

# The ‘Interface’ in Site-Specific Sound Installation

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## ABSTRACT

In site-specific installation or situated media, a significant part of the "I" in NIME is the environment, the site and the implicit features of site such as humans, weather, materials, natural acoustics, etc. These could be viewed as design constraints, or features, even agency determining the outcome of responsive sound installation works. This paper discusses the notion of interface in public (especially outdoor) installation, starting with the authors' Sculpture by the Sea *Windtraces* work using this recent experience as the launch-pad, with reference to ways in which others have approached it (focusing on sensor, weather-activated outdoor installations in a brief traverse of related cases, e.g. works by Garth Paine, James Bulley and Daniel Jones, and David Bowen). This is a dialogical paper on the topic of interface and 'site' as the aetiology of interaction/interface/instrument and its type of response (e.g. to environment and audience). While the focus here is on outdoor factors (particularly the climatic environment), indoor site-specific installation also experiences the effects of ambient noise, acoustic context, and audience as integral agents in the interface and perception of the work, its musical expression. The way in which features of the situation are integrated has relevance for others in the NIME community in the design of responsive spaces, art installation, and large-scale or installed instruments in which users, participants, acoustics play a significant role.

## Keywords

NIME, site-specific installation, outdoor sound installation

## 1. KEYPOINTS

- Considering site-specific installation as a large-scale musical instrument, the people interacting, data driving sonification, weather (in the case of the meteorologically-driven installations presented) become **agents** or **performers** influencing the musical rendering and expression
- Considering site-specific installation as a large-scale musical instrument, the spatial environment, its acoustic properties and the way it affects human circulation and listening to the work, form an integral part of the interface (the 'sounding board')
- There are different considerations and optimisations designing an interface for a single expert user to designing for novice or non-expert multi-user scenarios, especially in broad-access public sites

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- When an interface gives agency to an unpredictable data-source, such as weather, the design needs to balance random behaviours and structural coherence
- When an interface gives agency to an unpredictable data-source, such as weather, the design needs to balance data-determined, uncontrollable musical expression and the designer's aesthetic intentions

## 2. INTRODUCTION

As installations, including the specific genre considered here – namely, artistic applications of data sonification, become a more widespread form of musical expression in the public domain, it is useful to examine the ramifications for interface design in large-scale and outdoor NIMEs. Here *interface* defines the interface between the work and the public; the method of interactive engagement; the interface between mechanism and artefact; the juncture at which users or audience interpret the presentation of data; the work's interaction with its environment and its setting – the physical site, atmospheric conditions, and its affect on realisation of the work: interface effectively determines the *experience* of the music.

This paper considers the design of the site-specific outdoor installation, *Windtraces*, intended for a broad public audience exhibited over a number of weeks, and discusses the NIME design keypoints above. Although expounded in regard to this specific example, the keypoints are relevant to a broad spectrum of public large-scale installation design, and particularly for outdoor site-specific installations. A number of related works are presented to illustrate how others have approached these considerations.

## 3. WINDTRACES INSTALLATION

### 3.1 Background

*Windtraces* is a multi-channel, site-specific sound installation that was exhibited as part of the *Sculpture by the Sea* exhibition in Sydney in November 2011. It uses data from meteorological sensors as inputs to algorithmic processes, to generate a dynamic soundscape in real-time. Sculpture by the Sea is a large-scale art exhibition [1] that takes place each year on the coastal pathway between Bondi beach and Tamarama beach in Sydney, Australia. It is a free event and in 2011 attracted more than half a million visitors.

### 3.2 Site (Location)

The *Sculpture by the Sea* exhibition was motivated by the scarcity of "seriously enjoyable cultural activities that are free and not fringe" and Sydney's "need for an accessible visual arts event" [2]. The event has achieved popular status as an accessible public art event [3] now running for 15 years with consistently high numbers of visitors and its re-creation at other locations [4]. The Bondi-Tamarama coastal path provided the location with an abundance of natural plinths in the rock [2] – a steep rock formation approximately 11 metres in height and 12.5 metres in length. *Windtraces* comprised a set of 14 loudspeakers distributed across the site in the crevices and

fissures of the rock, emitting sounds generated by algorithmic processes that were controlled by sensor data relating to meteorological conditions at the site.

The site was challenging for an audio installation due to environmental noise from the sea, the wind, and from human activity. The noise varied greatly in its type (bandwidth, frequency), level and timing, in turn also significantly affected by weather conditions. Of the weather conditions in the area, the founding director of *Sculpture by the Sea* wrote: “On top of this physical variety is the added effect of the weather, with everything from gorgeous calm days to stormy windswept cliff tops and huge seas” [2]. Our response was to use the weather to control the sound produced by the installation, thereby natural weather sounds could support the artificial sounds produced by the installation, rather than potentially render them inaudible.

### 3.3 Artistic Considerations and Context

*Windtraces* is technically a ‘sonification’ work because it preserves a strict, factual relationship between the source data and its representation through a series of mapping processes. The range, values and data trends derive directly from site-located sensors. It utilizes the striking features of the SxS site’s spatial structure: the curving, contoured overhanging rock face with reflective concave surfaces, as well as undulating horizontal axes. The idea of *tracing* alludes to both the spatial tracing of the rock, and also the *Windtraces* of ephemeral weather data. The *tracing* element and time-based calculations allow it to present both an audible revelation of the current palpable state, as well as less obvious informative deductions (history and forecast) that rely on information about elapsed events. The real-time (live) sonification of data captured by the weather-station located at the site allowed this immediacy of representation and rapid responsiveness alongside the aim of making the sonification meaningful and apparent to the transient and general audience who may have no technical experience of auditory display of data, i.e. the dynamic information representation needed to be interesting and explicit to the lay public audience. In contrast, sonification is typically employed by people who have expertise in the field of visual analysis and graphing techniques or cognate in the subject of the data content (or both).

### 3.4 Informative Ephemera: Attention Span and Accessible Sonification

*Windtraces* was installed in a public thoroughfare, which had the advantage of catching many passers-by but also was characterised by an ephemeral and moving flow of pedestrians who may not have much time to stop and interpret the representation. The infinitesimal variety of individual tastes and reactions were difficult to anticipate in such a situation, however **rhythm** and **spatial movement** were selected as two communicative and intuitive means of mapping that may be easier to assimilate than, for example, fine graduations of pitch-mapping. Accessibility or availability is important for peripheral or ambient visualisation and sonification contexts. **Ambient visualisation** operates on the premise that the viewer/listener should be able to catch the ‘gist’ of an idea and immediacy of information without full attentive and analytical thinking. *Windtraces* used a variety of short, staccato sounds because they effectively convey rhythmic information, they are more easily audible in the presence of environmental sounds, and they are especially suitable for conveying movement when repeated sequentially in different loudspeakers.

The delineation of samples and spatial organisation were strictly data-driven (sonification), while compositional control was also exercised in the aesthetic selectivity and organisation of samples into groupings from which the computer program

makes its selection. The sound design involved a degree of metaphorical or figurative connection between the sample groupings and the weather conditions they represent: e.g. turbulent ‘swooshing’, noisy, timbral sounds evoking windy conditions; more ambient and pitched naturalistic sounds evocative of still early morning; pitched metallic gong sounds with complex spectra defining transitions between time- and weather-states at important junctures; ‘wet’, droplet and somewhat literalistic sounds to depict rainy conditions. Sounds sample groupings were, however, never completely representational or naturalistic, containing a blend of metaphorical (subjective, according to the designers) and synthetic and (‘contemporary’) machine-sounds or ‘industrial’ noises interspersed with natural sounds because the installation was not intended to be purely a soundscape. Ultimately, the weather data determines the deployment of sounds: their selection and delivery in terms of location, rhythm and tempo.

### 3.5 Spatial Composition and Vantage Point

Post-war, Twentieth Century contemporary music has many examples of works that integrated sound design with the spatial distribution of loudspeakers in a site-specific context. Edgard Varèse’s *Poème Électronique* was composed specifically for its first performance in the multimedia Philips Pavilion of the 1958 Brussels World Fair. The pavilion consisted of a series of hyperbolic paraboloids tensioned by steel cables. Iannis Xenakis’ audio-visual work, *La Légende d’Eer* (1977-78) is a site-specific spatial audio work [5]. From these early but seminal examples, *Windtraces* has taken the inspiration of site-specific sound *paths* (‘traces’) and a pointillistic speaker distribution following curving contours, which in this case form the flowing natural sandstone rock surface of the cliff-face at Tamarama beach.

In *Windtraces*, loudspeakers are treated as **point sources** of sound in a spatial configuration rather than as an array to be audited from a singular privileged position (the ‘sweetspot’, as occurs in Wavefield Synthesis for example). In this case, spatialisation forms a compositional element in which spatial audio functions as a *gesture* with two spatial attributes: **position** (location), and **motion** (the current location of a sound with respect to its previous location).

### 3.6 Technical Configuration

The technical set-up for *Windtraces* follows (see Figure 1). Local meteorological conditions are sensed using an Oregon Scientific WMR100N [6] weather station with its standard sensors and an additional solar radiation meter (Oregon Scientific UVN800). The weather station is connected to an Apple Mac Mini running three pieces of software concurrently: Weathersnoop [7] (a commercial program for collecting data from a connected weather station); *Windtraces* generative software (WGS) (which controls all sound generation and spatialisation in the installation); and an instance of *Windtraces* synthesis software (WSS) (which synthesises eight channels of audio, as directed by the WGS). A second instance of the WSS is run on the second Apple Mac Mini, connected by Ethernet. Each Mac Mini is connected to an 8-channel sound card, to output up to 16 channels of audio in total (14 were implemented in SxS). A set of three 6-channel amplifiers (Ashly Powerflex 6250) send output to a set of 14 JBL ‘Control 25’ weatherproof loudspeakers.

### 3.7 Spatialisation

In *Windtraces*, the movement of each sound across the rock is controlled by a finite state grammar (see, e.g. [8]). The loudspeakers are located in the crevices in the rock surface (Figure 2a). Sounds emitted from a particular speaker are followed by a linear sequence across a number of adjacent

speakers, creating the movement following these rock contours (traces). These paths are probabilistically selected by a finite state grammar (Figure 2b). Each wind direction is mapped to a set of probability distributions. Wind speed is mapped to two control variables: the interval between the time that a sound is played from a speaker, and the time that it is played from the next speaker; and the speed with which new sounds arise. Different types of movement are evoked using different time intervals and sets of probability distributions, e.g. to create clear wave-like motions or complex scenes with many sounds following random paths around the network of speakers.

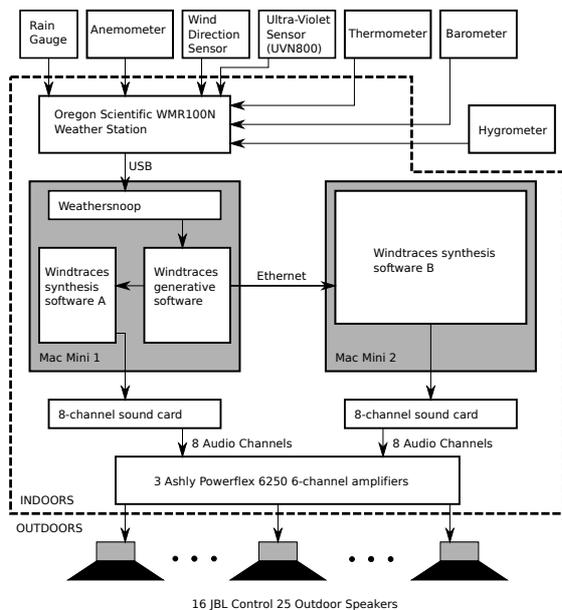


Figure 1. The hardware and software infrastructure for *Windtraces*.

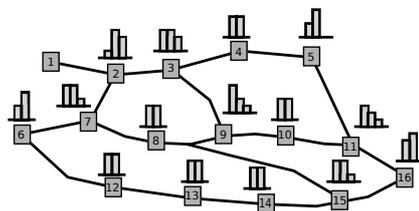
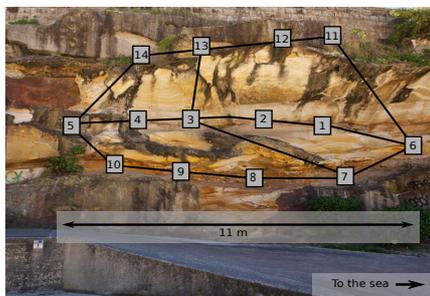


Figure 2. (a) Speaker locations on the rock surface and (b) finite state machine corresponding states and speakers, and an example set of probability distributions.

#### 4. FLEXIBILITY

For outdoor (especially) and public space installation, flexibility emerges as one of the essential qualities for a large-scale work, often installed over a period of days or weeks, that needs to be able to accommodate a range of conditions, responses and remain interesting for potentially multiple or sustained encounters. The aetiology of changing conditions is

complex, including varying physical and environmental conditions, ambient sound levels, fluctuations in audience attendance, size, and distance as a listener. The requirement for flexibility can also stem for constraints and regulations, such as local sound limits over different times of day or, in the case of sonification, arising from the variance in data determining the rendition. Aesthetic considerations with regard to flexibility include the wide gamut of potential listeners ranging from attentive experts to people unfamiliar with the modality, genre and style, with a wide array of musical tastes.

#### 5. DIFFERENTIAL ATTRIBUTES OF INTERFACE VS. INSTRUMENT

Arguably, differential attributes of a musical instrument include the likelihood that its interface has sufficient nuance, subtlety (even difficulty) and refinement that a performer typically practices and aims to improve their rapport both with its musical expression and, as a means to that end, through technical fluency and familiarity performing. Musical instruments are usually (though not always) individual or personal interfaces for one-on-one interaction, therefore also often on a human-scale or smaller than installation interfaces from a physical ergonomic perspective (some large percussion instruments perhaps being exceptions), often with a high-intensity (attentive) but short-duration timeframe of engagement. Thus, we are accustomed to the performer being a relative ‘expert’. By comparison a large-scale installation interface is designed for public consumption and needs to be ‘playable’ or listenable for experiences by relative novices: satisfying enough on a first encounter, and engaging enough with little expertise, to allow the audience to experience the music. It may be interactive giving agency for musical creation/expression to the public participant or, as in the case of *Windtraces*, it can be a non-interactive rendering, e.g. sonification, an automated process, or a pre-formed composition, etc. Others have looked at ingredients of successful engagement, playfulness, game-like qualities, the balance between occult or explicit procedures of operation (being able to discern or not ‘how it works’), the curiosity and novelty vs. familiarity, or randomness, alienation and unpredictability vs. comprehensibility or the fathomable factor [9,10,11]. Paine and Drummond, amongst others, have also developed ontologies and taxonomies for classifying real-time interfaces for electronic music performance [12,13]. The (outdoor) site-specific installation can be thought of as a multi-user interface with potentially many vantage points or a dynamic, mobile public audience, which, in turn, affects technical approaches such as spatialisation.

#### 6. RELATED CASES

##### 6.1 Garth Paine’s *Reeds* Installation

Garth Paine’s *Reeds* work also garners weather data (in this case from weather stations located in two of the pods in the reeds) from which the 8-channel music is composed in real-time in supercollider and relayed back out to 6 pods in the pond. Paine’s work was installed in the Ornamental Lake of Melbourne Royal Botanic Gardens (2000), sounding from dawn till dusk daily. Paine’s work confronted similar ‘interface’ considerations to *Windtraces*, such as the open-air dispersal of sound, the non-privileged position of the listener, that is, a constantly changing listening perspective but no one position that privileges all pods (speakers) equally so that spatialisation of sound is treated like a point source and the interface includes the environmental acoustics provided by ambient sounds of wildlife, wind on the lake, reeds blowing, acoustic wind-drift, and intentionally utilises diffraction off the highly reflective water surface.

As Darren Tofts (Chair of Media and Communication, Swinburn University of Technology and author) writes on *Reeds*, “At a time when virtual reality designers are seeking to remove the body from immersive experience, Garth Paine’s responsive, activated environments (*Ghost in the Machine, Footfall, Map 1*) make **physical presence** indispensable to the subtle invocations of the virtual” [14]. Thus, **situated media or site-specific installation creates a convergence of interface and spatial rendering**. Similar to the authors’ conception of *Windtraces* as a (larger-than human-scale) outdoor instrument, played by meteorological activity, Tofts writes of *Reeds*, “Responding to environmental information, such as light intensity, wind velocity and temperature fluctuations, the reed clusters play the environment like a musical instrument, a techno Aeolian harp or photosynthesiser, that amplifies the invisible and inaudible” [14].

## 6.2 James Bulley and Daniel Jones’ *Variable 4* Outdoor Installation

*Variable 4* is an 8-speaker outdoor sound installation that translates weather conditions into musical patterns in real time. It has been installed at Elizabeth Castle – Branchage, Snape Maltings – Suffolk, Dungeness – Kent. “Using meteorological sensors connected to a custom software environment, the weather itself acts as conductor, navigating through a map of 24 specifically written movements. Every aspect of the piece, from broad harmonic progressions down to individual notes and timbres, is influenced by changes in the environment: wind speed, rainfall, solar radiation, humidity, tropospheric variance, temperature, and more. ... Linking together the sensor data and scored motifs is an array of algorithmic processes drawn from the natural world, modelling phenomena such as tree growth, swarm theory and evolutionary development. The resultant composition is performed over a 24 hour duration through a field of 8 speakers integrated into the landscape” [15]. The structures draw from mathematics, statistics and biology (e.g. a Lindenmeyer System {L-system} branching tree structure), stochastic principles and Markov Chains. They stratify layers according to sectional durations to enable immediacy.

## 6.3 David Bowen’s *Tele-Present Water* Remote-Data Gallery Installation

Worth noting briefly is David Bowen’s *Tele-Present Water*. This is an installation that draws information from the intensity and movement of the water in a remote location, thus the “tele” reference to data collected in the environment and relayed to the gallery installation. While the **interface** in this case does not include the outdoor acoustic and physical, material space, the work effectively creates a ‘simulation’ or partial recreation of gestures from real-world data within the context of the gallery. The audience and spatial environment still form an integral part of the physical, immersive experience of the work and its ‘sounding board’ as a musical instrument expressing weather agency. “Wave data was collected in real-time from a National Oceanic and Atmospheric Administration data buoy Station 46246 (49°59’7" N 145°5’20" W) on the Pacific Ocean” [16,17]. “The wave intensity and frequency are scaled and transferred to the mechanical grid structure installed at The National Museum in Wroclaw, Poland. The result was a simulation of the physical effects caused by the movement of water from this distant location” [17].

## 7. DISCUSSION

*Windtraces* installation has been presented in detail as the vehicle for discussion but importantly the keypoints it raises are

issues pertinent to *all* site-specific sound installation and particularly outdoor, public-space installation which needs to address issues of changing conditions, ambient sound levels, and predictably unpredictable elements.

Installation interfaces require a high degree of design contingency – due to longevity of the installation, to safeguard against public damage, to withstand and express effectively in a variety of weather conditions, to provide variety and scope. In the NIME community, the “I” in NIME often focuses on instrument design (new instruments, hyper-instruments, digital instruments, augmented instruments, even virtual instruments). Hence this paper interrogates the paradigm of interface in site-specific installation, with special attention to the role of site and situated response.

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