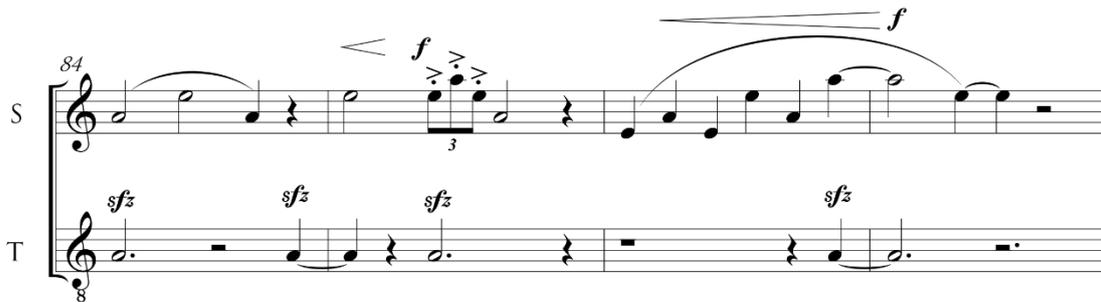


Figure 3: Section C, Measure 84-87: Quartal and quintal chords

Idea ‘b’, to experiment with the room’s resonance, is initially explored through notating the voices at “A = 432 Hz” tuning. This frequency approximates the room’s resonance, which is around 430 Hz. Since solo voices do not act as stable instruments that can offer a precise tuning, the specificity of 432 Hz is merely contextual, and it was chosen due to calculations based on the Earth’s rotation around the Sun, which result in A 432 Hz. In short:

- 1)  $365.2425 \text{ days} = 1 / 31558119.4368 \text{ seconds} = 0.00000003168756623 \text{ Hz}$
- 2)  $0.00000003168756623 \text{ Hz} * \text{pow}(2,32) = 136.1 \text{ Hz} = \text{C}\#3$
- 3) C#3 136.1 Hz can be found in the diatonic scale of A 432 Hz.

The first calculation only transposes days to frequency. The second raises the frequency to an audible frequency, transposing it to 32 octaves up. The third converts the frequency to the standard notation. This helps to elaborate the conceptual idea of the composition’s title, which shall be further explained later.

Idea ‘b’ is also explored throughout section A. The soprano sings the corresponding frequency (A 432 Hz) while the tenor reinforces this frequency singing the same note one octave below. Singing the room’s resonant frequency creates an interesting effect as the room vibrates producing a distinct sonority in comparison to common reverberation. The intention was to excite the resonance for a considerable time creating a quasi-static texture. Along with this texture, some moments of ‘noise’ are simulated through the syllable sound of *f* (sh). On measure 36 (figure 4), the note B (432 Hz tuning: 484 Hz) is introduced to

develop some distortion through its neighbouring frequencies, resulting in a denser texture. At this same measure, vowels are replaced to stimulate the reverberation and resonance through a variety of harmonics in the same spectrum range. Shifted harmonic peaks produced by changing the vocal tract are known as formants, and these were approached through the vowels of *o* (oh), *i* (ee), *u* (oo) and *ε* (‘e’ as in “net”). The glissando between formants seems to produce an interesting effect along with the room’s reverberation, as different formants can be perceived in conjunction.

The image shows a musical score for two voices, Soprano (S) and Tenor (T), covering measures 36 to 40. The Soprano part is written on a treble clef staff with a 3/4 time signature. It begins with a *sfz* dynamic marking and includes notes with phonetic notations: *ò (o)*, *i*, *i*, *i*, *i*, *sc (f)*, *ò*, *é (e)*, *i*, and *ò*. The Tenor part is also on a treble clef staff, marked *tempo rubato (solo tenore)*. It starts with a *sfz* dynamic and includes notes with phonetic notations: *u*, *sc (f)*, *ò (o)*, *ò*, *sc (f)*, *u*, *ò*, *sc (f)*, *ò*, *u*, *ò*, and *i*. Both parts feature various dynamic markings including *sfz*, *sffz*, *f*, and *f >*.

Figure 4: Measure: 36-40: Developing texture through noise, resonance and formant variations.

The third suggestion, idea ‘c’, concerned manipulating frequencies of long reverberation. In this composition, the soprano range goes from “D4” to “B5” (432 Hz tuning: 288.3 to 969.8 Hz). The tenor range goes from “F3” to “A4” (432 Hz tuning: 171.4 to 432 Hz). Tararabella’s research shows that most frequencies between 100 Hz to 1000 Hz can last up to 10 seconds in the space. High frequencies above 2000 Hz are the ones that have a shorter response. In comparison, the range of frequencies utilised in the composition corresponds to the frequencies that respond with the longest reverberation time. Therefore, the room’s response accommodates well both tessiture.

An approach to developing the experience of long reverberation was to employ “stopped reverberance”, as Blesser and Salter explain:

To hear the complete reverberation of a note, there must be silence after the note terminates, hence the name “stopped reverberance.” Music must stop in order to avoid masking the ongoing reverberation. Enter a large

church, clap your hands, and you hear stopped reverberance (Blessner and Salter, 2009, p.139).

This is evident at the piece's introduction. Regions of notated silence are meant to offer space for reverberation. In addition, as a potential guide for studying the site's reverberation, the tempo chosen for this piece was circa 60 bpm, which is equivalent to 1 second. Different time signatures were notated to separate regions where the room's reverberation can be experienced, for instance, a 5/4 measure may indicate that the reverberation sound will remain for about 5 seconds.

### **Composition title and conceptual thoughts**

The title, *Voci della Terra e del Cielo*, or Voices of Earth and Sky, was inspired by the way sounds behave in the Pisa Baptistery. Due to the cone shape of the inner dome, the reverberation concentrates at the superior level. When singers perform at the ground floor what is perceived is, in fact, two types of sound sources: natural voices and "metavoices"; voices transformed through the reflection on the marble walls. While natural voices seem to navigate from ground to dome, metavoices seem to go the opposite way. This listening perspective of lower and higher elements can be metaphorically expressed through the connection between Earth and sky. To extend this concept, the noted tuning of 432 Hz was chosen to associate the piece with the Earth's frequency of rotation around the sun, as discussed earlier.

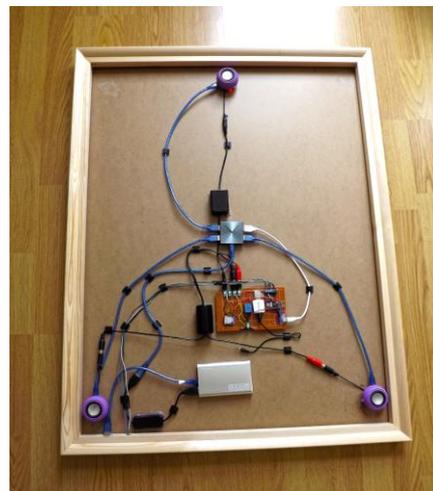
### **Recording and Spatial Reduction**

Another idea concerning the response difference between ground and superior level was not used on the written composition, but was added digitally in post-production. Since the sound of both levels was captured by microphones, it was

possible to produce interesting audio mixes. The final goal of this project was to create a type of mixed-media art to display the composition in art galleries. This engages with the ‘musical paintings’ project, the on-going research conducted by myself at the University of Liverpool, which consists of multichannel acoustic panels hanging on a wall in the same fashion of traditional paintings. Thus, a musical painting was constructed and designed to accommodate the composition. The painting displays an image of the exterior of the Pisa Baptistery and conceived inside the panel there is a multichannel circuit with three loudspeakers, two in the lower part and one in the superior part of the panel.

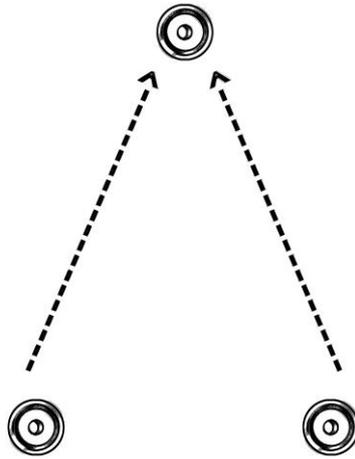


*Figure 5: Musical painting – exterior*



*Figure 6: Musical painting – interior*

The loudspeakers at the lower region correspond to the audio of the ground level, while the superior loudspeaker corresponds to the audio captured from the superior level, thus redimensioning the actual acoustic space. Through this method of reproduction, it is possible to perceive the sonority difference between levels through a divergent perspective. The superior level of the Baptistery also responds with a short delay from waves that come from the ground level. For this reason, a delay of approximately 200ms was simulated on the superior loudspeaker, resulting in an interesting effect of sounds navigating upwards.



*Figure 7: Schematic representation of the sound navigating upwards*

## **Results and Final Considerations**

This project has been fruitful in many ways. It has gathered evidence of how new music can interact with sites of exclusive acoustics. In terms of composition, this has suggested how resonance can be explored to develop texture, how reverberation can be effectively used to create chords and how stopped reverberance can be manipulated to produce acoustic phenomena within a space. Moreover, it has proposed that the spatiality of a large room can be reduced and reinterpreted by other creative means. Representing the Pisa Baptistery's sonic potentials through media that can run as part of exhibitions inside galleries, as in the format of musical paintings, is a valuable form of preserving and promoting the aesthetics of its sound architecture and sound tourism (Cox, 2017).

There is no doubt the Pisa Baptistery is a major site for experiencing reverberation. The research conducted by Tarabella has shown (Tarabella, 2006) that the reverberation time can reach up to 14 seconds. In comparison, the largest church in the world, Saint Peter's Basilica, reaches only to 7 seconds, and it has been reported that many cathedrals can reach up to 10 seconds (Blessner and Salter, 2009). The Hamilton Mausoleum in Scotland, surpasses the

Baptistery reaching up to 18.7 seconds in low frequencies, but it falls behind in mid-frequencies where it reaches up to 9 seconds. Yet, the long reverberation factor is not its only trait. As it has been noted, there are two main waves in the Pisa Baptistery. A horizontal that reflects on the perimeter wall and a vertical that is a result of the cone shaped dome. This interlace of waves creates a unique sound atmosphere. In the beginning of the last century, the perplexity of its acoustics had already been affirmed by William Dean Howells:

While we stood in some amazement at this, the conscious structure of the dome caught the sound and prolonged it with a variety and sweetness of which I could not have dreamed. The man poured out in quick succession his musical wails, and then ceased, and a choir of heavenly echoes burst forth in response. There was a supernatural beauty in these harmonies of which I despair of giving any true idea: they were of such tender and exalted rapture that we might well have thought them the voices of young-eyed cherubim, singing as they passed through Paradise over that spot of earth where we stood. They seemed a celestial compassion that stooped and soothed, and rose again in lofty and solemn acclaim, leaving us poor and penitent and humbled (Howells, 1907, p.240).

This expressive testimony accentuates the significance of the Pisa Baptistery's aural architecture, a place that deserves to be remembered as an important Italian soundmark. The compositional case study presented here has demonstrated one experiment that evokes the site's sonic spirit. The intention with the artwork developed on this project, the musical painting format, is that it will be exhibited in contemporary art exhibitions, as a representation of the Baptistery's soundscape.

