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The Role of Sound in Making of a Sense of Place in Real, Virtual and Augmented Environments

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Abstract

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Doctor of Philosophy in Architecture

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This study is an investigation of the role of sound in the making of a sense of place. The topic is explored both theoretically and practically within the scopes of real, virtual and augmented environments. It is argued that new media can be utilized to generate multi-sensory experiences that can engender a sense of place. By doing so, new media applications can provide valuable insight into the ways in which environmental perception function and make it possible to investigate how multiple senses interact with each other to generate place experience.

In the first part of the study, the concept of place is traced from its philosophical origins along its evolution through different traditions of western thought. This is followed by the analysis of four mainstream descriptions of sense of place from architecture and social theory. A phenomenological framework is proposed suggesting that place experience is founded on multi-sensory social and environmental interactions followed

by the introduction of the concept of soundscape, as the auditory dimension of place experience.

Two case-studies are presented in the second part of the study, both of which utilize new media to investigate the generation of digital soundscapes. In the first case study, the theoretical framework established on place and soundscapes in the preceding chapters is utilized in the modeling and evaluating a virtual soundscape environment for a cultural heritage reconstruction project. The second case study is an empirical investigation that uses mobile audio-augmented reality to test and evaluate the influence of sound on the sense of place.

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Introduction:
The Role of Sound in Making of a Sense of Place in Real, Virtual and Augmented Environments

> Mine is not a world of being; it is a world of becoming. The world of being, the silent, still world where things simply are, that does not exist. The rockery, the pavilion, the skyline of high-rise flats, the flagpoles over the cricket ground, none of this is really there. The world of happenings, of movement and conflict, that is there…
>
> Acoustic space is a world of revelation. (Hull 1990)

Architecture has often been criticized for having developed an inclination towards being visually-centric. The origin of this visual bias has commonly been attributed to the period when architecture was established as a formal discipline, with Leon Battista Alberti's treatises on architecture and Filippo Brunelleschi's studies on geometric perspective (Levin 1993; Perez-Gomez and Pelletier 2000; Pallasmaa 2005). This preoccupation with vision corresponds to the codification of the principles of perspective and projective geometry; and their subsequent methodological applications to architectural design. While architectural concerns over geometric proportions, spatial harmony and sculptural form go back much before this period, all the way to Vitruvius and before; it is after the perspectival turn (Panofsky 1991) that happened during the Renaissance, architecture has shifted predominantly towards the geometric appearances

of space and form rather than their technical mastery, material tectonics or personal experience. Before that time architects used to be skilled master craftsmen who dealt with the acts of building, construction, space and structural design in a hands-on and non-mediated manner. Architectural drawing techniques allowed architects to work off-site, test out several design alternatives on paper without having to cut a single stone, and to deliver stonemasons and craftsmen construction directions on paper. Eventually, the exercise of making visual diagrams, orthographic projections, perspective renderings became synonymous with making architecture. Architects today still operate behind perspective windows, with a significant portion of the design process focusing on the visual impact of buildings and spaces. The only difference from the times of Renaissance is that computational visualization and drafting has replaced the traditional precedents.

Digital media suggests a more significant revolutionary potential than what it is currently utilized for; it has the power to generate a new representational turn in architecture. The revolutionary potential is only there if architects and designers manage to overcome their visual-centricism, by treating the digital medium not simply as another canvas for visual expression and go beyond the use of it as a site to entertain fascinations with geometric and formal explorations.

Digital media allows architectural drawings to be more than just visual representations. In *The Language of New Media*, Lev Manovich identifies the characteristics of digital media as: numerical presentation, modularity, automation, variability, and transcoding (Manovich 2001). The possibilities of integrating semantic information into the

representation, processing it with ease and limitless computational acuity, transmitting it with the speed of light makes digital representation far superior compared to traditional media. Digital media, “profoundly influences content representation, management and communication” (Kalay 2008, p.3). The digital medium can aid the design, problem solving, communication and evaluation processes in architecture, as well as act as a virtual medium through which place experience can be transmitted (Kalay 2004). This dissertation focuses on the latter: the utilization of digital media to generate place experiences that aim to go beyond simple visual representation.

This study is an investigation of the role of sound in the making of a sense of place. Throughout the dissertation the subject is explored both theoretically and practically within the scopes of real, virtual and augmented environments. It is argued that new media can be utilized to generate multi-sensory experiences that can engender a sense of place. By doing so, new media applications can provide valuable insight into the ways in which environmental perception function and make it possible to investigate how multiple senses interact with each other to generate place experience. Sound is particularly focused on for the fact that it happens to be a highly spatial sense, and influences spatial presence and awareness of events. Even though direct architectural applications of sound in new media are rare; in films, virtual environments and computer games sound functions as an important element that greatly enhaces the sense of place within the fictional/virtual environment. Following a theoretical introduction to the concepts of place and soundscape, this dissertation summarizes and discusses specific applications of virtual and augmented soundscape environments which are designed and constructed in order to answer the question of how sound can generate sense of place

and influence immersion, familiarity, orientation, privacy, personal safety, along with many other aspects of place perception.

Chapter 2 discusses the concept of *place* from a theoretical standpoint and investigates the role sensory experience plays in place experience. First, the concept is traced from its philosophical origins along its evolution through different traditions of western thought. The ways in which these philosophical traditions approach embodiment, presence and sensory perception in relation to place are comparatively analyzed. The ontological relationships of place to human subjectivity, senses and experience are examined. This is followed by the analysis of four mainstream descriptions of sense of place from architecture and social theory.

Chapter 3 is a discussion on the roles of different sensory modalities in the making of a sense of place and an exploration on the possible reasons behind the visual bias in place perception. In this chapter, a phenomenological framework is proposed suggesting that place experience is founded on multi-sensory social and environmental interaction.

Chapter 4 introduces “soundscape,” the auditory dimension of place, and methods of analysis and representation that are used to study and document it. Different approaches towards the evaluation of soundscapes are presented and compared. While existing methods of visual representation can provide analytical tools to study and document soundscapes, it is argued that these may not be adequate means of conveying the soundscape experience in its phenomenological complexity and wholeness. Some examples of new media applications that convey soundscape experiences in a hybrid

fashion are provided, utilizing cartographic and other visual presentation techniques along with actual reproduction of recorded sounds.

As mentioned by Blesser and Salter (2007) what has changed from the early years of acoustics research and soundscape studies is that now we are looking at the concept of soundscape as something that we can digitally manipulate within architectural environments, or even generate from scratch in virtual simulations, thanks to the development in psychoacoustic simulation techniques, availability of high quality analog-digital and digital-analog conversion technologies coupled with much faster processing capabilities of today's hardware. There are now several methods to synthesize in real-time surround acoustic experiences using digital processing and presentation. The case studies provided in the second part of this dissertation serve to explore the question of how sound can help generate a sense of place with the help of digital media.

Chapter 5 discusses the role of sound in generating a sense of place in virtual environments. The theoretical framework established on place and soundscapes in the preceding chapters is utilized in the modeling of a virtual soundscape environment for a cultural heritage reconstruction project. The process of developing the virtual soundscape for the multi-user educational computer game West Oakland Jazz and Blues is described in detail. Methodologies of mapping and typological classification schemes developed by soundscape studies are utilized to design the spatio-temporal distribution of sounds in the virtual recreation of the cultural heritage environment. Applicability of

concepts from film theory such as sound perspective, diegetic and non-diegetic sounds are discussed in the context of virtual environments.

Chapter 6 is an empirical study which uses mobile audio-augmented reality to test and evaluate the influence of sound on place experience. An audio-augmented reality implementation, which overlays existing physical places with virtual acoustic atmospheres, was designed and carried out specifically for this study. Several tests were performed at four pre-selected locations at the UC Berkeley campus. Surveys and interviews were collected after letting twelve participants interact with the environments. The chapter presents and discusses the numerical and qualitative results from the surveys. The results of this experiment help confirm that new media can generate and influence sense of place, through non-visual means as well as visual. In addition, based on the survey responses and verbal feedback from the participants the interactions between visual and acoustic perception are explored and their influence on the sense of place are assessed. Soundscape and place experience are studied in combination, and specific effects of sound for sense of place are identified. Various influences of sound on the sense of place are observed and documented, including emotional, synaesthetic effects, along with effects on attention gaze and movement, spatial orientation, sense of scale, sense of personal and social space.

PART I

PLACE, PERCEPTION AND SOUND

2

The Sense and Sensation of Place

> … as place is sensed, senses are placed;
> as places make sense, senses make place. (Feld 1996)

This chapter will examine different theories on place and analyze these theories in relation to embodiment and sensory perception. The first section of the chapter will discuss the philosophical origins of the differentiations between the concepts of space and place. This will be followed by a comparative analysis of four mainstream approaches to sense of place from architectural and social theory. These approaches will be analyzed according to their ontological relationships to human subjectivity and experience and the ways they envision the role of senses and perception in the formation of the concept of place.

The distinction between space and place is an important issue to deliberate upon before explaining what is meant by "sense of place" in this study. The two words, "space" and "place" may have different and sometimes overlapping etymologies in different cultures and languages. To give an off-hand example, the word *yer* in Turkish (author's native language) can translate to both place and spatial location depending on the context of its usage. A similar situation exists with the words *lieu* and *espace* in French. The

difficulties in translating these etymologically nuanced word-concepts from one language to another sometimes result in incompatible usage even in contemporary academic literature. For instance, cultural theorists following Henri Lefebvre use the word “space” (French: *espace*) to refer to the social construct that is different from “place,” which in this literature denotes a geometric-rationality. Place, in this sense would be the extent that provides an objective account of coordinates and location (Lefebvre 1991 [1974]; De Certau 2002). This usage is in conflict with the English usage of these terms, both in colloquial means and within academic disciplines of architecture and environmental psychology: space as the objective, geometric extent, and place as the subjective human construct (Tuan 1977; Relph 1976; Norberg-Schulz 2000). Throughout this study, the latter form of usage is taken as standard.

2.1. Place and Senses and Subjectivity from a Philosophical Perspective

In addition to being an epistemological construct that relates to the knowledge, meaning and experience of space, place also happens to be an ontological concept with close relationships to human subjectivity. The understanding of place by a certain philosophical tradition is inherently connected to how that philosophy explains the condition of *being*. In turn, the condition of being is determined by the state of being *in* or *situated* in a place. While subjectivity informs the perception of place, place acts as the conditional, formational agent for subjectivity to emerge. In order to understand how a philosophical tradition envisions subjective experience one may look at the ways place is construed within that frame of thought. Contemporary phenomenology for instance often describes the *sense of being* as enmeshed and molded within place, to a degree that

the two becomes almost inseparable from each other. As an example, in *The Poetics of Space*, French philosopher Gaston Bachelard presents a close examination of the domestic place, one's childhood home. He thinks of home as a special shelter, a "cocoon" within which the subconscious gets cultivated (Bachelard 1994). Bachelard's psychoanalytic observations on domestic space can also translate to place and its experience in general. The places that we live in, our house, street, neighborhood, city, are also the places we deeply identify with. In this view, place functions as an ontological point of origin, a deep-seated anchor securing one's sense of self, in other words the "psyche."

Another philosopher of place, Jeff Malpas states: "Place is not founded on subjectivity, but is rather that on which subjectivity is founded. Thus one does not first have a subject that apprehends certain features of the world in terms of the idea of place; instead, the structure of subjectivity is given in and through the structure of place" (Malpas 1999, p.35). According to Malpas, place is formational not only for individual subjectivity, but also collective and social subjectivity. Social subjectivity is equally determined by place, as the interrelationship and identification of a culture with the geography that it inhabits is formative for its self-image, social practices and conceptions. Therefore, by investigating how the concept of place is constructed in different philosophical traditions one can also understand how individual or social subjectivities are envisioned within each of these frames of thought.

2.1.1. Plato and the Metaphor of the Cave

The first philosophical meditations on the distinctions between space and place go back to antiquity, to Plato and Aristotle. The early classical interpretation of place envisions it as an external entity that is both the site and the precondition of human perception. Within this philosophy, the existence of the outside world, reality, does not require the presence of a situated sensory being. Place is deemed as an entity that is not only separate and independent from human perception but also a precondition for it.

According to this philosophical position, we can only attain an indirect understanding of this preexisting outside world, which presents itself as material properties that we perceive via sense organs. In classical ontology this immediate sensory perception is seen only as an illusive reflection of the metaphysical reality. Plato illustrates this philosophical standpoint with the famous metaphor of the cave (Plato, *The Republic, Book XII*). The illustration, a thought exercise, suggests an analogy of the human being to a prisoner trapped inside a cave. The story goes as follows: A group of prisoners are chained inside a rock cave, seated in a way that they can only see the rear wall. A fire is burning close to the entrance of the cave. The prisoners are not allowed to turn their heads back to see the entrance of the cave or the fire that is burning behind them. They are only able to see shadows of cut-figures placed in front of the fire. Since the prisoners are allowed neither to turn back and face the fire or the light entering from the mouth of the cave, nor to leave the cave to discover the actual sources of the shadows forming on the cave wall, they take the ghostly shadows as reality. Plato uses this analogy to support his view that knowledge and experiences attained through sensory facilities are often

misleading and always far from complete. The seemingly direct knowledge attained by sense organs can only be a weak source of indirect illumination compared to the metaphysical knowledge of the world which can only be attained through divine insight.

A re-reading of the cave analogy as a spatial model can reveal how classical philosophy formulates the perceptual experience of the world. The cave metaphor demonstrates the detachment of human perception and thought from absolute reality. According to this model, a presupposed gap exists between the mind and the world, which are represented by what is “inside” versus what is “outside” of the cave. Essentially, this view describes the mind of the perceiving subject and the external world as entities of their own. Furthermore, one should also note that the perceiving mind is not physically situated within the world of matter but trapped within the metaphorical cave, which serves as the representation of the human mind. The cave only overlooks the world from a distance, from its location at the skirts of a mountain. The human relation to the outside world is limited to the act of looking at its reflected images. Most importantly, this act of looking at the world is not looking *from within* but rather looking while standing *at a distance*. Evidently, this situation of *being at a distance* plays characteristic importance in the understanding of the concept of place in early philosophy. In accordance with this dualistic ontology, it can be argued that place is envisioned to be both independent from and external to its human experience.

It is important to keep in mind that place and space as geometric or physical concepts do not directly appear in Plato’s philosophy. The Greek words *topos* and *chora* are the ones that most closely correspond to the words “place” and “space.” Edward Casey, a

philosopher specializing on the history of place, points to *chora* as the origins of a place-related concept in classical philosophy in Plato's philosophy (Casey 1997, p.37). *Chora* is a form of non-specific place. It is a "somewhere" for things to exist; in that sense it is spatial. However this enveloping spatiality must not be confused with the concept of the void or empty space; for even for the void to exist, it must be placed within the "web of choral spatiality" (Casey 1997, p.41).

Topos is another word related to place that emerges in Plato's philosophical discourse. The word is used in the Greek language to refer to a place or location within a wider extent. In its usage within the words topology, or topography, the term topos denotes a defined area or a region within an extension of surface geometry or landscape. *Topos* has a derivative relationship to *chora*. To simply explain, *topoi* (plural of *topos*) are particular places within the materially occupied *chorai* (plural of *chora*) (Casey 1997).

Because subjective perception of place is not mentioned by Plato, one can only think about the ontological connotations of this "placement of places" within the extent of choral space. However, it is important to note that this placement is meant to be symbolic and metaphysical, having nothing to do with physical or geometrical dimensions or an encompassing volume. One's "being located" within another in this sense does not imply spatial containment or physical presence but only some form of metaphysical hierarchy and interdependence. It is only after Aristotle space and place as physical, geometric entities became matters of philosophical concern.

2.1.2. Aristotle's Physics: Place as Geometry

It is Aristotle who first introduces space and place as tangible and physical concepts in his philosophy. In Aristotle's terms, *space* is an empty container with a geometrically definable extent, and *place* (*topos*) is the space that is physically occupied by a body in space (Aristotle, *Physics, Book IV, Parts 1-5*). Aristotle's *Physics* provides a quantitatively based description of what place is: It is a discrete volume with a geometric form and a unique location, marked by the material displacement a physical body caused by its presence in space.

Even though Aristotle's conceptualization of place is much less metaphysical compared to Plato's, it still does not take human perception and experience of place into account. Architectural theorist Christian Norberg-Schulz (2000) states that Aristotle chose to dwell on the sensible and spontaneous qualities of the world noticeably more than Plato has done. Norberg-Schulz argues that compared to the skeptical approach that Plato takes towards the senses which caused a split in the classical understanding of the world–the rational, quantitative vs. the sensory, qualitative–Aristotle managed not to overlook the qualitative dimensions of the surrounding world by pointing towards the immanent properties belonging to certain physical entities: "A stone falls to the ground; a flame climbs to the sky" (Norberg-Schulz 2000, p.63). While Aristotle's discourse may be sensitive to the sensory properties of material objects when compared to Plato's views, without question, much of his theoretical discussions on the nature of space and place in *Physics* rest heavily on the materialistic side. In the context of his philosophy, Aristotle refers to place almost exclusively in physical terms. The disconnection of the

concept of place from its lived experience, which had been already implicit in Plato's metaphysics, gets further reinforced in Aristotle's philosophy. This lays the foundations towards the modern objectification of spatial presence.

2.1.3. Descartes and the Secondary Nature of the Senses

The next major "revolution" in terms of our understanding of space and place arrives in the early seventeenth century with the French philosopher Rene Descartes. Descartes, who is considered to be the father of modern philosophy, made his major contribution towards the philosophical and scientific understanding of space by formally introducing the three dimensional coordinate system. In Descartes' analytic geometry, space is uniformly divided in all directions. The three-dimensional coordinate layout was named after Descartes as the Cartesian coordinate system. It allows for the numeric representation of space as numbers corresponding to all three axes, formerly known only as referential directions: front-back, left-right and up-down. This method, although seemingly straightforward, has been revolutionary in the mathematical conception of space. The three-axis coordinate system makes it possible to utilize ordinary arithmetic and algebraic operations in the manipulation of spatial geometry. Today, Cartesian geometry is at the core of all branches of modern science and practice that deal with space, from mapmaking and architectural representation to computational geometry and virtualization.

The philosophy of space that pertains to the Cartesian system completely undermines subjective ideations of space. In theory, space is equally definable in all directions and

distances; therefore, it is infinitely reachable and accessible. Along with the coordinate axes, scientific and mathematical rationality extends in all directions, permeating space with reason. Hence, Cartesian philosophy systematically pushes aside any consideration of subjectivity in dealing with space.

First, the bodily relative notions of location and distance, as one would refer to left, right, front, back, near or far, depending on one's position, become unessential and even meaningless in comparison to the objective and absolute locations easily and precisely defined in the three-coordinate system. Casey notes:

> The Cartesian spatialization of the dimensions is a characteristically modern reduction of the importance of the 'parts and kinds of place,' a reduction that is carried still further when height, breadth and depth are compressed into the X, Y and Z axes of Descartes's analytical geometry. (Casey 1993, p.75)

Second, sensory experience, as a way of tackling the outside world is dismissed as irrational, and qualitative aspects of material objects are labeled as elusive. Descartes is known to openly dismiss the significance of the sensory qualities of objects. He illustrates this point with the example of a hard piece of wax heated on fire: "For whatever came under the senses of taste, smell, sight, touch or hearing has now changed; and yet the wax remains." (Descartes 1998 [1641], p.67) Properties like hardness, weight, color and others that are perceived by the senses do not tell us the material reality of any object. An object's true nature therefore lies only in its breadth, length and depth (Descartes, *Principles of Philosophy*, Part II, Rule 5). Reminiscent of Plato, Descartes believes that the senses can be elusive, redundant and even irrelevant in attaining scientific knowledge.

Finally, within the Cartesian frame of thought body and mind are seen as separate, incommensurable entities. Human body is part of *rex extensa*, the spatial extension, whereas the thinking mind, *rex cogito,* is non-spatial, or metaphysical. As a result facilities of the mind get to be separated from and valued above the flesh of the human body. It is presumed that the perceiving subject is prone to error unless the information obtained through the senses is constantly scrutinized, analyzed and verified by the rational mind, through the enacting of a scientific thought process, reason.

2.1.4. The Critique of Descartes: Phenomenological Approaches to Place

The assumptions of Cartesian philosophy, especially Descartes' strong standpoint on the ontological distinction between the body and the mind, and the positivist approach associated with this division form the basis of the so-called "hard" sciences of today. This division provides the objective and disembodied perspective necessary for the scientific understanding of the outside world. This mode of understanding of the world, although quite useful in explaining physical phenomena, is however utterly unfruitful in responding to the question of being as a *human* understanding of place and presence in the world. Cartesian tradition, along with its inherent dualisms: of mind and body, human and nature, subject and object, stimulus and reaction and so on, does not provide a framework that is capable of adequately explaining the essence of place and experience.

This problem, the systematic undermining of the sensory experience in the Cartesian philosophy, provoked a wave of criticism within late 19th and early 20th century

philosophical thought, manifested in the works of Edmund Husserl, Maurice Marleau Ponty and Martin Heidegger. The reactionary form of philosophical methodology developed by this group of thinkers is called "phenomenology." Phenomenology means the systematic study of phenomena, i.e. experiences. It is the branch of philosophy that studies the perception of the world as lived experience from a first-person standpoint.[1] Phenomenology, by the nature of its formal definition, investigates the importance of sensory processes in our worldly experiences from an embodied perspective, and highlights the incompetency of positive science in explaining such phenomena because of its objectivistic detachment from the experiencing subject.

It is important to note that the criticism that arose with the thinkers of the new discipline of phenomenology does not aim to completely refute scientific knowledge, rationality or the methodologies associated with it. According to cultural ecologist and philosopher David Abram, phenomenology's criticism is centered on the dismissed role of the human body and of the senses in scientific approach (Abram 1997, p.43). In phenomenology, place regains importance as the locus of this newly formulated thought of human existence. It is no longer the volume occupied by an object, or space that is physically defined by boundaries. From the phenomenological view, it would only make sense to view place as a subjective phenomenon: Place as experienced by a particular, embodied subject.

[1] David Woodruff Smith, "'Phenomenology' (Stanford Encyclopedia of Philosophy, Fall 2007 Edition)," Stanford University, Center for the Study of Language and Information http://plato.stanford.edu/archives/fall2007/entries/phenomenology/.

There is a close bond between perception and place in phenomenology. Phenomenology states that the perceiving subject should be seen as that of an active agent situated in the world, rather than a passive observer that stands at a distance from it. According to Merleau Ponty, every perceiving subject possesses a "body schema" (Merleau-Ponty 2002 [1945], p.113). This schema is essentially spatial, as the body itself is, and it is armed with the facilities of perception, intentionality and motor abilities. Through the body schema the subject is not only able to perceive the world in a meaningful relevance to its own being, but also to participate in the construction of its own perception via intentional probing, or "enaction" (Noe 2004). Indeed according to the phenomenological view, it is argued that perception is impossible without embodied intentionality.

The body schema also serves as the most important point of reference in describing one's relationship to place. In reference to phenomenologist Edmund Husserl, David Abram (1997) points out that the experiential framework almost automatically overrides any previous scientific knowledge, especially during times when the two are in conflict with each other. Abram provides the following example: Galileo has scientifically proved that we are living on a spheroidal planet that revolves around the sun and around its own axis. At its time, Galileo's discovery resulted in what Thomas Kuhn describes as a paradigm shift in the world of science, which previously operated around the assumption that all celestial objects revolved around the earth (Kuhn 1962). However better and more accurate Galileo's solar-centered system of reference may be, the knowledge of it does not change casual reference systems. We still say "the sun rises" or "the sun sets." Scientifically speaking the Sun does not move up or down; yet speaking

from a human perspective, it appears to be doing just that. Scientific knowledge gets forgotten or plainly ignored under the power of the human experience of the sun as seen from the earth. This shows that when it comes to describing a lived experience, the reference system is never taken as an absolute spatial grid. The spatial framework that is most convenient and sensible to utilize when referring to human experience of place is the *egocentric* one of the body schema. In this framework one is able to describe a place, as it revolves around one's subjective experiences pertaining to her bodily orientation and location within it.

A phenomenological view of place would therefore define it as a spatial construction that both makes possible and is made possible through our bodily interaction with space. Through this coupling of the body schema and the exterior environment a sense of place emerges. Furthermore, the characteristics, capabilities and limitations of this coupling directly specify the nature of subjective place that a body experiences. It has also been pointed out that the nature of the sensory awareness afforded by the body schema influences the characteristics of the sense of place. Hypothetically speaking, different animals with different sets of perceptual systems and bodily-motor abilities would experience the same space in uniquely different ways from each other. "The more complex and sophisticated the creature's sensory awareness and cognitive and motor capacities, the more complex and sophisticated will be the subjective space which it inhabits" (Malpas 1999, p.52).

2.2. Sense of Place in Environmental Design and Social Sciences

In daily language, the word sense in “sense of place” may convey multiple meanings. First, it can refer to the sensation of a place through perception. Second, it may refer to the particular feeling or character of a place. Finally, the word sense as in “to make sense” can imply logical order. All of these explanations are equally valid. In this section, four theories of sense of place from perspectives of architectural theory and social sciences will be discussed. The analysis of these theories will serve as a transition to the next chapter where sense of place will be explored in association with modalities of perception.

The emergence of place as a topic of inquiry within architectural theory relates to the above-mentioned turn towards the acknowledgement of the significance of the human body, its senses and subjectivity of the lived experience, and the subsequent criticism of the established objectivistic paradigm of the natural sciences. Key philosophical influences to this turn have been the works of Husserl, Heidegger and Merleau-Ponty; with the birth of phenomenology as a critique of Cartesian philosophy and the dualisms associated with it: those of subject versus object, body versus mind. The reformulation of the body as an intentional being made of flesh and emotions rather than merely a physical entity that is located in space resulted in a shift of attention from space to place (Crary 1990; Casey 1997). This shift seems to have found a greater interest after the Post-modernist movement within the social sciences, geography and architecture among theorists like Lynch, Canter, Relph, Tuan, Lefebvre, Norberg-Schulz, and many others who criticized the Modernist approaches to space in the fields of planning and

architecture. These theorists instead contemplated the human experience of space and the ways in which this experience relate to the construction of a sense of place.

Even though all architectural studies concentrating on the topic of place emerged after the phenomenological turn and are associated with the rise of Postmodernism, the various explanations of place that are presented by architectural theorists have diverse takes on what sense of place is, and express intrinsic ways of assessing the particular role of perception in its construction. In what follows, four key theories of place that emerged within architecture and social sciences will be presented. These are sense of place as the spirit of the environment, sense of place as the cognitive image of the environment, sense of place as human experience, and sense of place as a socio-cultural process. These four approaches represent significant points in the evolution of the concept of place from an environmentally-based and static point of view to a socially centric and dynamic one.

2.2.1. Sense of Place as the Spirit of the Environment (*Genius-Loci*)

One of ways sense of place can be described is an attribute associated with the environment. The Romans believed that places had inherent spiritual characteristics that endowed them with a special feel and personality. These were attributed to physical, topological, architectural as well as metaphysical qualities that belong to a specific location. This was called *genius-loci*, the “spirit of the place” (Norberg-Schulz, 2000). Arguably, the concept genius-loci can be seen as an extension of the classical philosophy of place. This parallelism comes from the fact that both the Roman concept genius loci

and Greek spatial constructs topos and chora are all naturalistic, metaphysical and pre-anthropological. Genius-loci attributes a metaphysical meaning to physical locations in space. In the Roman interpretation these locations are defined by geography or architecture unlike the abstract notions of space that earlier philosophers meditated on. However, one can still see the mysticism of a metaphysical nature embedded in place.

Genius-loci, or the spirit of the place, in their modern use, refer to the totality of the qualities inherent to a place. Yet not all spaces engender this spirit of place. Only spaces with a discernable character qualify as places or can generate a sense of place. In some interpretations the spirit of the place is taken as an environmental constant. It is believed to persist in spite of profound changes in the basic components of its physical identity (Relph 1976, p.48).

2.2.2. Sense of Place as the Cognitive Image of the Environment

Another common theme that is used frequently in the literature of places is the definition of sense of place as one's cognitive understanding of space. This view partly differentiates itself from the environmentally deterministic explanations, as it involves a human-centric, subjective dimension. In accordance with the psychological studies of his time on the subjects of memory and recall, social scientist Kenneth Boulding hypothesizes that human beings maintain a coherent and organized record of the environment in their minds (Boulding 1956). It is as if the environment leaves an imprint in the mind as one interacts with the world. This imprint develops as one spends time within an environment and gathers experience. The resulting mental representation of

the environment resembles a map or a photograph that builds up and gets updated as one learns more about his or her surroundings. Boulding referred to this concept as the "image". The image is an *iconic* (one-to-one, picture-like) representation of the outside world, formed by one's entire body of knowledge pertaining to it.

It can be said that the image theory is an extension of the Cartesian dualism in its clear separation between the external world and the cognitive facility. The image is photographic, in the sense that it is analogous to the retinal projection that occurs in the human eye. This view has been contested with the rise of Environmental Psychology through arguments towards the contextual and mobile nature of perception (Gibson 1979) and fully disputed later in the century through the philosophical arguments against Cartesian materialism supported by the findings of cognitive and biological scientists that a neurological correlate for such an image does not exist (Dennett and Kinsbourne 1992; Varela et al. 1991). It has been argued in this literature that the existence of an iconic representation within the human mind would create a "homunculus" (little man) paradox, since that iconic representation would need to be re-perceived and reinterpreted by another cognitive mind within the mind which would then have to have a similar inner mechanism and so on.

The sensorimotor theory of perception is developed in opposition to the image-based theories. This view claims that self-conscious organisms do not maintain complete images of the environment but rather very incomplete semantic representations supported by a wide set of sensorimotor skills (Noe 2002; 2004). Nevertheless, for a significant period of time the theory of the image became influential for the emergence

of place-image theories within the fields of City Planning, Architecture and Environmental Psychology.

The most prominent example of the use of Boulding's theory of the Image in relation to place is Kevin Lynch's seminal study, *The Image of the City* (1960). Lynch defines the identity of a place as its individuality or distinction from other places, which serves as the source of its recognition. Successful physical environments are "imageable"; in other words, they have the power to evoke a strong image in the observer. Lynch states that this image is, however, not necessarily a photographic or visual one. It is generated by the totality of inputs from all the senses and filtered through the subjective perceptions of the individuals. Lynch found out that people often describe their experience of a city space through their encounters of five descriptive elements. These are "paths", "edges", "nodes", "districts" and "landmarks" (Lynch 1960, p.47). This categorization scheme serves as the organizational framework for cognitive images of cities.

The influence of Boulding's "image" reappears in other theories dealing with sense of place. Architectural psychologist David Canter argues that people act "*as if* there are maps in their head" (Canter 1977, p.78, original emphasis) Social geographer Yi Fu Tuan believes that cartographic skill is something learned, and it can be essential in certain cultures' understanding of their environments (Tuan 1977). Another social geographer, Edward Relph uses the term *image* in a meaning closer to identity of a place when he notes that "the image of a place consists of all the elements associated with the experiences of individuals or groups and their intentions toward that place" (Relph 1976, p.56). To summarize, sense of place as used by architectural and social theorists to date

can be described as the cognitive image of a place, whether as a photographic picture which exist in people's minds, or as a overall sensory impression of a location.

2.2.3. Sense of Place as the Human Experience of Space

While sense of place can be formulated as an attribute of the environment itself, or as its cognitive image, it can also be defined to include individual, cultural and social processes in its formation. A place takes on the qualities of its occupants, and may reflect these qualities in its character. In Casey's words, "place is not one kind of thing: it can be psychical as well as physical, and doubtless also cultural and historical and social" (Casey 1996). This view represents one of the most commonly supported approaches within environmental psychology, architecture and social sciences. Compared to image-based theories, this view allows for a less rigid but more subjective and socially comprehensive look at place, formulating it as a dynamic web of interactions rather than a static picture.

Tuan defines sense of place as a personal, psychological and emotional attachment to a setting. This attachment is called "topophilia" (Tuan 1974). Topophilia is the affinity towards a place, sometimes also referred to as "place attachment." Such ties between the habitants of a place and the landscape can include multiple forms; including aesthetic, perceptual or emotional. Relph describes the sense of place as the antithesis of his concept "placelessness". Placelessness is the condition created by the badly planned environments for they fail to invoke a warm, human response.

In practice, badly planned places do not necessarily qualify as being “placeless,” in other words lacking place qualities; and rigorous and detailed planning of an environment does not always result in a fulfilling sense of place. This is because architecture alone does not constitute place. Architectural theorist David Canter explains that places are combinations of *physical attributes* of a location or setting, personal *conceptions* of the people who inhabit it, and the *activities* that they take part in (Canter 1977). This model regards natural or manmade space as only one of the many elements of place, which is only equally important as the cultural, psychological, and social components that together make up the sense place. In this view, sense of place is created by the interplay of the physical environment with people’s actions and interpretations. A successful place is one that these three elements–people, environment and actions–are in a harmonious co-existence, supporting and enhancing each other.

The environmentally centered explanation of sense of place can also be interpreted from a phenomenological perspective. According to Norberg-Schulz, although sense of place is in part an inherent property of the environment, people experience this sense through physical contact with the environment, by inhabiting it. This type of spiritual and mystical presence of place is linked to Heidegger’s concept of *Da-sein*, which can be translated as “being-in-the-world” or presence (Heidegger 1996 [1953], p.58). From this standpoint, sense of place describes the strong and meaningful quality of presence that humans are able to feel through an intimate experience of a space.

But how is the feeling of place generated? Norberg-Schulz argues that all our knowledge about the spaces that we live in is experiential. It is the world of nature that enables this

human experience, which is “the world of life.” According to his view, sense of place is not an instrumentally achievable piece of knowledge since we can only access it through our bodily presence. It is neither the result of empirical inquiry, since the experiential exists a-priori to our cognitive experience. Thus, sense of place includes but “cannot be reduced to the level of motor behavior, [or] sensory impressions, emotional experience, or logical comprehension” (Norberg-Schulz 2000, p.42). Sense of place is then a human experience shaped by the “spiritual” qualities of a physical space provided by its nature as the center of the essence of *being*, and supported by architecture and human activities as the manifestation of *dwelling*. Together, these two constitute the emergence of “meaningful” presence in place. Place acquires its spirit by being the site that engenders this presence, thus differs from space which is uniform and nondescript without human presence.

Another issue to consider is the necessity of mobility and intentionality for the experience of the sense of place. According to the phenomenological approach to human perception, movement is considered necessary for sensory experience to occur. Perception results from a dynamic interaction that happens between the intentional body with the outside environment (Merleau-Ponty, 2002 [1945]). This theory is in line with Norberg-Schulz’s description of the temporal unfolding of the place experience. Sense of a place is perceived not as a snapshot but through a series of successive “moments” that are offered by the place, but “activated” in time, as a result of our movement through space (Norberg-Schulz, 2000, p35). Place also provides a sequence for organized movement. The environment then becomes an ordered repository of experiences; providing stability to our perception through “memory”, “orientation” and

"identification", all of which are central to the sense of place. Similarly, Relph notes "the essence of place lies in the largely unselfconscious intentionality that defines places as profound centers of human experience" (Relph, 1976, p43). Considered within a phenomenological perspective, sense of place is a feature that guides our intentionality and orders our experience in the world.

2.2.4. Sense of Place as a Socio-Cultural Process

Parallel to the understanding of sense of place as a human experience is the view to place from Marxist cultural sociology and geography. One of the prominent theorists of this standpoint, Henri Lefebvre defines place primarily as a social process.

Space as Perceived	Space of the senses; first level of bodily interaction with the world.
Space as Conceived	Space of constructed representations, belief systems, institutions represented in *maps, charts, drawings.* Static, atemporal, top-down.
Space as Lived	The world of everyday socio-cultural activities and processes, shaped by events, daily rituals, temporal experience of space. Dynamic, temporal, bottom-up.

Figure 2.1. Lefebvre's tripartite scheme of place

Lefebvre describes place as both a precondition and a result of social processes of production and consumption. According to his schema there are three overlapping layers of spatiality. These layers are identified as: "space as perceived," "space as conceived" and "space as lived" (Lefebvre, 1991 [1974], p38) (Figure 2.1). The perceived space is

that of the senses, describing the first level of bodily interaction with the world. The conceived world is the world of representations, belief systems, institutions and organizations, which assert hierarchy and order onto space. The lived space is the world of everyday activities and processes. Thus human experience of place is a trifold process. It is one that simultaneously exists in all of these three layers of spatiality.

In Lefebvre's tripartite framework, space as a static, abstract, mathematical entity is rejected in favor of place, socially and culturally determined construct. Place both produces and gets produced by socio-cultural processes in a continuous cycle. Perception and phenomenology are thought to be primordial components of a situated human experience, however they are also influenced by the dominant ideological mode of representation (conception) of space. For Lefebvre, sense of place lies in the essence of the everyday activities, not in the pure phenomenology of the senses, regardless of whether they are attributed to the human body or the landscape.

2.3. From Sense of Place to Sensation of Place

This chapter introduced the philosophical origins of the concept of place, and covered four approaches to sense of place from the perspective of architecture and social sciences. First, place was described as the intrinsic "spirit" of an environment that makes it unique from other places. Second, place was discussed from a human-perceptual standpoint, as the cognitive image of the environment. Third, the views that explore sense of place as an individual or social experience were presented. Finally, the view of place from cultural geography, as a socio-cultural and dynamic process was discussed.

The approaches to place covered in the previous section all explain that sense of place is a complex construct with multiple human and physical dimensions. This construct is operational at the levels of engagement with space in both personal and social scales. Sense of place involves the bodily and emotional ties between the environment and person inhabiting it. In addition to the personal dimensions of sense of place there are inter-personal aspects to the concept. Sense of place is a shared concept that is socially distributed and culturally specified. It is the characteristics of this shared affinity to space by the group of people inhabiting it, and the geographical, temporal specificities of such that make this network of connections substantially different from any other.

The word of sense in sense of place therefore does not correspond directly to the literal meaning of the word sense, as in sensory perception. Places are not exclusively made of perceptual interaction nevertheless their experience is necessarily transmitted through these channels of mediation. Moreover, this distinction between sense from the perceptual standpoint and sense of place in human experience of the environment starts to diminish if senses are regarded not as neutral pathways for information transfer, but as phenomenological, cultural and social constructs in themselves as well. This form of holistic approach relocates sensory perception within the subjectivity of the body, intersubjectivity of the social sphere, and the context of the environment. This enables one to rethink place as the indispensible site for sensory perception, and in return, embodied perception as the indispensible medium for sense of place. While they are not the site in which sense of place is to be found, senses are the mediating grounds through

which sense of place gets established. Following this line of thought, the next chapter investigates the comparative roles of different senses in place perception.

3

The Visual Bias in Place Perception

All facilities of perception contribute towards one's environmental sense and awareness. The environment makes sense as a whole and presents itself to us as such; as sensory modalities in correlation to each other. In place, an ecologically valid or "realistic" setting, different sensory inputs are in tune with each other in terms of informational content. These sensory modalities connect us to a singular reality through disparate yet parallel channels of information. For instance, the acts of looking at a burning fire, listening to the crackling noises that it makes, or reaching close to feel the heat, all inform us about the same phenomenon that is in front of us. The sensations of shape and color of fire is not the same with the sensations of sound, or heat that the fire produces. However, the bits of information about the fire conveyed through different senses are ecological equivalents to each other, in the sense that what they inform the perceiver about is the same object or event. While there is a degree of semantic redundancy between sensory modalities, this does not mean that senses can form complete substitutes to one another.

Although senses seem to operate within their independent perceptual domains scientific evidence shows that they sometimes interact with each other. Synaesthesia, an interesting psychological phenomenon, is the involuntary and automatic translation of stimuli coming from one sense as experience in another sense. A synaesthete, a person with synaesthetic ability, may perceive the color blue every time he/she hears a certain pitch; or smell a certain odor in association with a certain shape. The illusory experiences of color, sight or smell are triggered completely out of will and are described by synaesthetes as vivid real-life sensations. Cases of synaesthesia indicate the existence of a neurological interdependency between sensory systems.[2]

3.1. Sources of the Visual Bias

Even though it is widely accepted within geography, architectural theory, and ecological psychology that place experience is multisensory, there is still a considerable bias towards a visually centered approach in all of these disciplines. This is related to the widespread acceptance of vision as the primary sense. The roots of the predisposition can be traced back to physiological, cultural or philosophical sources. Vision is often assumed to be superior to the rest of the senses because seeing is thought to be the physiologically the most developed, culturally the most dominant, and philosophically

[2] Real synaesthesia is a rare situation which is found only in a very small percentage of the general population. Yet some amount of "synaesthetic ability" exists in all human beings (Blakemore and Jennett, 2001). Place theorists have shown considerable interest in the multi-sensory nature of place experience. Yi Fu Tuan states that place experience invites synaesthetic interaction involving all the senses. (Tuan, 1978) Inter-sensory associations are ecologically acquired through experience and appear to happen without premeditation. For instance, most people associate round shapes with lower pitches and sharp edged shapes with higher pitches. Sights of certain foods may induce or enhance their smells. There are also metaphorical connections between sensory adjectives which hint towards the cross-influence of senses, like "warm colors", "soft melodies," "sharp vibrations" and so on.

the most objective among the senses. The following sections aim to briefly summarize and respond to all three of these arguments.

3.1.1. The Hierarchy of the Senses

There are two-million nerve fibers connected to the eye, a number exponentially larger compared to twenty-thousand for hearing, four-thousand for smell and taste together (Flindt 2006). The amount of information that reaches the visual cortex is far greater than any other sensory input that is processed by the brain. Evolution has increased humankind's reliance on visual perception more than all the other senses. In *A Natural History of the Senses* Diane Ackerman speculates that the upright-frontal nature of human body may have placed vision in a privileged situation and made it strategically vital for hunting and survival. While certain animals' senses of smell and hearing may have evolved to become superiorly sensitive compared to ours, vision has become the most "densely informative" sense for humans (Ackerman 1990).

In ecological psychology the predominance of vision over other senses is sometimes explained by the hierarchical classification of the senses based on their intimacy versus their range. Vision is considered to be the most spatial therefore the most powerful sense. Hearing, touch, smell and taste are believed to be more intimate and less spatial with shorter ranges compared to vision (Figure 3.1).

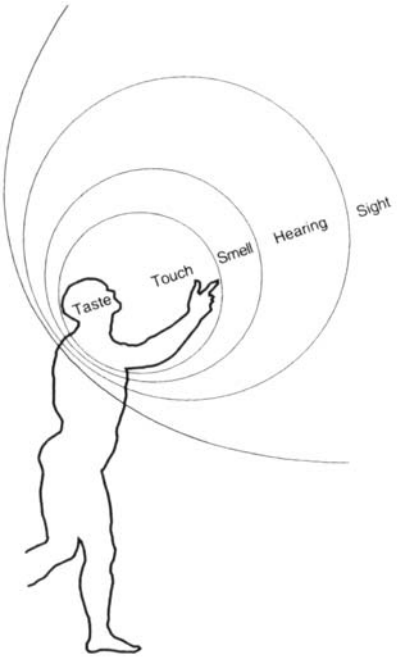


Figure 3.1: Senses and their ranges (Rodaway, 1994)

There are many examples in architectural and geographical literature that support the hierarchy of the senses. For instance Yi Fu Tuan identifies senses of vision and touch as primary spatial senses for the perception of the environment (Tuan 1977, pp14-18). Tuan supports the view that human beings can perceive spatiality, distance and geometry only through seeing and touching. He explains that other senses are deemed to be secondary since they are "non-distancing" in character. They are only present to expand and enrich the "spatializing" abilities of these two primary senses. Sounds may help us orient ourselves in space, or tell us where to look, yet only vision can provide genuinely spatial information (Tuan 1977, p16). Phenomenological and multi-sensory richness of place experience often gets stressed elsewhere within Tuan's discourse on place; yet in the meanwhile he seems to be inadvertently reapproving the hierarchy between the senses as he submits to the belief in the primacy of visual perception in place experience.

While senses can be scientifically classified and rated in terms of their objective abilities and strengths, such as acuity, dynamism, range and so on, it is not too meaningful to directly project this classification for discussions pertaining to the experience of place. In ecological settings, designed or natural, physical or virtual environments senses often operate in permutations disrupting any objectively defined hierarchy. For instance certain places may be characterized by their noises or smells more than their colors of geometry. In critical survival situations, life-saving information can reach us faster or solely through non-visual channels than through visual means.

It is true that visual field extends to a greater distance than the field of awareness associated with other senses. However this argument assumes an unobstructed line of sight, which rarely exists in actual ecological settings. In practice, visual range is limited by the viewing direction, covering less than a half of the space that lies around (Flindt 2006). Visual acuity can extend to great distances yet the line of sight can easily be obstructed by objects in the environment. In comparison, within ecological settings, auditory and olfactory fields of awareness can extend farther and wider than the range and angle of view enabled by sight. Besides, senses can be employed in spatial configurations in ways that are quite opposite to what is assumed in this ordering based on spatiality and range. For example, we can imagine listening to the radio while reading a book, at the same time feeling the breeze coming in from an open window, carrying the smell of trees that are at the garden across the street. Here, the ordering based on range and spatiality of the experience becomes reversed, smell and touch becoming the senses that inform us of the farthest distance, while vision and hearing are utilized as the nearest and intimate senses.

There is no meaningful way one can compare a color with a tone, or a flavor on the same grounds. Comparing any two senses with each other is similar to comparing apples with oranges. A hierarchical ordering of the senses according to the amount of information processed by the brain, their speed, acuity or range fails to take into account the unique qualitative characters of sensory stimuli. In summary, it would not be wrong to state that while different senses may be phenomenologically unique from each other, each sensory modality is equivalently powerful within its perceptual dimension.

3.1.2. Sensory Biases within Culture and Communication

Perception does not only rely on the physiological functionality of the sense organs, body and the mind. It is also geographically and culturally constructed (Rodaway 1994). Taking into account that senses are ordered, utilized and valued in varying ways from culture to culture, it can be argued that the so called visual bias is not only physiologically or ecologically determined but also culturally constructed. As a matter of fact, the visual bias is often exclusively associated with Western culture.

Theoreticians of media and linguistics support the view that pre-literal cultures relied predominantly on spoken language for their daily activities and communication thus had a heightened sonic awareness and sensitivity (McLuhan 1962). Therefore their understanding of place was more *aural* and *oral* compared to that of the industrialized world (Ong 1982).[3] Support for this theory comes from anthropological research based on pre-literal societies, exemplified by Steven Feld's study of the Kaluli tribesmen in

[3] *Aural:* pertaining to the sense and the organ of hearing. *Oral:* related to verbal communication as in speech or singing.

Bosavi, Papua New Guinea (Feld 1996). Kaluli people use songs and poetic exchange as part of their daily routine and communications in order to record and represent their encounters with nature. Similarly, indigenous Australian tribes have special songs called "songlines" that identify landmarks and other geographical features that exist on geographical tracks. These songs have been used for recordkeeping, storytelling and also as navigational aids for travelling.

According to McLuhan (1962), Western culture took a turn towards ocularcentricism with the invention of the print press. Widespread availability of printing caused proliferation of textual and visual media and this eventually developed a mass culture reliant on textual and image based communication. However the invention of electronic mass communication technologies such as radio and television reversed the effects of print press. In the age of electronic telecommunications we are again living in a world that is in "simultaneous resonation," much resembling the auditory landscape of the pre-modern cultures (McLuhan 1962). One can argue that, following TV and radio, the development of global networks of digital communication further increased the real-time interconnectedness of global cultures and helped create a digitally mediated multisensory network of places. Digital communication and interaction do not have an identifiable bias towards one sensory modality or another, since images, sound, text and video, along with all kinds of information are ultimately transcoded into the same type of binary abstraction.

3.1.3. Vision and Objectivity

The common saying goes: “seeing is believing.” Vision has long been considered as the most objective of all the senses. Light has been regarded as the metaphor of truth since the ancient times as illustrated by the Platonic allegory of the cave discussed in the previous chapter. Especially after single-point perspectival rendering was mastered in Renaissance imagery and later instrumentalized in the modern period, during which cameras and other optical devices like the microscope and telescope began to be used widely in scientific research and documentation, vision acquired its strong association with objectivity and positivism. Jonathan Crary, a historian of art and representation specializing in modernity, argues that the development of technological instruments of vision gave birth to the idea of the “disembodied” and “mechanical” seeing and therefore philosophically disassociated it from the artifacts of bodily subjectivity (Crary 1990). Thanks to modern techniques of print, photography and typography visual images and text were easy to reproduce faithfully. As they can be reproduced through mechanical means, visual representations acquired the connotation with truthfulness and objectivity. Sound much later achieved a similar connotation with objectivity after the proliferation of sound recording and reproduction techniques around the late 19th Century (Sterne 2003).

Western thought at least partially managed to emancipate itself from visual objectivism thanks to the reformulation of vision as subjective experience illustrated with the rise of the Impressionist movement in art and phenomenological thought in philosophy (Crary 1999). Even so, the inherent “occularcentricism” associated with the objectivist

framework that these movements contested, stayed embedded in the visually centered thought process and language of contemporary culture.

3.2. Senses as Conduits of Perception and Presence in Place Experience

Sensory modalities function as frameworks of interaction between human beings and the environment. They also form the channels of communication through which human beings interact with each other. Each sensory modality simultaneously operates in active or passive dimensions. Senses are passively engaged in the case of unattended perception, in which sensations are in their raw form and devoid of meaning. Any object that falls in front of our eyes gets "seen" by our eyes, in the mechanical sense of the word. However we have a sense of visual awareness of an object only if we are actively paying attention to the act of seeing. This is true for all of the senses. Without attention and cognitive interpretation any sensory input is meaningless. This interpretation is dependent upon cognitive ability, bodily intentionality and memory.

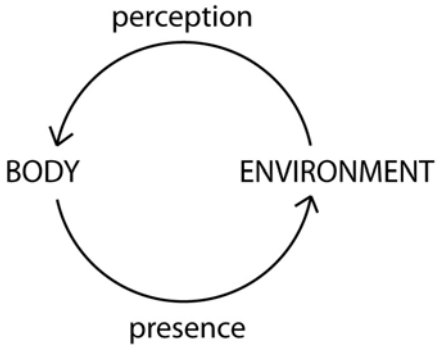


Figure 3.2: Body, environment (physical+social), perception and presence

Place perception is intersubjective. One perceives place in a similar fashion to others perceiving the same place. And as one perceives place, he or she is also perceived in place. The site of sensory perception is the human body; therefore, in order to be able to perceive one must first be present in the environment.[4] Perception and presence operate in opposite directions to each other, making place experience a complete circle between the body and the social and physical environment (Figure 3.2). Senses operate in each direction as conduits between the two.

Phenomenologist David Abram also points towards this dual-nature of sensory perception and presence:

> We can experience things–can touch, hear and taste things–only because, as bodies, we are ourselves included in the sensible field, and have our own textures, sounds, and tastes. We can perceive things at all only because we ourselves are entirely a part of the sensible worlds that we perceive. (Abram 1996, p.68)

Similar to perception, presence can take both active and passive forms. Proof to the multi-faceted nature of senses is visible in the nuanced usages of sense-related verbs in daily language: “hearing” (passive-perception) is different from “listening” (active-perception), “observing” (active-perception) is not the same as “appearing” (passive-presence) and so on. A complete list of verbs that correspond to the sensory matrices of vision and hearing is provided in Figure 3.3.

[4] This two-sidedness does not fully apply to place experience conveyed by media such as books, films or surveillance video where the presence of the perceiver is not overtly manifest. While the sense of place, how it looks or feels, may be conveyed through such media, it is arguable whether the “experience” of place can be fully generated. Films and books can compensate for the lack of audience presence through narrative techniques, character or camera identification, in which the perceiver delegates his/her agency to a character or narrator in the story, or becomes the imaginary person at the viewpoint of the camera.

HEARING	Sensation (passive)	Meaning (active)
Perception	*to hear*	*to listen*
Presence	*to be heard*	*to sound, voice*

SEEING	Sensation (passive)	Meaning (active)
Perception	*to see*	*to watch, to look*
Presence	*to appear*	*to look like*

Figure 3.3: Sensory matrices for hearing and vision (Rodaway 1994)

Sensory modalities also function as channels of communication between members of a social group. These channels allow individual subjects to manifest their presence to other beings and engage in social interaction. Therefore senses introduce a participatory and social dimension to space by allowing a variety of meaningful human actions.

Sensory modalities act as phenomenological and social conduits between the body and the environmental-social context. The bi-directional conduit theory of sensory interaction requires reformulation of the "sense of place" in a manner that acknowledges not only perception of the environment but also one's presence within it. On this regard Norberg-Schulz argues that perception should not be seen as a one-directional activity that brings the knowledge of the world to us. He suggests the term "perception" should actually be "replaced entirely by 'presence,' understood primarily as a corporeal identification with environmental forms" (Norberg-Schulz 2000, p.128). This mutual relation between perception and presence must be regarded as a precondition for human environmental experience.

3.3. Conclusion

Tuan notes that “an object or place achieves concrete reality when our experience of it is total, that is, through all the senses as well as the active and reflective mind” (Tuan 1977). Sense of place owes a lot to both vision and hearing along with all the other dimensions of the human sensorium. Even though vision seems to be the dominant sense of the contemporary world, this does not mean that prevailing hierarchies between the senses need to be accepted for face value. Sensory modalities are interactive mediums that enable social communication, engender sense of presence, and function as channels of perception. Each modality of perception generates a sense of place with intrinsic qualities of its own. Just like one speaks of landscapes, one can think of the extent of space defined by its non-visual qualities, such as soundscapes, smellscapes, touchspaces (Porteous 1990) The following chapter will introduce the concept of soundscape, the auditory dimension of place experience.

4

Soundscape: The Auditory Sense of Place

The previous chapter discussed the role of senses in the experience of place as theorized first by philosophers then examined the concept sense of place from four mainstream approaches within architectural and social theory. A discussion on the presupposed hierarchies within sensory modalities was carried out. It was argued that different sensory modalities provide parallel yet disparate phenomenological conduits for environmental and social interaction. While existing theories of sense of place predominantly contemplate visual aspects of place, a significant amount of research has also been carried out to investigate how senses other than vision participate in the making of environmental character and experience.

This chapter will introduce the concept of *soundscape* and the field of inquiry named "Soundscape Studies" that specifically investigates the auditory dimension of place and its experience. Techniques of documentation and qualitative criteria for analysis of existing soundscapes are presented and compared to visual methodologies used in other studies of place theory. Soundscape, "place as heard," is discussed and evaluated as a symbolic counterbalance to the landscape-ist view of place, that is, to "place as seen." The objective is to evaluate how auditory perception compares with, complements, or negates the creation of a sense of place based on other sensory cues.

4.1. Soundscape: The Auditory Sense of Place

In so far as one can speak of place as a conglomeration of shapes, forms, colors and appearances, one can think of places made of sounds, smells, tastes and textures. As argued in the preceding chapter, in ecological situations, these modalities operate in conjunction with each other in place experience. Nevertheless, it makes analytical sense to think of each of the sensory modalities as capable of generating a perceptual landscape of their own.

4.1.1. Soundscape Defined

The overall sonic environment of an area, whether it is a room or a region, is described as its "soundscape" (Schafer 1977; Porteous & Mastin 1985). Initiated by Canadian composer R. Murray Schafer (Schafer 1977) and communications theorist Barry Truax (Truax 2001), Soundscape Studies emerged during the late 1960s side by side with environmental psychology. Urban planner Michael Southworth's study of Boston's sonic environment is an early example of soundscape research (1967). Southworth, a student of Kevin Lynch, carried out his work to complement Lynch's research and theories on the visual image of the city by applying similar mapping methodologies to urban sound perception. Around the same time, Schafer and his colleagues took on the subject of sound pollution and founded the World Soundscape Project (WSP) (Caro and Daro, 2008). Their aim was to document and preserve the sounds of urban and natural environments in a reaction to the mechanization of environmental sound and increasing noise pollution. WSP and followers developed analytical methods, a terminological

lexicon and techniques to map, document, and study how different sonic environments function.

4.1.2. Elements of the Soundscape

Just like the word landscape can refer to an expanse of visual scenery, soundscape is an auditory scene made up of the sounds of a space. It is the extent of acoustic environment that exists around a listener. Because landscape is the field of view that lies in front of an observer, and soundscape is an area that envelopes the observer from all sides; landscape can be thought as frontal and detached, while soundscape is more surrounding and immersive.

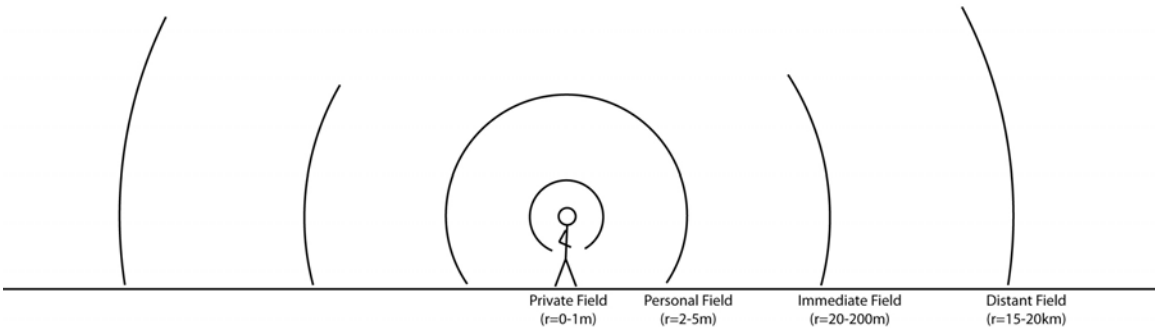


Figure 4.1: Types of soundscapes classified according to their ranges

Soundscape can be spatially classified into different "fields" based on the scope it covers. From where the listener is located, soundscape extends to an "immediate field," a circular area ranging from 20-200 meters in radius; then it continues to a "distant field" as far as 15-20 kilometers from the receiver (Porteous & Mastin 1985). One can add to these a "personal field" which covers the range of sounds that are only a couple steps

away, and a “private field” for sounds that are only audible to the listener alone (Figure 4.1). These fields correspond with the four spheres defined by social scientist Edward T. Hall (1966), in his studies on “proxemics,” the study of the anthropological distance and its role in social communication, namely the “intimate”, “personal”, “conversational”, and “public” spheres.

Blesser and Salter (2007) have argued that the social spheres and the acoustic “arenas” defined by them imply sets of rules that are associated with the use of that space. Each one of these arenas delineates a different acoustic experience with intrinsic characteristics of range, frequency, and variety of sounds and with changing levels of expected privacy and personal control over the soundscape. The private field is the audible range of intimate sounds like those generated by personal headphones, mobile phones, or those that are exchanged in whispering conversation. Personal and immediate fields are places where interpersonal and group conversations take place. Distant field is a larger geography the extent of which is defined by the maximum range of audibility at the point where the listener is standing.

At the distant field, only loud and broadly dominant sounds can reach the listener. Since these sounds reach a broad area, they are collectively experienced by a large audience. Because of this reason they tend to acquire a community and geography defining power. Church bells, prayer calls, police sirens, train or factory whistles are some examples of sounds that operate in the distant field. At this scale sounds can function as means of long-range communication as well as symbols of communal unity, sacred power and political authority.

Sounds audible at the distant field can be formative elements for a community functioning as an anchor around which the collective spirit gets formed. These sounds often become the medium through which social and political control is exercised and maintained. This is exemplified in the work of Alain Corbin on the church bells of French villages (Corbin 1998). Corbin mentions the political tensions and the social unrest caused by the regulations that banned ringing of church bells, put in place during the secularization era of the late eighteenth century France. Similarly, the Russian Bolshevik revolution that took place during the early twentieth century had banned the use of church bells (Hernandez 2004). Long-distance communication and amplification techniques can also be seen as mediated extensions of the distant field. Similar to the effect of church bells, amplified sound and public radio are used to reach broad audiences. Adolph Hitler once stated that "without the loudspeaker we would never have conquered Germany" (Altman 1992). Political discussions over the control of the distant field continue to exist in the modern world. A contemporary example is the occasionally reported disputes over the introduction of amplified Islamic prayer calls into dominantly non-Muslim settlements (Leland 2004).

In the digital age, when vast distances collapse under sound travelling at the speed of light without losing clarity or loudness, another conflict of competing soundscapes emerges, this time within smaller sound fields. The increased utilization of mobile phones and portable audio players in social space introduce a tension between private, personal and immediate fields. These devices operate in the private field and tend to compete with or completely block the interpersonal and social fields. The result is an involuntary decrease in social interaction for the mobile user. The interpersonal and

immediate fields are not utilized during mobile media usage, leading to a significant decrease of attention to one's surroundings. Not to mention the negative effects on social interaction, this can sometimes cause dangerous situations, even catastrophic ones such as traffic accidents.

The concentric sound fields create diverse yet overlapping place experiences for the listener. A soundscape is made up of a collection of sound elements organized both in space and time. Each of the sound elements, from the collection of which a soundscape is composed, has a "sonic character" and a "soundfield". The sonic character of a sound source is defined by its properties like timbre, frequency and duration. The soundfield is the spatial envelope of a sound, or simply the shape of its spatial reach (Porteous & Mastin 1985).

Similar to the way Kevin Lynch's analytical classification of the elements that make up the cognitive image of a city (landmarks, districts, edges, paths, nodes), Schafer classified sonic elements that make up the soundscape into four types. These are keynotes, signals, soundmarks and symbols. These elements cumulatively form the characteristic features of an environment's soundscape (Schafer 1977, p.9). Figure 4.2a provides a short description of these elements, with some examples for each.

Elements of a Soundscape (Schafer, 1977)		
Type	Description	Examples
Keynote	The dominant background sound characteristic of an environment	• traffic hum in a city • bird songs in a forest
Signal	A foreground sound that is attentively listened because of its informational content	• amplified announcements, • fog horns • tv and radio sounds • traffic signal sounds
Soundmark	A community sound which is unique or possesses special cultural qualities	• church bells • prayer calls from mosques • cable cars sounds in San Francisco
Symbol	Archetypal sounds that carry cultural and historical meaning – not necessarily tied to a location or instance	• religious chants • national anthems

Figure 4.2: Elements that make up a soundscape (Examples provided by the author)

One has to keep in mind the categorization of a particular sound can easily shift from one to the other depending on the context of listening, and the expectations of the listener. A signal, for instance an advertisement on the radio, which is not consciously attended to ceases to be a signal and merges into the background thus becoming part of the keynote. A ship horn can be a signal for a captain trying to navigate his ship in the fog; yet for another person, it can function as a soundmark: a sound that carry sentimental and cultural connotations.

4.1.3. Research and Documentation of Soundscapes

Soundscapes are dynamic entities. The acoustic character of an environment may change over time and under different conditions. Because of the temporal and ephemeral nature

of sound, research and documentation of soundscapes are more challenging compared to those of visual landscapes. Special methodologies have been proposed and utilized in the area of soundscape research. These include analytical terminologies for classification and visual mapping techniques, which are often used in conjunction to field recordings and listener surveys. These representational methodologies operate as ways to render the acoustic environment more tangible in order to facilitate research and analysis on soundscapes.

The earliest example of soundscape research that is carried out on an urban context is the aforementioned work on Boston's soundscape by Michael Southworth (1967). Southworth investigated the acoustic experience of place in Boston through an experimental methodology carried out with a group of voluntary participants. For the experiment, the participants were distributed into three groups. The first group was blindfolded; the second group was asked to wear a combination of earplugs and earmuffs so that they could not hear; and the remaining participants had normal seeing and hearing. They were all asked to stroll through a predetermined route in central Boston and simultaneously comment on their experience on a tape recorder. Feedback from these three groups was evaluated in terms of the sense of delight, identity, uniqueness and informativeness of the encountered sounds, and these were correlated with the visual aspects of the visited environments. Southworth found out that areas that were reported to have pleasing soundscapes featured more informative, unique and interactive content compared to areas that were rated unpleasant. For participants who were able to see and hear, attention to visual form reduced the perception of sound, yet the presence of sound increased the strength of the urban experience by enhancing contrasts, and increasing the

"sense of involvement and of the flow and rhythm of events, particularly if the sounds related to the scenes" (Southworth 1969).

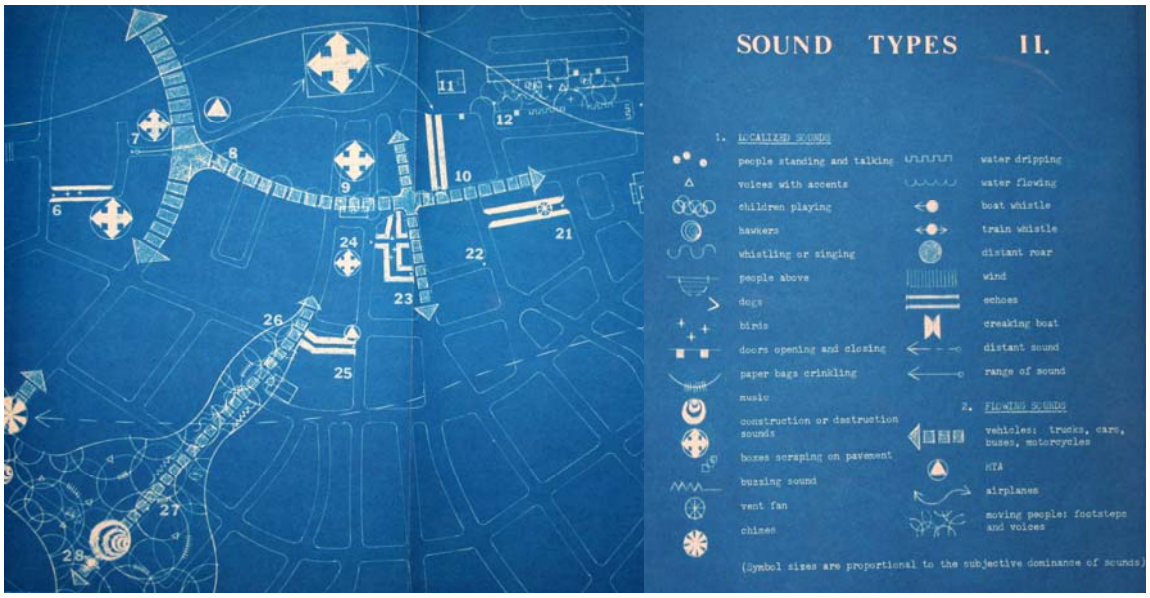


Figure 4.3: Southworth's sound map of Boston and the legend of visual symbols used to describe different sound types (Southworth 1967)

In combination with participant surveys, Southworth's study also relies on visual mapping strategies to document the typology and distribution of sounds. These closely resemble the maps that Kevin Lynch used to describe the "city image" in his studies (Figures 4.3, 4.4, 4.5). Analogous to the way Lynch's image-maps show significant visual elements that made up the cognitive image of a city, Southworth's sound-maps make visible the identifiable characteristics of a city's soundscape. In these maps, visual symbols are often used as an abstract language to represent the kinds and types of sounds along with their locations, perceived loudness and soundfields.

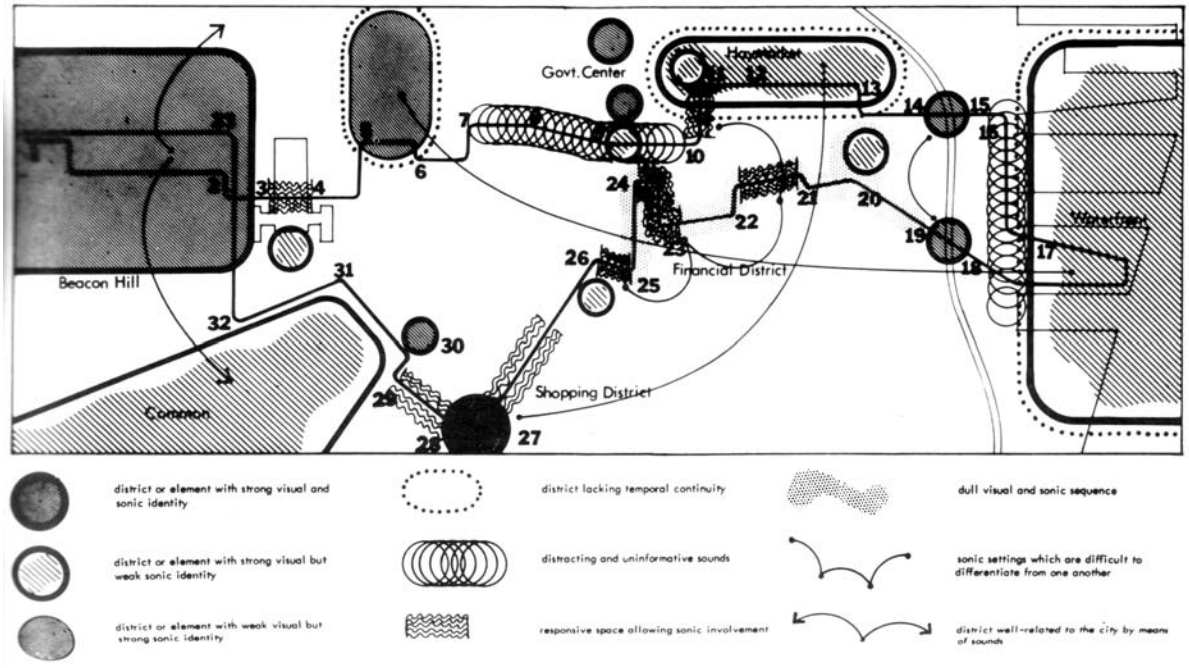


Figure 4.4: A sound event map of Boston (Southworth 1969)

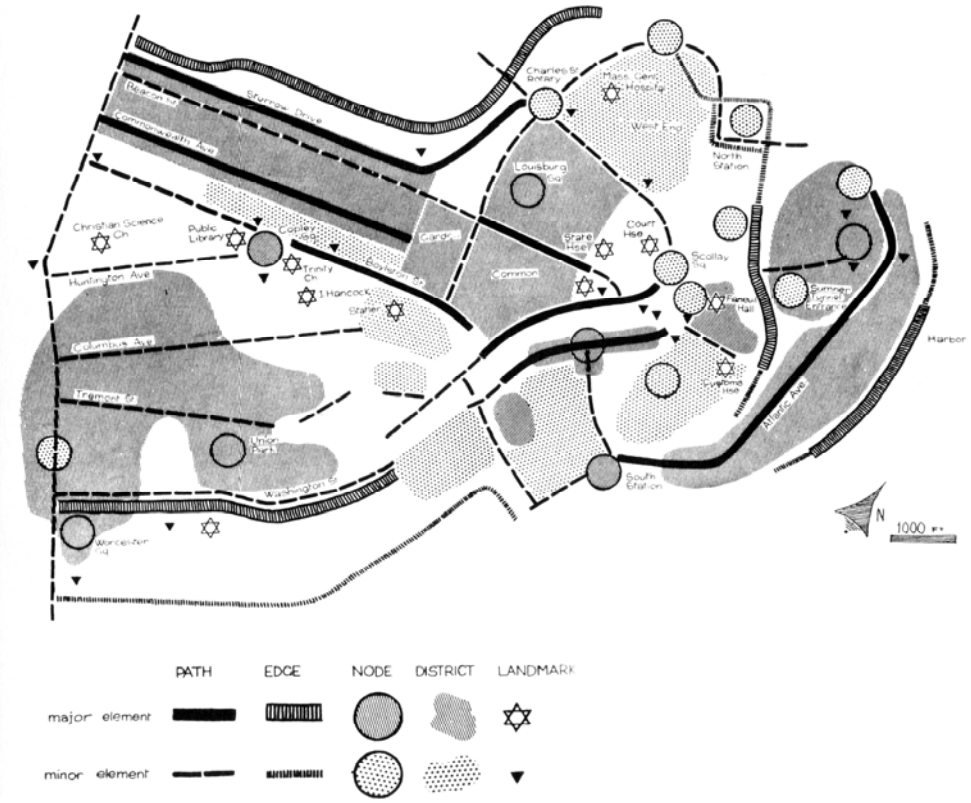


Figure 4.5: The "image" of Boston (Lynch 1960)

Similar mapping techniques, referred by WSP as “aerial sonography,” found use in their studies titled *Five Village Soundscapes* and *Vancouver Soundscape* (Truax et al., 1977). WSP’s “sound-event maps” and “isobel maps” provided visual demonstrations to concepts such as acoustic horizons, sound profiles and directions, and sound pressure level distributions across the geographical extents of these environments (Figure 4.6).

Figure 4.6: Sound-event and Isobel (equi-loudness) maps from Five Village Soundscapes (Schafer 1977)

Before sound maps were in common use, non-spatial qualities of sounds have been visualized in a variety of notational systems, for acoustic, phonetic and musical purposes (Schafer 1979, p.123). In phonetics, human speech gets transcoded into a set of typographic signs. In acoustics, mechanical vibrations are represented on a two-dimensional graph showing amplitude and/or spectral distribution as a function of time. In musical notation, symbols, lines, text and even sketches can be used together to convey musical qualities of sounds in an abstract visual language. Sound maps are the

outcome of a new perspective on sound that begins to regard space as an integral dimension of acoustic experience, in addition those such as pitch, timbre, intensity and time.

There are several benefits that can be associated with the visual representation of soundscapes. Sound maps are instant aerial descriptions of experiences that are in reality spread over an extent of space and time. They collapse the spatiality and temporality of soundscapes into two-dimensional snapshots. In doing so, they transform what is intangible, invisible and ephemeral into a format that is more static, immediate and accessible. A sound map represents the soundscape as a whole: a composite visual entity that lends itself easily to inspection and analysis. In these maps, zones with particular sonic characters can be identified and compared to each other in their ranges and loudness. An environment's acoustic profile can be readily observed in combination to the individual sound elements, along with features that make up its geographical and architectural character. Looking at a sound map, one can instantly acquire an overall impression of the soundscape of an entire town or a city. Visual diagrams are versatile tools for carrying out side-by-side comparisons of two or more soundscapes.

Indeed, soundscape itself implies underlying visual connotations. The use of the suffix "–scape" implies a similarity with the concept of landscape and makes the word soundscape acquire an image-like meaning (Rodaway, 1994, p86). The parallelism between Kevin Lynch's city-image maps and soundscape maps is therefore not accidental. Lynch theoretically formulates the image of a place as a term that is synonymous to the overall cognitive character of that environment. This "image" is not

necessarily limited to the components of a city that lend themselves to visual perception (Dempsey, 1974). Even though Lynch's empirical work does not diverge much on dimensions of place other than its visual experience, it is also possible to think of an environment's "acoustic image."

Lynch's formulation of sense of place as the cognitive image of the environment gets translated in Southworth's and WSP's studies to an aim of capturing the complete acoustic essence of an environment. However, even though it is useful to be able to visually represent them, soundscapes are not meant to be seen but heard. Without a doubt, the acoustic image of an environment rendered in a cartographic diagram does not convey its first person experience. The sound map reproduces the spatial and temporal ordering of aural experiences on paper, because of the topological parallelism between scaled geometry of the map and the spatial distribution of sounds in the actual environment. Visual maps, however, fall short of re-creating the actual, sensory and qualitative nature of these experiences, and end up being descriptive at best. They also introduce a "distancing" problem. The attribution of visual qualities to soundscape implies a static point of observation with a detached view from the object of interest. In them the landscape is visualized from a birds-eye view, losing the "from-within-ness" of soundscape and making it a visual object for distanced observation. In addition to this, in such maps acoustic experiences are substituted by visual symbols. This sensory substitution relies on the imagination of the viewer, requiring the task of indirect interpretation rather than conveying direct experience. While their primary aim is to attract attention to the sonic attributes of the landscape, sound maps carry the danger of preconditioning the observer into a visual mode of thinking.

Figure 4.7: A screenshot from the Sound-track website where acoustic experiences of soundwalks are overlaid on interactive satellite views (Kinayoglu 2005)
URL: http://www.terrasound.org/soundtrack/index.htm

On this matter, Schafer also acknowledges that "No silent projection of a soundscape can ever be adequate. The first rule must always be: If you can't hear it, be suspicious" (Schafer 1977, p.132). Both Schafer and Truax point out the inherent limitations of visual documentation techniques and suggest that direct listening and recording should be employed in conjunction to these techniques whenever possible. Portable tape recorders can be used to record and archive the soundscape "as is." When played back, soundscape recordings can reproduce a close image of first-person perspective that can directly demonstrate how environments sound like from within, an experience contrasting with the top-down view of the map.

Compared to the early years of soundscape research, when analog recording devices were expensive to obtain and difficult to operate, field recordings are now much more feasible due to the widespread availability of portable digital recorders. New media and digital technologies provide not only better ways of recording sounds, with increased fidelity and higher dynamic range, but also novel and interactive means to deliver and present these recordings to the listener. In the author's on-line project titled *Soundtrack*, soundwalk recordings collected from various cities are presented as tracks on interactive satellite maps (Kinayoglu 2005). GPS track-logs of the walks are collected simultaneously with the sound recordings, and these are later matched together to generate "sound tracks." The user can interact with the tracks freely through the map interface (Figure 4.7). The interface allows any point on the track to be listened to by dragging the cursor over the desired location. This project combines together the birds-eye view of the satellite map with the immersive and surrounding acoustic experience generated by the stereo sound recording. At the same time the website highlights the contrast between the distanced and two-dimensional character of the map with the intimate and temporal flow of the soundscape.

Another example of the uses of new media for soundscape art and cultural heritage representation is Elisa Giaccardi's project titled *Silence of the Lands* (Giaccardi 2008). In her project Giaccardi uses digital media as a way of engaging public awareness on the natural soundscape of Boulder, Colorado, an intangible natural heritage. New media is utilized in three consecutive phases of this project. Portable digital assistants, equipped with GPS and sound recording capability, are provided to participants who are asked sample the elements of the soundscape on-site. The sound recordings are gathered at a

central server through which users can insert semantic tags to the samples and compose their own soundscape on a geographic map. And finally, the generated soundscapes are made available to be experienced on-line via a public web site.

New media technologies open a new page for soundscape studies, bringing new possibilities to the art and science of sound. At the same time, traditional approaches like field-recording, mapping, listening along with sound-making itself get enhanced. New media transforms sound, which in essence is intangible, abstract and ephemeral, into a more tangible and malleable form. Although multimedia representation of soundscapes can transcend the limitations of purely visual and verbal descriptions, none of the methods described above can achieve a truly faithful and complete reproduction of the first-person experience of a soundscape. There is nothing close to being literally surrounded by the sounds of an environment from all sides and being able to walk around, explore, listen and participate. Visual and textual descriptions can give an impression but do not convey the audible. Even stereo or surround-sound recordings cannot stand as perfect substitutes to direct experience because they are confined to the standpoint of the person who made them, similar to photographs or films that are bound to the perspective seen from the viewpoint of the camera.

The premise of this study is that as newer technologies become available, soundscape experiences that are more interactive and immersive can be generated. In Part II, two projects that aim to incorporate technologies of virtual and augmented reality in soundscape representation will be presented and discussed as examples of interactive and immersive soundscape experiences created through digital means.

4.1.4. Evaluating Soundscapes

What makes a good soundscape? Similar to the way one can make aesthetical judgments on a landscape, one can argue whether a soundscape is good, or bad. However, any answer to the question would be highly subjective, therefore requiring detailed deliberation and reasoning. Different theories and approaches exist in this area. These include judgments based on noise annoyance, musical harmony, and a combination of other factors such as variety, complexity and balance.

Soundcapes are most often evaluated according to the presence or lack of noise annoyance. Noise pollution is a common problem seen in living environments. Especially big cities are associated with the increase in the concentration of mechanical and human sounds due to industrialization and rapid increase in population coupled with mass motorized transportation. Indeed, an important motivation for the founders of the WSP has been their shared concern over the global rise of noise pollution (Caro and Daro, 2008).

With the purpose of raising public attention towards the detrimental effects of noise pollution in environmental quality, Schafer came up with two concepts to classify sound environments according to their acoustic balance: High-fidelity or “hi-fi,” and low-fidelity or “lo-fi.” The two opposing terms originate from signal theory. Hi-fi stands for situations in which signal-to-noise ratio is high, and lo-fi stands for the other way around. In lo-fi situations noise dominates signal therefore communication becomes

impossible. A hi-fi soundscape does not have to be quiet; rather it is one in which unwanted sounds do not cover up or pollute the sounds that are desired to be heard.

Despite the fact that there is usually a positive correlation between the amount of noise annoyance and measured sound-pressure levels in an environment, noise does not necessarily translate to loudness. This makes it difficult to define what is meant by noise. Not all loud sounds are disturbing to the human ear. An opera singer can sing louder than the sound of a street car; reaching to a level around 75dB, while the latter is only around 65dB (Thompson 2002, p144). Whether or not that singing qualifies as noise depends on the quality of the singing and the listener's taste for opera. Conversely, a quiet cell phone conversation would be regarded as noise in a library reading room. Therefore, the most accurate and useful definition of noise is simply "undesired sound." This is what makes assessment of noise difficult, since any such judgment would be subjective and conjectural.

A more extended view towards the evaluation of soundscapes comes from Truax, a member of WSP and a communication theorist. According to Truax, soundscape is a shared ecological environment hosting an acoustic community, "a system within which acoustic information is exchanged" (Truax, 2001). He explains the criteria that make up the functional acoustic community as variety, complexity and balance. In a healthy soundscape, a variety of sounds, and variations of a particular type of sound are present without competing with or masking each other; the types and levels of information exchanged carries a level of complexity, and all these coexist within a functional balance that is sustained through "spatial, temporal, social and cultural constraints on the

system" (Truax, 2001, p.76). These criteria apply to natural and manmade sound environments alike. According to musician and natural field-recordist Bernie Krause, well balanced soundscapes can be readily found in natural environments that are not influenced by human intervention. An inherent harmony exists between the sounds that different species produce at a given natural environment. Krause calls this special relationship existing between interspecies' utilization of acoustic space the "biophony" (Krause 1998, p82). Postulating that in nature different species utilize their own "spectral niches," he argues that their sounds do not overlap or mask each other yet create a unique spatio temporal harmony only to be found in nature. Such acoustical harmony is the direct indication of a functioning balance between multiple species sharing the same environment.

Krause's model is a nostalgic one biased towards natural perfection, motivated by an underlying dissatisfaction with the soundscapes of man-msade environments. Urban soundscapes are composed of more mechanical and human sounds than natural ones. This does not mean however that urban environments are doomed to failure. While Krause's "biophonic niche" hypothesis may well be applied for the evaluation and design of urban soundscapes, these environments ought to be evaluated much differently from natural ones. Southworth's analytic study on urban soundscape is an example that uses an evaluative framework specially designed with urban soundscapes in mind (Southworth 1969). In his study, Southworth was able to identify five main criteria according to which urban inhabitants evaluate soundscapes. The first is sonic delight; the inherent aesthetic qualities of the individual sounds themselves, whether they are natural, human or mechanical sounds. The second is informational content, meaning people

appreciate sounds that have semantic relevance for the context. The third is the possibility of sonic interaction. For example, silent streets where one can hear the echoes of his or her footsteps, are highly valued. The fourth is uniqueness: Environments with distinguishable soundscapes are favored in contrast to generic ones. And the final criteria is auditory-visual correlation, which refers to the preference of soundscapes where visual and auditory information are closely correlated.

Evaluation Criteria for Soundscapes

Southworth (1969) – Urban Environments

- **Sonic delight:** Aesthetic qualities of sounds.
- **Unique character:** Distinctiveness of the soundscape.
- **Informational content:** Presence of meaningful yet non-intrusive sound content.
- **Interactivity and responsiveness:** Possibility of sonic interaction and participation.
- **Auditory-visual correlation:** Synchrony and meaningful correlation between visual and auditory events.

Schafer (1977) – Urban or Natural Environments

- **Hi-fi vs. Lo-fi:** Signal to noise ratio within the environment.

Truax (2001) – Urban or Natural Environments

- **Variety:** Coexistence of multiple sound sources that do not mask or compete with each other.
- **Complexity:** Exchange of multiple types and layers of information.
- **Balance:** Spatial, temporal, social and cultural constraints on the system that maintain the sonic equilibrium.

Krause (1998) – Natural Environments

- **Biophonic harmony, "niche hypothesis":** The existence of a balance in the spectral and temporal distribution of sounds.

Kang (2007) – Urban Environments

- **Sound:** Characteristics of sounds that determine their perceptual and cognitive character.
- **User:** Individual and social factors and subjective preferences.
- **Space:** The acoustic effects of the architectural environment.

Figure 4.8: Evaluation criteria for soundscapes suggested by different scholars.

Most recently Kang (2007, p.45) pointed out that in order to understand and evaluate urban soundscapes one should take into consideration three components: Sound, user and space. The characteristics of sounds that determine their perceptual and cognitive character are only as important as the individual and social factors and that shape their subjective preferences, and the acoustic effects of the spatial environment such as echoes and reverberation. In evaluating a soundscape's functionality or aesthetics all of the abovementioned criteria apply together. These criteria can be useful as strategies for urban design and planning. Following these simple principles soundscapes of existing cities can be evaluated and their problems can be identified. Planners can become more conscious of how the sounds of different functions interact or compete with each other and aim for harmony in acoustic space as well as in visual.

The qualitative evaluation criteria proposed by different theoreticians and soundscape experts are summarized in figure 4.8, with their key points highlighted. Overall, there is no objective way to comprehensively assess the goodness of a soundscape. It would be most sensible to consider each of the different approaches mentioned above. While they may be incomplete by themselves each of them can complement what the others may have missed.

4.1.5. Social Dimensions of the Soundscape

Soundscapes are not passive sceneries but active environments in which most of our social interactions take place. This is bolstered by the fact that sound is the most natural medium of human communication. The soundscape of an environment reflects the

natural and cultural cycles practiced by the community that lives in that environment. For instance, a village soundscape would have patterns that are reflective of daily and seasonal routines marked by specific communal activities. The harmonious nature of such a soundscape reflects the social unity and collective nature of that place. In contrast, with their cacophonic characters and keynotes composed mainly of traffic noises, most urban soundscapes stand as acoustic evidence of conflicting social interactions that constantly compete for spatial and temporal domination.

While soundscapes stand as a backdrop to social interactions, they also indirectly contribute to their making. Places have socially determined soundscape requirements in terms of what is acceptable and what is not, regulated both by cultural norms and social control. For example, singing along in accompany to the performance would be perfectly fine at a rock concert, but doing so would not be acceptable in the setting of a classical music performance. A soundscape full of car horns and traffic noise will induce the feeling that it is acceptable to make more loud noises. As a result more drivers will use their horns without much thinking that it will ruin the soundscape. Different acoustic environments imply different “social contracts” that regulate sonic interaction along with other types of behavior in social space.

Soundscape is inclusive, embodied and social, arguably more so than the visual landscape because it is centered around the perceiver. It is a medium that both induces a sense of self-awareness and welcomes social participation. In contrast, vision is not as inclusive of the self. We do not perceive ourselves within our own visual field however the sounds that we create are always present to us. Musician John Cage noted that even

inside a sound-proofed anechoic chamber, one can hear the sounds of his own body, his "nervous system in operation" and "blood in circulation" (Cage 1961). The most silent sounds that one's body involuntarily emits, along with the louder ones that are produced at will, such as singing, speaking, making music are manifestations of one's presence in his or her own soundscape:

> Speaking and singing are actions which, like hunting and carving, 'bring out' or release aspects of being into the fullness of the acoustic space surrounding the person. Unlike the framed, pictorial space surveyed by the eye, acoustic space is 'dynamic, always in flux, creating its own dimensions moment by moment. (Ingold 2000, p.249)

Soundscapes are defined not only by the natural or mechanical sounds but they are also composed of human sounds, speaking and singing, language, songs and music. Hence, soundscapes are collectively created by the inhabitants unlike planned architectural and urban spaces, which is often top-down, built and imposed. No amount of planning or design can predetermine the exact way a sound environment will function. At the end it is people, as participants rather than audience, who are responsible of the constant flow of activities, which keep a soundscape alive. In Lefebvre's terminology, soundscape would qualify as a social construct. The conglomeration of intentional acts of sound making that produce the soundscape ultimately endow it with a sense of "theatricality as sophisticated as it is unsought, a sort of involuntary *mise-en-scene,"* a quality that Lefebvre finds in nature and associates with organically developed cities (Lefebvre 1974, p74).

Although they are harder to predict, control and design, sounds play an important role for the making of a sense of place. As anthropologist Stephen Feld points out: "… as a

sensual space-time, the experience of place potentially can always be grounded in an acoustic dimension. This is so because space indexes the distribution of images, and time indexes the motion of sounds…" (Feld 1996). Unlike vision, which informs us about the state of things, sound tells us about events and activities that occur in time. For this reason, acoustic space is necessarily dynamic and temporal, compared to the visual space which can be abstracted into static visual snapshots. Sound carries place experience to a temporal dimension as the indicator of continuity and motion that connect discrete moments to each other. Soundscapes are therefore the life pulses of places.

4.2. The Enactive Approach to Perception and Hearing

Qualitative phenomena like color, shades of light, or pitch, timbre, loudness, must be clustered in structured groups or streams to generate meaningful significations for the perceiver. Therefore perception requires attention, active participation and cognitive ability on part of the perceiver. However, perception can not be explained as a computational decoding activity.

As discussed in chapter 3, perception is an intentional and embodied act rather than a passive process or a disembodied, computational activity (Noe 2004). Noe's work is a follow-up on Merleau-Ponty's phenomenological meditations as well as Gibson's experimental research on visual perception. In Noe's work some of Merleau-Ponty's concepts such as "body schema," and Gibson's research on ecological perception come together in the shape of a more structured hypothesis. Noe's "enactive account of

perception" is built around two major assertions: "intentionality" and "sensori-motor interaction." The enactive view of perception suggests that any perceptual experience is pre-structured; meaning that it has content that is directed toward the world and about the world (Noe, p.189). For intentional perceptual experience to occur, "sensori-motor interaction" is required. According to this theory one makes sense of the world through his or her bodily actions within it.

Does the enactive approach to perception apply to hearing? As explained in the previous chapter, phenomenological research often exclusively studies the visual experience of the world. Yet in most cases same principles can be found present in all types of sensory perception. Auditory sense, similar to the olfactory sense, seems to be more passive and immobile compared to the visual and tactual senses. Therefore one could ask how the enactive approach applies to hearing, or to what extent it does.[5] This question, although not directly addressed in discussions of perceptual phenomenology may be approached through two directions. The first approach would be to negate the initial assumption that auditory sense is immobile. Auditory input is related to bodily action and transformation in a similar way to vision. We change our auditory perspective by turning our head, or moving our bodies in space. Acoustic space is also a field for sensory exploration. What we hear is physically dependent upon which direction our head is facing, and where we are located. The second approach is to think of attention as an act of active probing, although it does not involve motor-activity. Our body literally acts as part of our auditory sense. Especially low frequency sounds are heard through bodily vibrations. In addition, similar to the way we move our head, eyes and body in order to probe features

[5] This question was initially proposed by Prof. David Wessel.

of the visual environment we can actively listen to sounds that reach our ears to attend to certain auditory features present within.[6] The so-called "cocktail party effect" is the proof of this phenomenon. In a multi-source environment, it is possible to selectively focus on a specific source of sound while ignoring all the other acoustic sensations. Although this does not involve actual movement, the effect is phenomenologically equivalent to fixing one's eyes onto the point of visual attention in order to make its image fall on the fovea region of the retina where visual nerves are concentrated. Therefore the enactive approach to perception is perfectly applicable to auditory perception. The case study in chapter five builds upon this argument, that auditory perception is enactive just like the visual perception. In a geo-located augmented audio application the possibility of embodied interaction with the soundscape makes it virtually indistinguishable from real experience.

4.3. Conclusion

This chapter introduced and discussed soundscape, the auditory dimension of place and its experience. It presented various documentation and visualization techniques used for soundscape research along with novel ways of recording and representing soundscapes enabled by digital interactive media. Each sense creates a specific sense of place of its own. Therefore one can talk about landscapes, soundscapes, smellscapes and so forth.

[6] How we attend to what we hear is another question, which falls out of the primary scope of this chapter. For now suffice it to say that as well as unconscious processes of auditory stream segregation (Bregman, 1994; Begault, 1997), there exists a conscious selection process (Cusack and Carlyon, 2004) that dictates how we direct our attention to individual sound sources. Auditory space has many dimensions. In addition to the three dimensions of the physical space, it includes the space of the frequency-time domain. Through bodily motion and selective attention, one actively navigates and makes sense of all of these dimensions at once.

While it makes analytical sense to study each of these separately from each other, one should remember that the world that we live in is multi-sensory: An “allscape” as Porteous (1990, p.196) calls it. A complete understanding of presence and sense of place is only possible through an understanding of the world as a multisensory compound instead of breaking it apart into limited perspectives of the modality-centric viewpoints. Senses must be investigated not as disconnected entities on their own but in their social and ecological context.

The following chapters will present studies that utilize new media to generate and investigate the nature of multi-modal interaction in virtual and augmented reality experiences. The first will explain the methodology followed in the virtual and interactive recreation of the soundscape of a historic street along with its visual environment. The second will present another project that mixes embodied interaction in physical space overlaid with virtually generated soundscapes.

PART II

CASE STUDIES

5

Modeling Virtual Soundscapes: Recreating the 1950s West Oakland 7th Street Within a Multi-User Virtual Environment

The previous chapter presented the auditory dimension of place, soundscape, and argued that sound contributes to the making of sense of place. Traditional methods of documenting and visualizing soundscapes were discussed. These techniques are useful when an analytical account of an environment's acoustic profile needs to be gathered. Conventional media utilized by these techniques often fail reproduce the first person, immersive experience of the actual soundscape. New representational methodologies offered by digital media make immersive presentations of soundscapes possible. Virtual Environments and computer games can generate engaging and interactive first person experiences of three-dimensional audio-visual environments. Moreover, these synthesized experiences are not only created as simple and disconnected experiential analogues but they can also be reproduced within their intended social and cultural contexts.

In the age of new media sense of place as a concept applies not only to physical spaces but virtual ones as well. Digitally generated environments are essentially constructed spatial representations. Therefore according to Lefebvre's schema they qualify as

"conceived spaces," by default. The challenge of any such environment would then be to make the conceived space of the virtual representation a realistically sensed, and socially and culturally lived experience. The former is dependent on the mediation factor, which is the mode in which the digital representation is presented to the user and the satisfactoriness of the mode of interaction. As the level of realism and depth of interactivity offered by available simulation techniques improve, better and more fulfilling virtual places can be generated. The latter, making the virtual environment a *lived-place*, is a more challenging task. This requires envisioning the virtual space not only as an empty geometric model, but also providing ways in which it will function dynamically. Virtual places have to provide content as well as context; consider social presence and engagement as much as physical realism.

This chapter presents and discusses the technical, theoretical, creative challenges of digitally synthesizing the soundscape of a cultural heritage environment that no longer exists. The project that will be described is the digital reconstruction of 7th Street in West Oakland, California during the 1950s, at the time when it was a lively cultural hub famous with its music scene, bars and clubs as well as busy shops, hotels and restaurants. A Multi-User Virtual Environment (MUVE) was designed at the Digital Design Research Group at UC Berkeley with the aim of virtually recreating the entire street in a computer game format that unfolds as a first-person hyper-textual story. The grounding premise of the project was that a multi-modal interactive representation of the environment would enhance the feeling of immersion compared to visual-only virtual environments, while greatly contributing to the sense of historic authenticity. The methodology used in synthesizing the virtual soundscape for the MUVE builds up on the

theoretical framework of soundscape research which was presented in the previous chapter. In this chapter, the process of generating lifelike three-dimensional, interactive soundscape of 7th Street is presented in detail, followed by a discussion of the applicability of the approach for other projects in the area of virtual cultural heritage representation.

5.1. Rationale Behind the Study

Intangible aspects of place such as its social context, culture, activities, often get unnoticed and neglected in virtual environments. Similarly, existing attempts of virtual reconstruction of cultural heritage sites rely predominantly and exclusively on the geometric-visual modeling of their physical environments (Kalay 2008). The underrepresented components of cultural heritage also include the non-visual aspects of place experience. Real places are often identified and remembered with their sounds (not to mention smells, tastes and other sensations) as well as their images. A reverberant Venetian square feels very different from a bustling street market in Istanbul. Hearing the call for prayer in Cairo or the chimes of Big Ben in London are elements that contribute greatly to the characteristic experiences of these cities. Sound is an integral component that can change the perceptual character of any environment. Even subtle daily variations in the soundscape may drastically alter the experience of the same physical space. A virtual reconstruction of a cultural heritage environment can be much more effective and encompassing if the dynamic soundscape experience can be regenerated along with the visual environment.

As mentioned previously in chapter two, places are formed by the combination of three elements: Physical spaces or the “setting”, people or “actors” that generate and inhabit these settings, and their activities (Canter 1977). Architecture, if regarded merely as the physical dimension of place, is influential yet insufficient by itself to generate the genuine feeling of a place. Places are made by people and activated by their social interactions. Designs for virtual places need to consider this as a starting point and aim to represent the totality of place by being as faithful as possible to the social dimension of places as much as the physical surroundings (Kalay and Marx, 2001). Therefore a virtual place has to include representations of people and their actions in order to create a social context as well as a spatial one, and indicate how that place is used by its inhabitants. Doing so helps a virtual environment acquire a dynamic character alive with movement and interactions. Only this way it can be ensured that the virtual experience of a place engenders more than what is in a still picture of the environment.

Similar arguments can be made about the inclusion of a place’s soundscape in its virtual reconstruction. First, sounds are some of the most important outcomes of human interactions. The social context of an environment is equally readable in auditory form as it is in visual. Second, being temporal in nature, sounds highlight the passage of time. An environment that is audible automatically acquires a temporal dimension, and becomes no longer static like a picture would be. Third, sounds can function as anchoring elements that provide temporal context to an environment. The type of music playing, the specific variety of environmental sounds, can tell the listener about which specific historic era the place is situated within. And finally, sounds bear the traces of the environment’s collective character since they can overlap in the ambiance to reflect

simultaneously happening social events. For all these reasons and more, soundscapes are valuable tools for conveying the social and temporal context of a place in a virtual environment.

Virtual places also suffer from the lack of a sense of materiality. Material substance is poorly represented by visual models that try to substitute for the lack of tactility by colors, shadows and textures. Sound can contribute to the feeling of materiality and spatiality at the same time, as it does in real space, by providing acoustical cues of hardness and softness, smallness and largeness, closeness and farness. Sound, being a temporal sense, introduces time as a new dimension to virtual places, making them closer to live events than static images. Both human presence and the lack of it, functional differentiations and natural variations within an environment can be represented readily through sound. Music and language adds an even deeper dimension to virtual environments. They function as soundmarks, conveying the cultural context, as well as environmental character, ambiance and mood of a space.

Environmental sound, when incorporated skillfully, can breathe life onto a virtual environment. Yi-Fu Tuan points to the fact that while the organization of human space is primarily dependent on sight, other senses expand and enrich visual space expending its dimensionality and realism (Tuan 1977). Sound expands the spatial reach of a person's awareness to include areas behind the head that cannot be normally seen. Sound also makes spatial experience more engaging and dramatic. This argument applies perfectly to virtual environments that aim to recreate the realism and liveliness of actual places.

Being the most spatial of all the senses, sound also bears the power of increasing the feeling of immersion within a space, be it real or virtual. Examples of previous research have demonstrated that the use of three-dimensional, localized sound in virtual simulations results in measurable increases in the level of presence that is engendered (Bormann 2005; Hendrix 1996). Even though research on the effects of immersive audio have mostly been carried out with specialized hardware, technological requirements for generating real-time 3D positional audio have now become widely accessible to regular personal computer users. All popular gaming consoles ship with capabilities to generate surround sound and a great percentage of desktop PCs feature sound hardware with equivalent specifications to these. This presents a great opportunity for cultural heritage reconstruction, as well as other cultural and educational uses of virtual environments.

5.2. Reconstructing 7th Street

7th Street in West Oakland, California, used to be a lively commercial district during the 1940s and 1950s. It was home to an emergent blues music scene, which was played at dozens of local jazz and blues clubs on the street. The street was home to a large population of African-Americans who migrated from the South to work in the naval shipyards during the 1940s. Among these were talented musicians who brought with them a culture of blues music from Lousiana, and became famous after launching their performance careers at 7th Street clubs. There were also numerous other business establishments within the eight-block stretch of 7th Street, all of which turned the street into one of Oakland's major commercial and social centers at the time. During the 1960s

and 1970s, a series of planning decisions led to the demise of the entire neighborhood. First an elevated highway, named the Cypress Freeway, was constructed across the street, dividing the street in half. This was followed by the construction of Bay Area Rapid Transit (BART) rail and subway system along the street, and the building of a 12-square-block postal service distribution facility on its south side (Kalay and Grabowicz, 2007).

Figure 5.1: Slim Jenkins Club, West Oakland, c. 1950
(Photo courtesy of the African American Museum)

Today, only a small number of the original buildings from the 1950s remain on the street. Most of the ones that are still standing are vacant and boarded-up. For many decades after 1970s, the street was an unsafe environment notorious of drug dealing and crime. Nowadays, gentrification efforts are starting to emerge in and around West Oakland. However, these efforts bear no visible investment in reviving or referencing the cultural heritage of the neighborhood. Nothing seems to have survived from the

glorious days of 7th Street except black and white pictures scattered in photo albums of old-timers' of the life and events that once made the neighborhood a special place.

5.3. The Virtual West Oakland Jazz and Blues Project

Between the years 2006 and 2008 the Digital Design Research Group at the Department of Architecture of the University of California, Berkeley took on a project to reconstruct the 1950s 7th Street as a Multi-User Virtual Environment (MUVE). Initiated by Paul Grabowicz from the Department of Journalism, and supported by The Knight Foundation's News Challenge Grant, DDRG's efforts culminated in a MUVE, titled "West Oakland Jazz and Blues." In the West Oakland MUVE users don an avatar to navigate the environment, and engage with the in-game characters and other players. West Oakland Jazz and Blues features some aspects of a 3D-adventure game genre. It is played from the standpoint of a musician who recently arrived to the scene. The main task is to complete the necessary steps in order to get the player's music recorded, financed, distributed and performed. Players engage in pre-scripted hyper-textual dialogues with non-player characters (NPCs), who are computer controlled. NPCs guide the players towards completing game "quests", such as retrieving a stack of newspapers for a local newsstand owner, finding out the name of a club's owner, or purchasing a vintage blues guitar from a pawn shop. The interactive storyline increases the engagement and appeal of the environment, and helps facilitate the game's educational ambitions. The aim is to provide an educational tool that also makes it entertaining for young generations to learn about the history of West Oakland in its 1940s and 1950s. To

be able to achieve this, the game had to recreate an authentic and believable sense of place, of the neighborhood.

Figure 5.2: Birds-eye view of the reconstructed 7th street

How can virtual environments engender a sense of place? David Canter's trilogy of "physical setting, people, and activities" is an especially suitable framework for the virtual reconstruction of a cultural heritage environment. Designing the virtual environment as a first person adventure game helps address all three aspects of place at once. In the West Oakland Jazz and Blues, the inhabitants of the street as well as the users are represented by custom-designed avatars wearing period clothing. Popular characters of the time, such as famous musicians, club owners and community leaders are modeled in a lifelike manner and placed within the game for the users to interact

with. In addition to around 20 of these interactive NPCs there are more than 100 “bots”, non-descript generic virtual inhabitants, that populate the environment and act as a social backdrop as they independently navigate the street, gather in groups, enter and leave bars, dance in front of the stage and engage in other social activities. The NPCs can interact with the players through pre-scripted hypertextual dialogues. The activities of the bots which populate the street are dynamically generated according to a context-based rule set (Lam et al. 2007). The street also has two cable cars, and many other vehicles that run along the street. In all its complexity and dynamism, the West Oakland Jazz and Blues is a lively virtual environment that looks and sounds like 7th Street in the 1950s (Figure 5.2).

The West Oakland MUVE is developed using Torque Game Engine, a commercially available kit for developing Internet-enabled multi-user 3D games (Garagegames, 2009). The server module of the engine maintains a persistent representation of the virtual environment, and manages communications with the client modules interconnected through a TCP/IP network. The engine allows in-game events and interactive behavior of objects in the environment as well as the user interface events programmed through a scripting language. 3D Modeling for the game was done in 3D Studio Max, and the game’s proprietary editor named Constructor. Avatar modeling was carried out using Poser 6.0 (Smithmicro, 2008) and 3D Studio Max 8 (Autodesk, 2008). Audio files were processed and edited using Audacity (2008).

The client module of the engine utilizes the OpenGL (Silicon Graphics, 2006) subsystem for graphics rendering, and in combination implements the OpenAL to deliver 3D

Audio. OpenAL (Open Audio Language; Creative, 2008) is a cross-platform application programming interface that is designed to program and render three-dimensional positional audio. This gives the flexibility to design the sounds of the game in an abstract manner, independent of the specifics of hardware configuration. For instance, one user may be using a high-end desktop system with 7.1 speaker surround output, while the other may be using a notebook with low-end sound support and stereo earbuds. Whichever the case may be, the local implementation of the OpenAL ensures the best possible quality for rendering environmental audio enabled by the capabilities of the available hardware configuration.

5.4. Creating the Virtual Soundscape

In his historical analysis of the socio-politics of sound and music Jacques Attali notes, "More than colors and forms, it is sounds and their arrangements that fashion societies… All music, any organization of sounds is then a tool for the creation or consolidation of a community, of a totality" (Attali 1985, p.6). Speaking of West Oakland, this statement carries particular significance, since the music and sound of 7th street functioned like a keystone that held the community together. The life on 7th Street revolved around the production and consumption of Jazz and Blues music in public venues. Sounds of live bands poured outdoors from the bars and clubs into the street and blended with the noises of crowds that frequented the venues and populated the street. The music of 7th Street functioned as a medium of self-expression for its producers and audience, making it literally the life and soul of the neighborhood. Indeed the music which used to fill the street's ambiance eventually outlived the street itself. The singles and longplay albums

that survived to our day constitute the Oakland Blues genre and represent the unique musical style of the 1950s West Oakland. Through its music, we get a glimpse of the vanished subculture that once lived in this neighborhood.

The synthesis of a virtual soundscape of a disappeared cultural heritage site present intrinsic theoretical and practical challenges. Despite the fact that the use of sound in computer games and virtual media has a long history, limited amount of research has been carried out that contemplate on the theoretical aspects of the issue. Two fields of research compensate for this lack. First one of these is the analytical methodologies and terminology developed by the World Soundscape Project that the previous chapter discussed. The second is film and film sound theory (Bordwell and Thompson 2004; Altman 1992). Even though both of these fields, soundscape studies and film sound, lay outside the specialization of game design or Virtual Environments, they became useful in providing direction and theoretical grounding for the West Oakland Jazz and Blues project.

For virtual and digital environments three key areas of responsive sound interaction has been identified: 1) generative sound that derives its composition and relevance from social and physical interaction within a digital environment; 2) the relation of sonic structure to visual experience; and 3) responsive and reactive real time sounds activated by environmental conditions and human behaviors (Beilharz 2004). The West Oakland project aims to integrate these three principles with the concepts and methodologies from soundscape studies and film-theory with the purpose of generating an interactive, realistic, multisensory and authentic virtual atmosphere. The sections that follow will

discuss the steps that were followed in the design and implementation of West Oakland Jazz and Blues soundscape.

5.4.1. Elements of the Soundscape

While designing, modeling and scripting the visuals, buildings, avatars and their dynamics each have their difficulties, regenerating the soundscape of the street was considerably more challenging compared to these. The visual environment was modeled with the help of several photographs, maps and written accounts of the street. Interior plans for some buildings were recovered which simplified the modeling work. Many of the photographs that were available were directly used as texture maps for the virtual environment model. However there was no raw material to be used to compose the auditory environment other than some commercially distributed music that remained to our times. Available indirect sources were oral histories, and some written descriptions of how the street sounded during the period. From the "earwitness" accounts of "old timers", people who remember the 1950s, lived on or visited the street, or operated a business there during that time, it was possible to determine that it was a place with stores and businesses bustling with activity, and had a vibrant club scene with sounds of live jazz and blues flowing out from the clubs and filling the street.

Unfortunately, the only sounds that one would be able to hear or record on 7th Street today are the loud, overwhelming noises of the Bay Area Rapid Transit (BART) trains that rush through the street every 6-to-7 minutes and the recurrent police sirens that mark the neighborhood's contemporary "acoustic horizon." Residents who were interviewed

for the project noted that the noise created by the trains made it impossible to make or enjoy music on the street. The fact that the authentic soundscape has long been wiped out of existence, made it necessary to follow a partially speculative approach for its virtual reconstruction. Therefore the soundscape was synthesized from scratch by putting together bits and pieces of "found" sounds, with the aim of reaching at the complete sonic ambiance as it would have existed.

Soundmarks & Symbols *Foreground - w/ high cultural significance*	• Jazz and Blues bands playing in clubs • Music playing from jukeboxes • Gospel music flowing out from churches
Signals *Foreground, w/ generic character and pragmatic use*	• 1950s advertisements playing on the radio • Yells of street sellers including a tamale-man and shoe-shiners (Not implemented) • Car horns • Cable car bells
Keynote sounds *Background ambience*	• Sounds of traffic and cable cars • Various crowd sounds in clubs, restaurants and pool halls • Sound of children playing on the side streets • Sounds of musicians practicing their instruments • Natural sounds including occasional dog barks, bird songs • Construction noises coming from Cypress Freeway the east end • Industrial noises coming from the shipyard at the west end

Figure 5.3: The soundscape elements for West Oakland 7th Street in the 1950s

One of the central aims of the project was to recreate the authentic "sonic image" of 7th Street. For doing so, a list of different types of sounds that have existed in the soundscape of the street was generated. The list was structured using Schafer's typological classification system as a framework which is shown in figure 5.3.

Jazz and blues music were important soundmarks of 7th Street in the 1950s. A limited amount of local music from West Oakland is available, passed down to our times in the form of vinyl albums and remastered audio discs. Permission was obtained to use pieces of recorded material from famous musicians who played on the Street, including Lowell Fulson and Juke Boy Bonner. These were processed, with equalization and indoor reverberation added to make them sound like a live performance in a club. Other existing places with similar soundscapes were considered as possible sources for inspiration and raw material. For instance, the sounds of cable cars in San Francisco were collected and edited to stand in for the cable cars of 7th Street. Places like New Orleans' Bourbon Street provided a living model to help envision the kind of ambiance that 7th Street might have sounded like. To create a unique combination many individual sound samples from Freesound Project, which is a collective repository of Creative Commons licensed sound effects, were also used (Freesound, 2008).

5.4.2. Spatial Distribution of Sounds

Once an overall list of sounds were made and the necessary samples were collected from the sources mentioned, they were organized in space and time so that they could blend together into a coherent and interesting whole. This was a design problem that had to be

treated in a similar fashion to creating a musical composition. The concept was to recreate the sonic experience of a visitor walking through 7th Street listening to it freely, and coming into the appreciation of the nuances between different zones with distinct identities and dynamics. Google Earth software was used to visualize the geographical distribution of the sounds and as a means of notation, design, and archival system for sorting the long list of sound effects (Figure 5.4). Media tags hyperlinked each location to the corresponding sound effects, which could be listened to and evaluated separately form each other before inserting them into the virtual environment.

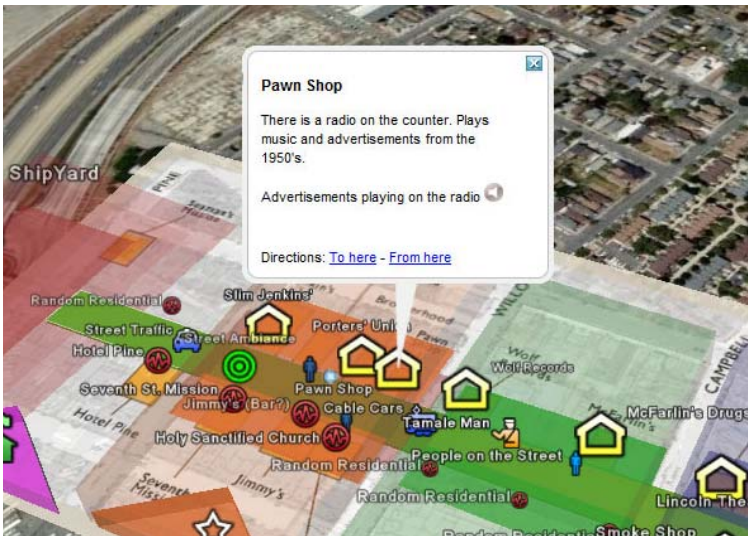


Figure 5.4: Screenshot from the Google Earth map which was used to manage sound effects and locations

It was known from the Sanborn Maps, available photos and old-timer's accounts, that the street had groups of similar businesses clustered around specific zones (Figure 5.5). The block where Slim Jenkins' club existed marked the main center of attraction surrounded by several other clubs and bars. This area, marked by the live music flowing out from the clubs, was labeled the "Center of Attraction." The three other sonic zones

on the street were the “Residential,” a stretch with domestic sounds; “Urban,” an area where shops restaurants and a large theater used to be and a “Transitional” zone that stood between the Clubs and the Ports, with several Hotels and clubs that used to host sailors and train porters who frequented the street. On the east side, the street was blocked by the Cypress Freeway, the construction of which was in progress during the 1950s. The west end of the street was marked with the sounds reaching from the shipyard. These two ends defined the two opposite acoustic horizons of the street, marking the border of the perceived acoustic space. The users were not allowed to walk past these two ends of the street.

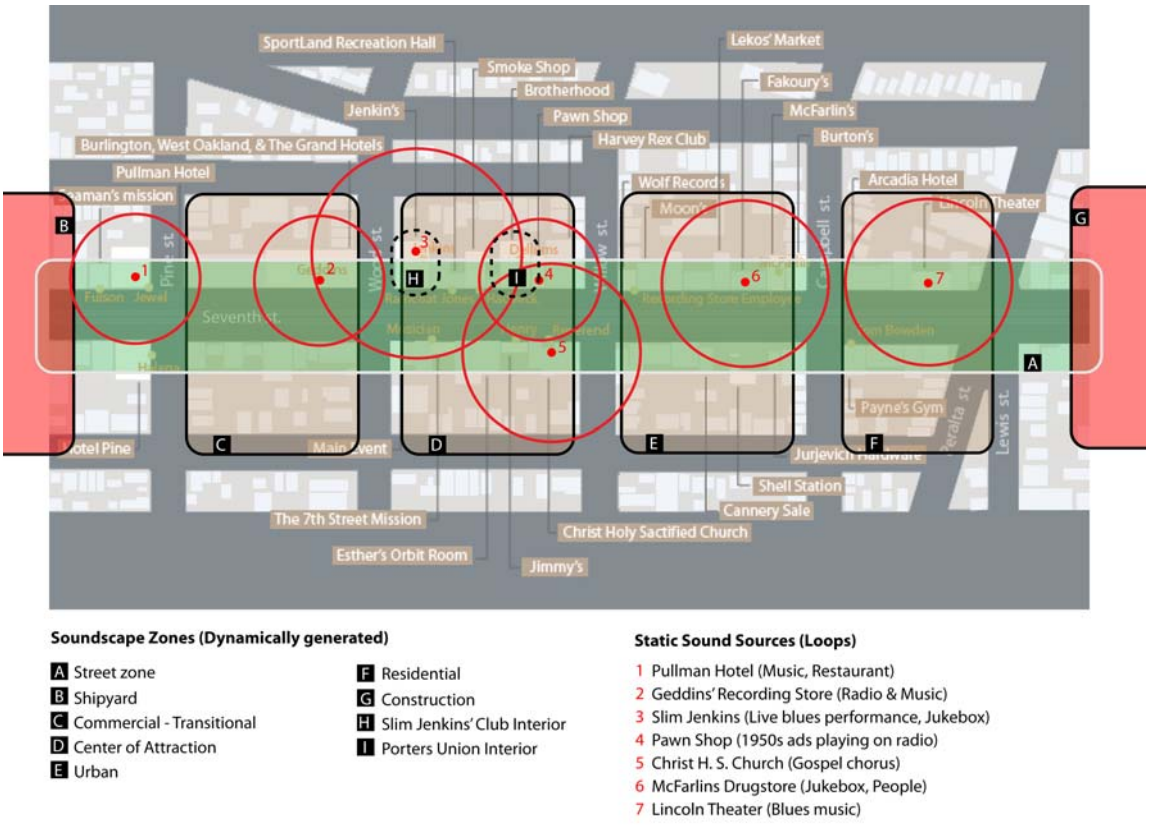


Figure 5.5: West Oakland Jazz and Blues soundscape map showing the dynamic soundscape zones and static sound sources

5.4.3. Defining Acoustic Zones: A “Sonic Foliage” Generator

A major challenge in designing a virtual soundscape environment is generating the continuous ambient background without obvious looping sounds. Even if sound clips are edited to loop seamlessly so that the “loop-gap” between the beginning and the end of the sound is not noticeable, people can usually notice the artificiality. This is especially the case if identifiable sound events exist in a relatively short loop. Obviously detectable loops in the background sounds not only break the suspension of disbelief but also can be very distracting and annoying for the user. This is similar to the tiling effect that happens in 3D modeling when small visual textures are applied to large surfaces. As with all other natural phenomena, sounds of a real environment carry great amount of unpredictability behind an overall impression of order. Realistic simulations can be achieved by utilizing simple pattern randomization or more complex stochastic processes. These types of generative algorithmic processes have been applied to musical composition and architecture by composers and architects like Brian Eno and Iannis Xenakis (Licht 2007; Beilharz 2004).

For the virtual soundscape of West Oakland Jazz and Blues a generative algorithm which schedules the timing and manages the placement of sound effects has been implemented. This algorithm triggers sound clips according to parametric inputs for location, frequency, and randomization factors for both frequency and location. All of these parameters were provided for individual point sources which needed to be non-periodical. Foreground sound samples are digitally processed to avoid sharp cuts in their beginnings and ends: fade-ins and fade-outs were added as necessary. When overlaid on

top of a relatively quiet ambient loop, these foreground sounds introduce a dynamism and unpredictability to the background, generating a vivid yet natural sense of activity. This algorithm was utilized for both interior and exterior audio zones on the street with realistic results. These zones within which the soundscape is generated dynamically are indicated with letters A to I on the map.

5.4.4. Implementation of Spatial Acoustics

In West Oakland Jazz and Blues, sounds placed within the environment model are localized and attenuated by the sound hardware, depending on the user's location and head direction within the environment. Localized sound is particularly important to provide a sense of directionality and depth to the 3D environment. Perspective rendering of the viewport can only show a narrow visible portion of the virtual space, as seen from the small window of the game screen. This can only give a sense of uni-directional presence, since the users are only visually aware of what is in front of them. However, hearing gives us a sense of space that is omni-directional, a sense of being surrounded within space. The resulting experience is more complete in the phenomenological sense.

Due to the taxing computational requirements of implementing real-time software algorithms to simulate environmental-acoustics, and problems of compatibility that may arise from using real-time hardware-based environmental extensions as well as the proprietary nature of those (such as Creative Systems' EAX-4.0), the spatial acoustic effects like reverberation, echoes and coloring, are "baked" onto the sound sources themselves. For instance, the sounds of gospel music coming from within the 7th Street

Mission, is a looping sample that is manually pre-processed to reflect the way the sounds would be first reverberated within the room, then muffled by the outer wall of the church. All of the interior sounds are also pre-processed to reflect the acoustic characters of spaces that they belong to.

Another environmental effect that was simulated was the acoustic occlusion caused by building walls. Several interior audio zones and a single exterior zone were mapped onto the environment and outputs of these were assigned to discrete audio channels. Realistic physical occlusion was achieved by selective mixing, or muting of these interior and exterior audio channels based on the location that the user is standing at. For instance, when the user is right outside Slim Jenkin's bar, sounds of the bar are suppressed while the sound of the street is amplified. When the user enters the bar, the opposite happens. This creates the illusion that the wall in between two spaces has actual thickness that reduces sound transmission. More recent versions of most gaming engines natively simulate realistic 3D occlusion with a similar technique that employs polygonal occlusion meshes.

5.4.5. Sound Perspective: Diegetic vs. Non-Diegetic Sounds

Following a terminology originating from film theory, the sounds of a narrative virtual environment can be classified into two main categories. The first one is the *diegetic sound,* comprising of sounds that belong to and originate from the narrative space. The second category is the *non-diegetic sound,* which includes sounds that do not belong to the story world (Bordwell and Thompson 2004, p366).

Diegetic sound emerges from the represented world therefore its proper utilization increases the sense of realism. In movies, off-screen diegetic sound specifically works for this purpose. Sounds that are coming from sources that are not visible on the screen make the audience think that the fictional world continues outside the field of view available to the camera. With the appropriate use of off-screen diegetic sounds and cross-editing between shots with different angles cinema engenders the feeling that what is visible within the frame of the screen is only a part of a much bigger space that surrounds the viewer. This way, a sense of spatial continuity is generated that extends outside the frame and between the shots. The positioning, sense of distance and locationing of sounds in the diegetic world creates what is called a sound perspective. Sound perspective in cinema is influenced by the acoustic characters of individual sounds, determined by the room acoustics at the source, distance of the microphone and recording technique (Altman 1992, p49). Complex spatial organizations can be created through multi-channel mixing of multiple different sound perspectives.

In Virtual Environments (VE) the spatio-temporal experience of the represented world is continuous and there are no editing tricks involved. However, off-screen diegetic sound still plays a very important role in the making of the spatial surround feeling. Introducing a rich variety of sounds that are intricately layered in time and space as well as the sonic spectrum can drastically increase the feel of realism and contribute to the sense of immersion. Differently from movies, in a VE the sound perspective is generated dynamically by selective mixing and panning of virtual sound sources, and real-time processing of spatial effects according to the users' location, direction and movements

relative to the sound sources. Therefore, just like the visual perspective, sound perspective is also user-controlled in a VE.

In the world of computer games and other VEs the dual opposition of the diegetic versus non-diegetic applies to visuals more significantly than it does to sound. An avatar representing a character in a computer game is diegetic since it belongs to the virtual world, whereas the “save game” or “inventory” buttons as well as the on-screen chat window are non-diegetic. The design of any virtual environment should factor in the necessary interplay of the two modes of interaction, competing with yet at the same time complementing each other.

Non-diegetic sounds necessarily carry with them an effect of alienation, because they call attention into the presence of the interface layer that stands in between the virtual world and the real one. Generally speaking, this works against the primary goal of virtual environments, which is based on the premise to make the interface as transparent as possible. Although it can be argued that non-diegetic elements may break the suspension of disbelief, they can also help increase the effectiveness of the narrative and facilitate interactivity. A common example to the former is the narrator’s voiceover often used in the documentary genre. This technique lets the narrator communicate with the audience directly, to give the background story of what is seen in the scene, and direct their attention. An example to the latter is the on-screen audio/visual interface elements. For instance on a DVD player, these may show the current scene number, or display the current volume when a button is pressed. These are necessary user interface elements, yet they are often removed from the view as soon as the interaction is complete because

they tend to distract the viewers' attention from the actual story. Similar examples can be found in computer games and other forms of virtual media.

Being a virtual environment designed to be realistic, West Oakland Jazz and Blues relies mostly on diegetic sound and vision. The contents of the virtual soundscape are completely diegetic. However there are certain points where non-diegetic elements are used. The introduction scene is an example where music and a narrated video serves to transition the user from the interface of the login screen into the game world. Another case is when the on-screen street map is activated by the user. While some "iconic" sound effects were implemented to highlight "in-world" interactive elements, only a minimal amount of sound effects are implemented for the on-screen interface in order to maintain the users' focus of concentration within the virtual world.

5.5. Virtual Soundscape as a Medium for Social Interaction and Participation

By definition, MUVEs necessitate each user to be aware of the presences of other users that are simultaneously logged in to the same environment. Co-inhabitation of the same virtual environment by multiple users makes it closer to an actual place where social interactions can take place. In order to facilitate interaction, first of all the presence of each user must be manifest to others. Second, there has to be means of mediation through which bodily interactions can be intercommunicated. In virtual worlds this is achieved most commonly by assigning each user an avatar, an animated, three-dimensional visual representation of a human body. Since real-world social

communication relies heavily on bodily and facial gestures, newer MUVEs aim to mirror these as closely as possible.

In fact, both phenomenology and communication theory agree on the fact that we experience the environment through enactive perception which relies on bodily engagement with the outside world. Therefore participation is essential in any sensory perception leading to a sense of presence, implying we are not passive observers; and that we have engage in active probing in order to perceive (Noe, 2004). Sensory participation, making noise, to be seen, heard, touched etc. are also essential and formational for sensory and spatial experience and carry it to a social dimension (Rodaway, 1994).

Participative qualities of sound happen to operate slightly different for sound compared to those of vision and other senses. As Truax notes, acoustic participation requires active effort: “unlike the passive quality of ‘being seen,’ the listener must make an active gesture to be heard” (2001). We can be virtually silent, but not make ourselves invisible. Nevertheless, acoustic forms of communication are also important for the formation of social space. Perhaps this is because sound conveys personal agency and voluntary control, more so than vision which is involuntary. In this manner, spoken language is the most powerful of all social interactions.

Figure 5.6: Users participating in the creation of the virtual soundscape by "jamming" with the live band in Slim Jenkins' Club

In West Oakland Jazz and Blues, auditory social participation is allowed thorough a set of indirect means, even though direct voice communication has not been enabled in the Torque Game Engine. Firstly, interactive objects such as jukeboxes respond to user actions by playing music or sounds. Secondly, the users can "jam" with the band playing on the stage at the Slim Jenkin's bar. The users can step on the stage and play the piano by pressing keys on their keyboard. Pre-recorded riffs are assigned to different keys on the user's keyboard, and the user can decide on the order in which the riffs get played. In the meanwhile the rest of the band plays a 12-bar blues pattern to act as a musical background for the soloing players. The other users can also hear what's being played, and can respond by dancing or clapping (Figure 5.6). By exercising control over the production of the acoustic ambiance of the game the users become active participants of the soundscape.

5.6. Conclusion

In this chapter a case study involving the soundscape modeling for a virtual cultural heritage environment was presented. West Oakland Jazz and Blues' virtual soundscape features a generative sound system that is responsive to user interactions, and determined by environmental context. The methodology described here is strongly influenced by soundscape studies initiated by Schafer and Truax, and implemented through contemporary capabilities of a gaming engine running on commercially available 3D sound hardware. The presented methodology that was developed and implemented for this project can be useful for other projects that will utilize sounds, and multi-modal interaction, in support of traditional visual modeling to represent architecture and cultural heritage.

Due to the limitations of time and resources, some functionality that could have further improved the sonic complexity of the environment and helped increase the level of interactivity have not been fully implemented. Some of these are the capability of supporting voice-chat between users, voice-overs for NPC dialogs, and more variety and flexibility in terms of musical expression for the jamming sequences.

A structured evaluation of the perceptual and cognitive effects of the use of sound has not been carried out for West Oakland Jazz and Blues, however verbal feedback collected during user evaluations confirmed the findings of previous research that the immersivity and engagement engendered by the virtual environment increases with the inclusion of the virtual soundscape. The next chapter deals more specifically with the

questions of how acoustic and visual perceptions interact in the creation of a sense of place through a structured participant study that involves virtual surround sound implemented in an augmented reality setting. The emphasis will be on user testing and responses, in order to evaluate the effect of audio-visual interactions on the sense of place in actual environments.

6

Modeling Augmented Soundscapes: Assessing the Role of Sound in Environmental Perception Using Mobile Audio-Augmented Reality

The first three chapters argued for the multisensory and embodied nature of perception and place experience, and discussed the importance of sound in the making of a sense of place. Later, the field of soundscape studies was introduced and studies related to environmental analysis of sonic environments were presented. The case study in the previous chapter discussed the implementation of a virtual soundscape environment within a cultural heritage representation project. However the following questions need further elaboration: How does sound interact with other modes of perception to shape our perceptions of place? What are the ways in which the visual environment and soundscape influence each other? Can the effect of sound on environmental perception be measured, analyzed, predicted? This chapter seeks to answer these questions through a case study using mobile-audio augmented reality carried out in order to better understand how sound influences sense of place. The theory, methodology, outcome and implications of this study, which aims to extend the scope of previous research on the role of sound in shaping environmental perception and sense of place, are presented.

In the first section of this chapter, existing research and findings on the interactions of sound and vision in laboratory and environmental settings are summarized. Second, the theoretical justifications of the study and the motivations behind the use of audio-augmented reality are discussed. Third, the methodology of research will be explained in terms of survey procedure and technical implementation details. Following this, the sites included in the study are introduced, and a detailed analysis of the findings and interpretation of the results are carried out. A correlation framework is established between soundscape and sense of place that depends on audio-visual congruence based on cultural, aesthetic and semantic factors. Finally the significance of the findings and observations of this study are discussed within the overarching concept of sense of place.

6.1. Existing Research on Audio-Visual Interaction in Environmental Settings

Studies show that perceptual processing of auditory and visual information interact with each other. Literally speaking, what is seen can alter what is thought to be heard, and likewise, what is heard can change what is thought to be seen. This effect is found to be most evident for scenes that are audio-visually complex or when visual and acoustic information are incongruent. The interaction of audio and visual processing can occur at neuropsychological or cognitive levels. The multi-modal nature of perceptual processing is demonstrated in the McGurk experiment, which shows that in linguistic interpretation, audio and visual information can interact to generate the illusion of a synthesized audio-visual percept (McGurk and Mac Donald 1976). In this experiment the close-up video of a person saying “Ga Ga Ga” was montaged together with the voice of the same person saying “Ba Ba Ba.” 98% of the subjects who watched and listened to this video reported

hearing “Da Da Da.” The McGurk experiment shows that visual and auditory perception can interact with each other to generate a synthesized perceptual phenomenon that is not purely visual or purely auditory but a hybrid sensation between the two.

This section will summarize experimental research findings in the area with a specific focus on perceptual interaction of audio and vision in environmental settings. Studies of visual influence on loudness and acoustic comfort evaluations, acoustic influence on task performance and sense of presence in virtual environments, and the role of soundscape on place perception (sense of place) will be covered.

The multi-modality of perceptual processing is influential in cognitive interpretation, semantic and aesthetic judgments related to environmental scenes. For this reason, loudness and acoustic comfort studies must take into consideration the visual factors. A strong correlation between the type of visual scene and subjective evaluations of loudness has been demonstrated. It has been shown through an experiment using sound-image pairs that red trains are perceived to be louder than blue ones (Patsouras et al. 2002); sound of white noise is reported to feel more pleasant when simultaneously presented with a picture of a waterfall (Abe et al. 1999); engine noises are perceived to be less disturbing in the presence of the visual image of a vehicle (Hashimoto and Hatano 2001); images of greenery reduce the perceived loudness of noisy soundscapes (Fastl 2004); a large scale survey made with a group of people living in the vicinity of wind turbines showed that the amount of noise annoyance is positively correlated to the visual presence of the turbines (Pedersen and Larsman 2008).

Using image-sound pairs, Viollon et al. (2002) examined the effect of the level of urbanization on the perception of various kinds of noise. They showed that the more urbanized the visual environment was, the less tolerable the noise became, even without any changes to the acoustic input. This effect was demonstrated for natural sounds and traffic noises alike, with the exception of human-generated sounds like footsteps and talking. They suggested that human-sounds attracted more attention to themselves presumably overriding the influence of the visual stimuli.

It is important to mention that loudness is not the only acoustic factor influencing acoustic comfort in environmental settings. Yang and Kang (2005) studied the links between loudness, the type of dominant sound and acoustic comfort in urban public spaces. Their results suggested that while acoustic comfort is negatively correlated with loudness measurements in decibels, the type of sounds that are heard also influenced the ratings. It was shown that introducing pleasant sounds can improve the comfort ratings even at higher sound pressure levels.

While visual input can influence acoustic evaluations of environmental settings, acoustic input is also highly effective in the perception and functionality of environments. Research in the area can be divided into those investigating performance and presence gains resulted by the use of sound within virtual environments and those that investigate the acoustic influence on the sense of place within physical settings.

Even though hearing is often thought to be a sense inferior to vision in terms of spatial acuity, it has an advantageous position when it comes to spatial range. Acoustic space is

not limited to a narrow frontal cone like vision is. While we can only see what is in front of us hearing can sense all-directions at once. Hence the sonic experience of an environment involves the feeling of being surrounded by percepts, objects and events in that environment. One can then speculate that the acoustic encounter of an environment engenders a fuller form of embodiment than the visual one.

Because of its surrounding nature, acoustic experience has an enveloping effect making us feel more present and engaged within an environment. Studies employing virtual simulations were used to examine the effects of sound on behavior and task performance as well as its influence on improving the sense of presence in virtual environments. Turner et al. demonstrated the possibility of generating a strong sense of presence – a sense of being somewhere – by producing multichannel surround recordings of an indoor environment and playing them back in a laboratory setting to blindfolded subjects (Turner et al. 2003). In audio-visually simulated virtual environments, reported levels of presence and realism were shown to increase by the introduction of localized acoustic information and negatively influenced by its absence (Hendrix and Barfield 1996). Localized and distance attenuated audio was found to increase task performance in addition to resulting in improvements in reported presence values in virtual environments (Bormann 2005). Similar “presence gains” related to the employment of surround audio were reported in another simulation in which the virtual environments were presented as photorealistic 360-degree panoramas of real locations (Serafin and Serafin 2004).

Virtual environments benefit from the inclusion of acoustic cues and sonic ambiance to enhance the feeling of presence that they can engender in the user. However it is not clear how these findings would translate to the experience of physical environments. A number of studies have analyzed the perceptual effects of different types of sounds superimposed on top of existing environments.

Carles et al. (1999) carried out a laboratory experiment in order to study the ways in which different sounds could influence the aesthetical perception of visual landscapes. Their hypothesis was that there would be a significant correlation between aesthetic judgments of visual landscape and the ways in which visual and sonic stimuli are combined. To test this hypothesis the researchers designed an experiment in which 75 subjects were presented with a set of 6 image slides and 6 sound recordings. These were first shown and played individually and later presented as randomized combinations of sound-image pairs. The subjects were asked to rate each display within a scale of 1 to 5 in terms of aesthetic preference. The results indicated that: 1) Coherent combinations of sound-image pairs were more likely to get higher ratings. 2) Certain sounds, especially natural ones like stream or thunderstorm improved the ratings of the images regardless of the coherence within the image-sound pairs. 3) The images of city parks were rated higher when the subjects did not hear the parks' actual sounds, which were mostly composed of a mixture of urban and traffic noise from the nearby streets (Carles et al. 1999).

Ge and Hokao (2005) used a similar strategy in their study focusing on urban sound environments in Saga City, Japan. Their method included on-site analysis of the

soundscape, measurements of sound pressure level (SPL), along with interviews with people who were using the environments. In the “image evaluation” phase that followed the on-site surveys the researchers played back video and sound recordings of the sites to a group of subjects and asked them to rate each environment according to their perceptual attributes such as harmoniousness, naturalness, activity level, congruence of sounds and sights and so on. This was done first by just playing back sounds without the video, then playing back the video together with the sounds. They found that in noisy environments, introduction or removal of visuals did not significantly change the perceptual profile of the environments. However in environments with less noise and a more overall positive ambiance, visual information was shown to improve the preference ratings. This study differentiates itself from the others mentioned before in methodology in that it uses information collected through on-site surveys in support of experimental data collected in the lab. In this study tests with random combinations of sounds and visuals were not carried out, hence there is no data to show the combinatorial effects of different types of soundscapes on the same environment.

6.2. Rationale Behind the Study

The majority of the studies summarized above were carried out as controlled experiments or virtual environment simulations in the confines of the laboratory. All of them relied on two-dimensional display techniques, slide projections or video, with the exception of Serafin and Serafin who used a head-mounted display to present photographic panoramas. In some of the experiments the observer was able to navigate the environment virtually, by controlling the viewpoint of the camera. Others fixed the

user's experience to the viewpoint of the displayed image or video. Maintaining a high level of control over the input variables and limiting the type of user-environment interactions allowed researchers to prevent uncontrolled variables from influencing the results of their experiments. This ensured a higher internal validity, which in turn strengthened the reliability of the results. However, because of the isolated nature of the experiment, the ecological and contextual nature of perception and interaction have not been fully accounted for.

Previous chapters argued that in addition to being multi-modal, sensory perception operates within an ecological setting rather than exclusively within the neurological domain of the senses. Phenomenological accounts of perception suggest that intentionality and embodiment are integral to sensory experience of the world (Merleau-Ponty 2002 [1945]). In similar terms, Heidegger argues that human experience is place-centric, proclaiming that the nature of human experience can only be understood as "being-in-the-world", or *Dasein* (Heidegger 1996 [1953]). In line with the arguments of existential philosophy and phenomenology, Gibson's investigations on the ecological nature of perception also suggest the importance of the environmental context and sensorimotor interaction in perceptual processes (Gibson 1979). Accordingly, the Cartesian paradigm which formulates perception as the passive interpretation of a stream of sensory information flowing inwards from the world through our senses and into our minds gets discredited in favor of a mobile-intentional subject model that actively explores, probes the environment in constant interaction with it (Noe 2004).

Computer games and online virtual environments are on one hand powerful tools in simulating and communicating environmental experience. On the other hand, they are largely limited by the affordances of standard interface paradigms, such as the keyboard and the mouse, and constrained to a physically immobile desktop user-interaction. The experience of presence and immersion in virtual environments are determined by the set of affordances provided by the representational medium. These include the quality of physical realism, possibility of interaction and free action, and the awareness of social co-presence within the environment (Riva et al. 2003). Multi-user computer games such as 7th Street Jazz and Blues presented in chapter 5, are examples of such fully-mediated virtual reality where the feeling of immersion depends on the bodily-social affordances enabled by the specificities of the virtual interactive medium, at least as much as the capabilities of the user interface hardware.

Unlike fully-mediated virtual environments, which operate as complete substitutes masking out and replacing immediate experiences with synthesized ones, augmented reality works by combining the natural physical experience of space with digital interactivity. Therefore the strong feeling of presence naturally associated with the experience of physical space is coupled with the limitless representational capabilities of digital media. Augmented reality simulation techniques also resonate well with the ecological paradigm of perception since bodily-spatial interaction is incorporated into the interaction framework. Augmented reality is defined with three characteristics: 1) Combines real and virtual content. 2) Allows for real-time interactivity. 3) The virtual content is registered together with the real world. This means digital content is associated with and contextualized within the physical environment. (Azuma et al.,

2001). By coupling the realism of the physical setting with the representational versatility of computer generated representations, augmented reality techniques incorporate the body and its interactions with the physical space back into the equation.

Augmented reality techniques provide new and effective ways of approaching questions surrounding architectural and environmental perception. Studies that previously had to be carried out in controlled laboratory settings can now be taken out into the field. This makes it possible to investigate the effects of environmental treatments in their intended contexts and better understand how existing environments influence human perception and behavior. With the increased availability of ubiquitous computing and mobile communication devices equipped with coordinate, motion and direction tracking capabilities, the utilization of mobile augmented reality techniques for contextually based research becomes more and more viable.

6.3. Methodology and Implementation

This study was carried out as a series of surveys that were conducted at the University of California Berkeley campus with a group of 12 volunteer participants, all graduate students from the College of Environmental Design, between 23 and 34 years of age. The surveys took place at four different pre-selected locations within the campus. Each participant was randomly assigned to three locations on campus, which they were asked to visit and evaluate. For two out of the three places, the participants were asked to wear a mobile audio-augmented reality device and freely explore their surroundings by walking. For the third location they were asked to remove the headphones and interact

with the environment in an unmediated manner. After exploring each environment, participants were asked to respond to a one-page survey and an interview.

The mobile audio-augmented reality system was designed to deliver its wearer a geo-located, immersive acoustic experience. The participants were able to see, smell and touch the physical environment and freely move around while wearing the headphones connected to the system. Their acoustical experience was substituted by a virtual 3D soundscape delivered through the headphones. By dynamically tracking the users' geo-location and head direction, the system presented virtual sound sources with simulated spatial and directional cues.

For each study location, a control group of participants was created for whom no acoustical treatments were made. In the surveys and interviews that followed participants were asked to evaluate their experience as a whole, without focusing on hearing or vision alone.

The study examined the effects of the soundscape on environmental perception in situations where visual and acoustic information were in combinations featuring varying degrees of congruence with each other. The type and degree of congruence were classified for the inherent aesthetic characteristics of the sounds themselves and their semantic and cultural compatibilities with the existing places. The sound recordings were compiled from the BBC Sound Effects Library, two tracks from an audio CD titled *All hail blue & gold: music of the UC Berkeley carillon* containing pieces recorded on-campus at Sather Tower, and the personal sound recordings collection of the researcher.

While the study was designed to follow the methodology of a scientific experiment, it aimed to be more exploratory than scientifically accurate in nature. The surveys were envisioned as field experimentations, or quasi-experiments. Numeric results were envisioned as indicators to be supported by the subjective textual and verbal evaluations collected in the surveys and interviews. Nevertheless, the numeric variations between the normal and augmented survey groups were remarkably substantial for most of the cases.

Figure 6.1: Study locations marked on a satellite image of the central UC Berkeley Campus: Upper Sproul Plaza (S.P), Lower Sproul Plaza (L.S.), Campanile Esplanade (C.E.), Memorial Glade (M.G.) (Source: Google Maps)

There were altogether four campus environments included in this study. These were Upper Sproul Plaza, Lower Sproul Plaza, Campanile Esplanade and Memorial Glade all on the UC Berkeley Campus (Figure 6.1). These places were selected for the study for a couple of reasons. First, they were all architecturally well defined locations. They had clear margins marked by buildings, landscape elements, streets or pathways giving them enclosure and a unique spatial character. Second, they were all centrally located on campus, within close proximity of public functions like libraries and cafeterias. Therefore they were places that were utilized frequently by the campus community. This ensured that all of the participants would have previous familiarity with these places. Third, each one of the places represented a different environmental character in terms of activity level, type of landscaping, and amount of noise allowing a variety of audio and visual factors to be investigated. Fourth, their scale was neither too small nor too large, allowing the participants to fully assess the general ambience in a time period of fifteen to twenty minutes for each location.

6.3.1. Study Locations

Upper Sproul Plaza: Upper Sproul is a public plaza that functions both as a central circulatory node in the campus and connects it to Telegraph Avenue to the south. The plaza is surrounded by Sproul Hall to its east, Sather Gate to its north, Martin Luther King Student Union and Cezar E. Chavez Student Center to its west. A wide set of stairs descend from the middle of Upper Sproul Plaza to Lower Sproul Plaza which is adjacent to the west. Upper Sproul is used by thousands of people every day. During weekdays, it is one of the busiest places on campus. Student groups set up tables here, people gather

around to socialize in their free time between classes. It is a preferred outdoor venue for spontaneous concerts by street musicians or student bands, impromptu speeches by political and religious activists attracting small groups of audience. Sproul Plaza has a linear character aligned with the north-south direction. Its axial nature is strengthened by two rows of trees. In the middle of the plaza there is a small circular pond around which people can sit. There are also benches placed along the eastern side of the plaza. Sproul Plaza is nearly at all times an acoustically active place with a soundscape full of noises of people walking around and talking in groups and music playing from many locations. Towards the south end of the plaza, traffic sounds from Telegraph Avenue start to be heard.

Lower Sproul Plaza: Bordered by Martin Luther King Student Union to the east, Zellerbach Auditorium to the west, Cezar Chavez Student Center to the north, and Eshleman Hall to the south, Lower Sproul is a concrete-paved plaza with very little landscaping. The four buildings that surround it give it a strong rectangular definition and visual sense of protection. However, none of these buildings relate very well to the plaza, making it a less-preferred location for students and visitors alike. Except for the times when there is a show going on at the auditorium, or there is an organized event taking place at the plaza, Lower Sproul looks like an isolated and alienating environment. In the interviews, most people noted this fact, however, some mentioned that they liked the uncrowdedness of this place and the sense of privacy it offers when compared to Upper Sproul Plaza. The soundscape of the Lower Sproul is noticeably quiet compared to Upper Sproul however the noise of traffic from the street is relatively more noticeable. Sounds of people are also not as dominant.

	Group 1 *Actual Soundscape,* *no headphones*	**Group 2** *Augmented Soundscape,* *with headphones*
Upper Sproul Plaza 	Busy and loud atmosphere. People talking, cheering. Music, shouts, sounds of water from the pool. Traffic noises coming from nearby Bancroft Street.	"Moroccan Market" (*semantically compatible, culturally incompatible, aesthetically neutral*)
Lower Sproul Plaza 	Traffic noises coming from nearby Bancroft Street. Music from the temporary tent structure in the middle. Sounds of people walking by.	"Seaside & Forest" (*semantically incompatible, culturally neutral, aesthetically pleasing*)
Campanile Esplanade 	Occasional sounds of birds and wind on trees. Sounds of visitors talking. Campanile ringing the hour. Sounds of construction at a distance.	"Nature Park & Carillon Music" (*semantically compatible, culturally compatible, aesthetically pleasing*)
Memorial Glade 	Silent atmosphere. Sounds of people playing, resting on the lawn, biking. Vaguely heard sounds of construction and traffic at a distance.	"City Noise, Traffic & Construction" (*semantically incompatible, culturally compatible, aesthetically unpleasant*)

Figure 6.2: Study locations and evaluated soundscapes for the two study groups

Campanile Esplanade: Campanile Esplanade is a small scale, elevated park that is home to Sather Tower, the signature landmark of the campus. Esplanade's symmetrical baroque landscape is shaded with London Plane trees and surrounded by high shrubs at four sides. Sather Tower, which is a clock-tower with a 61-bell carillon, sits at the center of the park towards the south. Esplanade is a comparatively secluded and relatively quiet place isolated from the rest of the campus thanks to its location, landscaping and elevation. The clock bell strikes every hour and carillon music is played at 12pm and 6pm every weekday. The Sather-tower and its campanile function both as an important landmark and a deeply cherished soundmark for the university community and the city of Berkeley. Sather Tower is a popular tourist attraction visited by campus guests and students that sometimes arrive in groups, resulting in occasional activity peaks in the otherwise natural and quiet soundscape of the Esplanade.

Memorial Glade: Memorial Glade is a large green lawn located on the north of Doe Memorial Library. Compared to the other three places Memorial Glade is the one that is least architecturally defined. However, its half-bowl shaped topography which slopes up towards the north and north-east makes up for this fact. The slope overlooks a nice view of evergreens on its west, and has a sense of shade and protection provided by the row of trees surrounding it on its north and northwest, at the top of the slope. In good weathers students use the lawn as a field for playing Frisbee, or as a relaxing picnic area. The monumental façade and baroque steps of Doe Memorial Library overlooks the lawn

from the south balancing the naturalness of the green landscape with an institutional character.

The experiments were carried out weekdays while classes were held, between 10 am and 3 pm. It has been observed that between these times the environments showed fairly consistent levels and type of activity. The weather conditions were also relatively consistent throughout. All sessions took place within a two-week period in November 2008. Rainy days were avoided. The sky was mostly clear and temperatures were varying between 14-18 degrees Celsius.

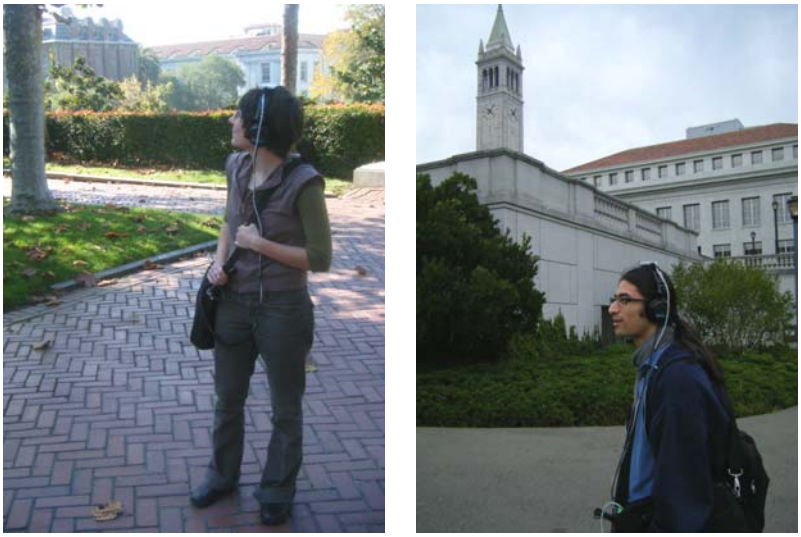


Figure 6.3: Two participants using the Mobile Audio-Augmented Reality system

6.3.2. Implementation Design For Real-Time Spatialization for Augmented Audio

The concept of audio-augmented reality was initially envisioned in 1993 (Cohen et al. 1993) Later technological developments in wireless and GPS tracking and increased portability and processing capacity of mobile computing devices allowed for progressive developments in the area. Many implementations and usage areas for augmented audio have been described such as an audio-guide in an indoor art-museum context (Eckel 2001), free-field applications for non-visual low-attention navigational interfaces (Holland et al. 2001), or for geo-located sound art (Helyer 2001).

A simplified mobile audio-augmented reality setup was developed specifically for this experiment. The system ran on a notebook computer equipped with a GPS receiver (GlobalSat BU-353 USB) for motion tracking, and headphones (Sony MDR7505) with a 3-axis digital compass and a tilt sensor for head tracking (OceanServer OS5000-US) mounted on the top. Soundscape authoring and spatial audio simulation via psycho-acoustic signal processing was carried out by a custom patch built on version 5.0 of the Cycling74 MAX/MSP signal-processing environment.

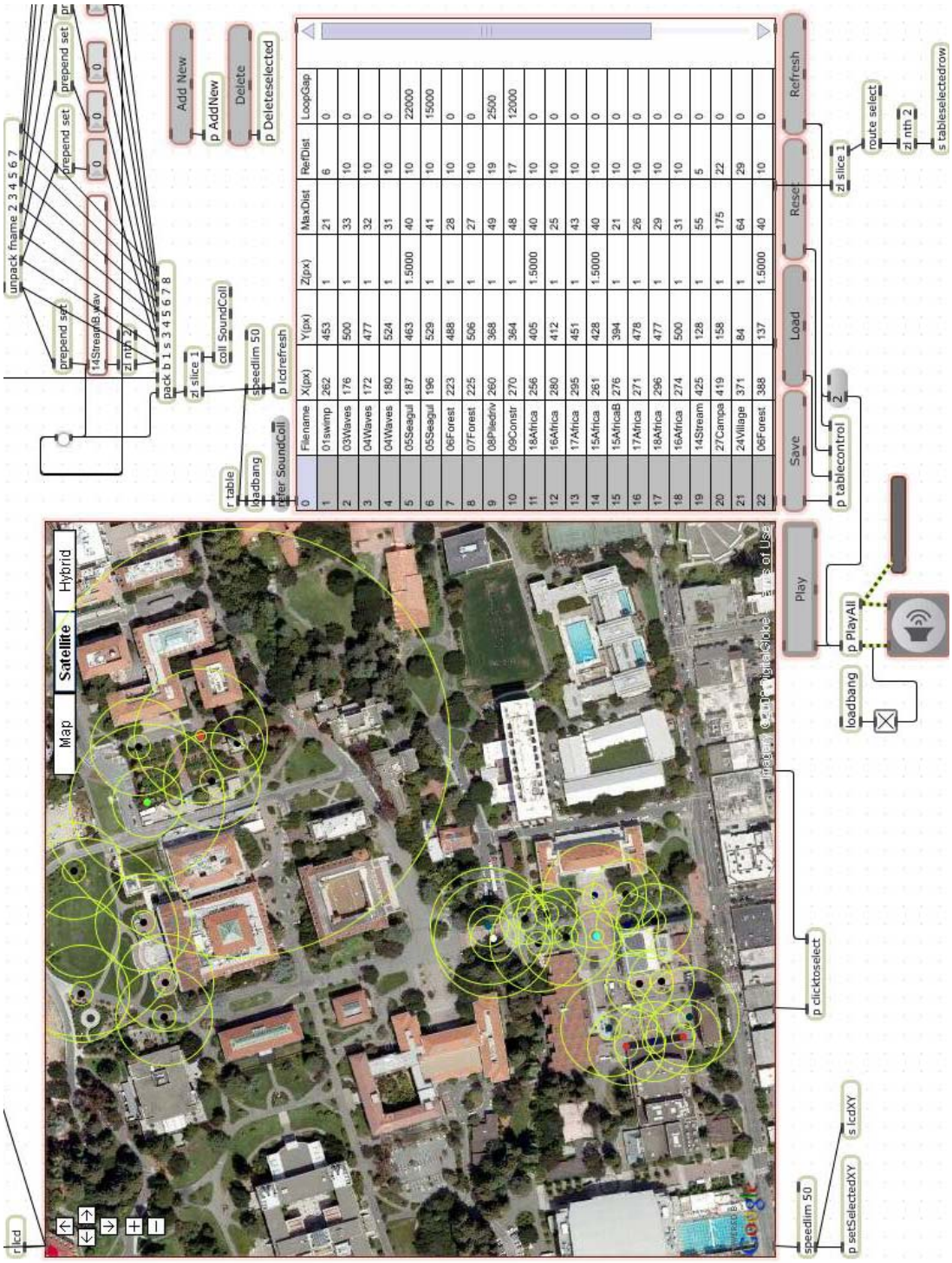


Figure 6.4: Partial view of the soundscape authoring patch developed in MAX/MSP

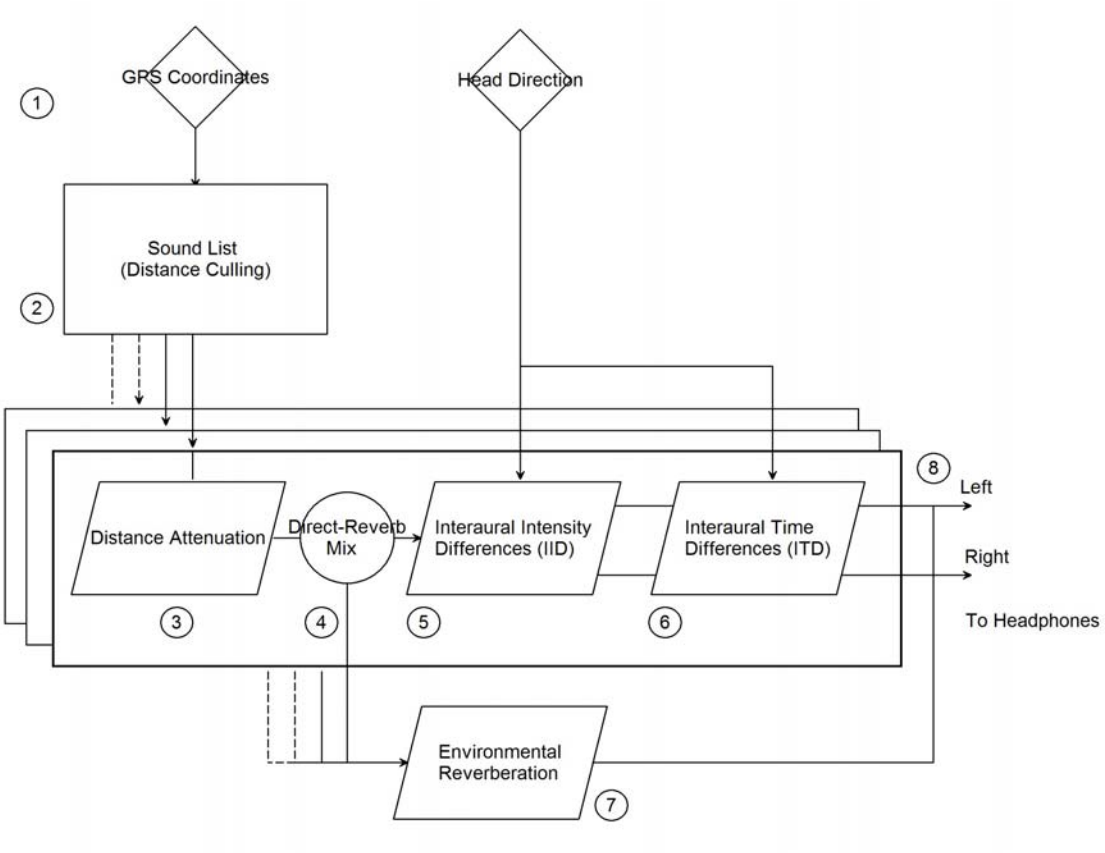


Figure 6.5: Diagram showing signal flow in the real-time localization algorithm

Figures 6.4 and 6.5 respectively show a partial screenshot of the soundscape authoring interface of the MAX/MSP patch, and a schematic signal flow diagram of the multi-source real-time localization algorithm. The algorithm is modeled to simulate psychoacoustic cues for sound-source localization as described in Howard (2006) and Cook (2001). A step-by-step explanation of the diagram shown in figure 5.5 is provided below:

(1) **Motion Tracking:** Real-time motion composed of geo-location and head-direction information is gathered via the GPS receiver and digital compass mounted on the headphones.

(2) **Distance Culling:** Sounds located on the virtual soundscape map are sorted based on their distance to the user. Sounds that are within audible distance are played. Those which are not within audible range are culled out in order to preserve system resources. Each individual source signal is passed on to a separate instance of the localization algorithm (encapsulated inside a MAX/MSP *poly~* object) to be processed for distance and direction cues.

(3) **Distance Attenuation:** Sounds are attenuated in amplitude based on their proximity to the user and preset maximum and minimum source reference distances. A linear-attenuation model is used.

(4) **Direct-to-Reverb Ratio:** A copy of the audio signal is sent out for environmental reverberation. While distance attenuation provides relative distance cues, direct-to-reverb ratio contributes substantially to the perception of absolute distance and also tends to reduce in-head localization errors.

(5) **Interaural Level Difference (ILD):** At this step the sound source is divided into two separate streams, one corresponding to left and right ears. Source azimuth relative to the head direction of the user is calculated and sound volume is adjusted for each stream to account for the directionality of the source.

(6) **Interaural Time Difference (ITD):** Depending on the azimuth of the sound source, a short delay of 0 to 0.7 milliseconds is introduced to the signal corresponding to the farther side.

(7) **Environmental Reverberation:** Environmental reverberation for all audible sound sources is cumulatively processed by an effect algorithm that emulates outdoor reverberation conditions.

(8) **Final Mix:** The Left and Right outputs from individual sound sources are sent to the corresponding headphone speakers after being mixed with the environmental reverberation.

6.4. Evaluation of the Survey Results

Figure 6.2 shows the four study locations, with brief descriptions of the corresponding soundscapes experienced by the two study groups. The first group represents the visits to the locations without any acoustic intervention. The second group is the set of visits with participants wearing the headphones. The soundscape treatments were classified according to their intrinsic acoustic pleasantness and their compatibility with the visual environment in semantic and cultural terms. One environment, Campanile Esplanade, was used as a test case. For this environment the aesthetic, natural and semantic characteristics of the implemented soundscape were in tune with the existing visual ambiance. For the other three locations sounds that are played through the headphones were in different configurations of incongruence with the visual landscape. Influence of each of these treatments on participants' environmental perception and preferences were queried for factors of pleasantness, vibrancy/impressiveness, noisiness, relaxation, orientation, familiarity, personal/intimateness, and familiarity (Figure 6.6). In the surveys these factors were presented in question form and the answers were collected in

Location _____

1. Please fill the survey below to rate the environment. **Think of your experience as a whole, <u>not</u> just based on the sounds that you hear.**

a. Do you think the overall atmosphere of this place is pleasing to the senses?

Not at all ☐ ☐ ☐ ☐ ☐ ☐ ☐ Absolutely

b. Do you feel this place is exciting, vibrant, or impressive?

Not at all ☐ ☐ ☐ ☐ ☐ ☐ ☐ Absolutely

c. How would you rate the noise level?

Quiet ☐ ☐ ☐ ☐ ☐ ☐ ☐ Noisy

d. Do you find this place relaxing?

Not at all ☐ ☐ ☐ ☐ ☐ ☐ ☐ Absolutely

e. Does this place provide enough sensory cues for orientation?

Not at all ☐ ☐ ☐ ☐ ☐ ☐ ☐ Absolutely

f. Would you consider this a personal/intimate place?

Not at all ☐ ☐ ☐ ☐ ☐ ☐ ☐ Absolutely

g. How familiar do you feel to this place?

Not at all ☐ ☐ ☐ ☐ ☐ ☐ ☐ Absolutely

2. Write 2 to 4 adjectives that describe this place (You may use the list above or find new ones):

_____ _____ _____ _____

3. Other notes, observations, impressions about this location (you can use the back of the paper):

_____

Figure 6.6: Participant survey form

linear scale with 7 check boxes horizontally placed in equal spacing. Only the boxes at the left and right ends were marked as “Not at all” and “Absolutely.” The participants were informed that the boxes were in linear increments from left to right. Later on, these responses were converted to numbers from 1 to 7, and mean values for each factor were calculated. The participants were also asked to provide additional comments both on the survey forms and verbally at the interviews.

The following sections present and analyze numerical results in graphical form and discuss them in parallel with the subjective evaluations collected during the surveys and interviews.

6.4.1. Numeric Results

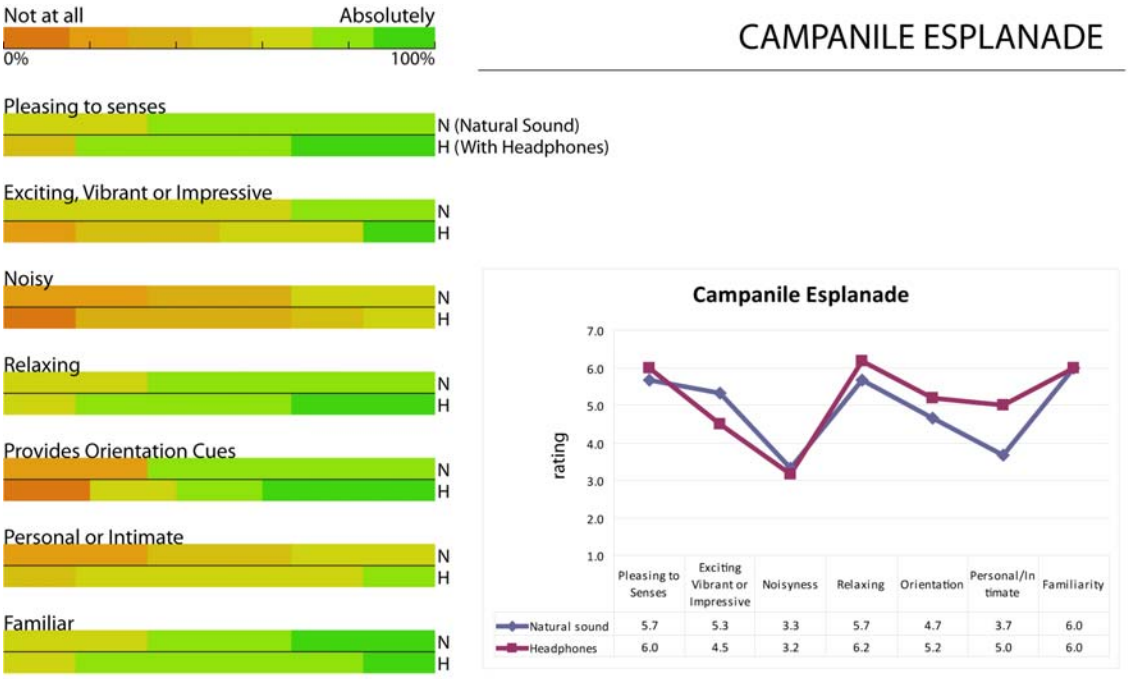
Results of the experiment confirmed the significance of the role of sonic cues in shaping environmental perception. Measurable variances in each of these factors were demonstrated and correlated to the type of acoustic treatment applied.

Upper Sproul Plaza: The intent of this part of the experiment was to test how culturally alien soundscapes can influence sense of place. The sounds chosen to be overlaid on top of Upper Sproul Plaza were sounds of a Moroccan marketplace, with sounds of the market crowd with audible conversations in Arabic, ethnic music playing, sounds of metal smiths and craftsmen, and various cattle sounds. The expected outcome was acoustic alienation, a decreased sense of familiarity; hence, lower ratings. An aesthetic effect, in terms of pleasantness, excitement or impressiveness was not expected since the

overlaid sounds were neither disturbing or pleasing in their own aesthetic/semantic attributes but solely designed to be “out of place.”

The results did not correspond to the expectations. The majority of the participants did not report a big discrepancy between the sounds and the visual landscape of the Upper Sproul Plaza. Those who noticed the discrepancy reflected upon their finding by asking the source of the sounds or commenting on the type of ethnic music playing. However, none of the participants registered this as detrimental to the aesthetic character or familiarity of the environment. On the contrary, substantial increases in the aesthetic preference ratings and some increase in familiarity were recorded (Figure 6.7.a). When asked about what made them find the environment pleasant, the subjects referred to the vibrancy and the fulfilling quality of the presence of human activity in the plaza. Most participants were not struck by the sounds’ distant cultural origins, and when informed of the fact that the soundscape they experienced was of a North African marketplace, they reasoned that they did notice a different language being spoken, but were able to naturalize these sounds by associating them with the heterogeneous crowd of the plaza. The congruence between the semantic characteristics of the audio and visual inputs, and the sensory awareness of human activity, even though the human sounds that were heard were not the *actual* sounds coming from the crowd, resulted in an increase in the pleasantness of the overall audio/visual ambiance.

Figure 6.7.a, b: Survey results from Upper and Lower Sproul Plazas. Colored horizontal bars indicate the comparative distributions of ratings with the associated color (orange: not at all, green: absolutely).



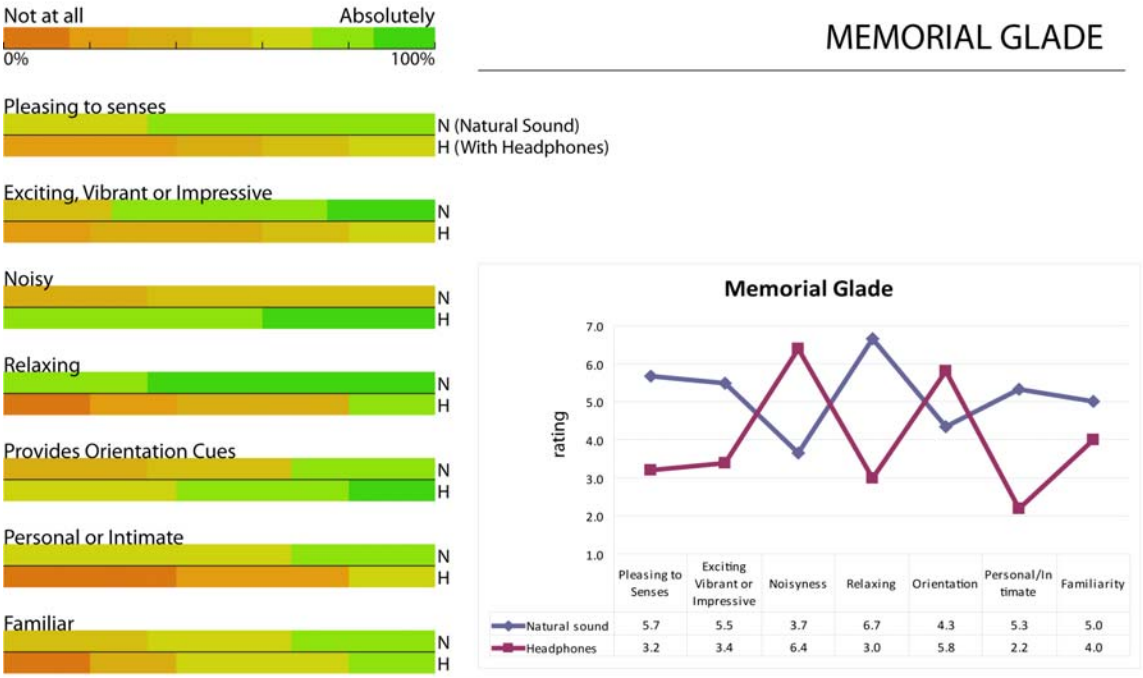


Figure 6.7.c, d: Survey results from Campanile Esplanade and Memorial Glade. Colored horizontal bars indicate the comparative distributions of ratings with the associated color (orange: not at all, green: absolutely).

Even though the participants wearing the headphones found the augmented environment more attractive and pleasing compared to the ones that experienced the natural soundscape, they also reported it to be noisier. The increase in ratings of noisiness when wearing the augmented audio device can also be the outcome of an experimental artifact related to the headphone volume itself. At the beginning of the experiment the participants were asked to set the volume to a level that they feel comfortable, however there is a chance that what was initially comfortable might have felt too loud later during the experiment. It is important to note that the mean values for noisiness with augmented audio increased for three out of the four locations, with the exception of the Campanile Esplanade where sounds and the visual environment were in near-complete congruence.

Another striking outcome was that despite the fact that the plaza was perceived to feel noisier with the headphones on, it was also reported to be more relaxing. This may be attributed to the use of headphones causing a feeling of isolation from the environment making one feel insulated in his/her private 'bubble', an effect which is also observed in personal stereo users (Bull 2000). Correspondingly, people found the environment more personal/intimate with the headphones on, than without.

Lower Sproul Plaza: Sounds that were introduced through the augmented audio system intended to create a naturally pleasing sonic atmosphere were overlaid on the urban visual characteristics of the Lower Sproul. A series of looping sounds of ocean waves were placed in a row along the west side of the plaza, corresponding to the edge marked by Zellerbach Auditorium. Sounds from a forest, consisting of birdsongs and wind in leaves, were placed on the opposite side. Sound clips of squawking seagulls were placed

in the middle of the plaza. The augmented soundscape was intended to be aesthetically pleasing, culturally neutral yet semantically incompatible with the visual environment.

The results indicate that the strongest influence was on the aesthetic attributes and comfort values (Figure 6.7.b). This finding was in line with the expectations. The mean values for responses to questions regarding aesthetic preferences had the most profound shifts, pleasantness increasing from 3.5 to 4.8, and exciting/vibrant/impressive jumping from 1.5 to 4.25. This shows that the soundscape elements, although they were not visually in tune with the environment, generated positive aesthetic influence on the place. Also, there was a significant increase in the sense of relaxation provided by the environment. Nevertheless, some participants complained about the lack of congruency between the visual and the auditory information, and reported lower values for relaxation and aesthetic preferences. The decrease in the orientation ratings was in parallel with the expectations of the study, since the participants often struggled to find out where the sources were originating from and could not reach a definitive conclusion due to lack of visual cues. No significant change was found in the personalness/intimacy provided by the environment or how familiar it feels to the participants.

Campanile Esplanade: This environment served as a test case for which the acoustic treatment was designed to match the visual landscape as closely as possible, only enhancing or making use of the sonic affordances existing on site. For instance, carillon music originally recorded at the Sather Tower was played back from the virtual location of the tower. Nature sounds, sound of trees, chirping birds and crickets, were scattered

around the park. An imaginary water fountain was placed in front of the campanile as the soundscape element that worked against the audio-visual congruence.

The results showed that mean value ratings for the groups with and without headphones closely overlapped. The acoustic treatment in this case caused no significant change in the average ratings (Figure 6.7.c).

No human sounds were included in the design of this artificial soundscape. Since the participants were not able to hear the actual surroundings when their headphones were on, some pointed out the perceived feeling of isolation which is reflected in the slight increase in the personal/intimate rating. This feeling was most apparent when other people were present on the site. This was not as noticeable in Upper Sproul, since at that location there were human sounds included in the artificial soundscape. In Upper Sproul the presence of human sounds in the synthetic soundscape balanced well with the visual input even though they did not synchronize with the actual events taking place in the visual environment.

Memorial Glade: The audio environment overlaid on top of Memorial Glade was that of a crowded urban plaza. Sounds of traffic were placed at the north and western edges of the lawn. Sounds of a reverberant bus station interior with announcements and crowd noises overlapped the Doe Library steps. Loud noises from a construction site were over the northeast quadrant of the plaza. The sounds of the Sather Tower carillon were designed to be audible at the southeast corner of the site where it borders the nearby Campanile Esplanade.

The overall impact of the new sonic ambiance was aesthetically and semantically negative, as reflected in the ratings. Nearly all participants reported the environment to be much less pleasing, much less exciting or impressive, even though the sonic activity level was higher than what is actually on site (Figure 6.7.d). This contrasted with Upper and Lower Sproul values, where the aesthetic impact of the introduced soundscape was generally positive. Noisiness was reported to increase and the environment was much less relaxing than it would have been with the actual soundscape. The place was also perceived as much less personal/intimate, and more public, and less familiar.

Strikingly, there was a small but notable improvement in the orientation ratings. Upper and Lower Sproul Plaza orientation ratings were negatively influenced by the artificial soundscape treatment. The increase seen in this case may be partly tied to the fact that the visual environment of Esplanade is less rigidly defined and more visually fluid, compared to the first two sites, both being rectangular in shape surrounded by buildings. Even though the space of the lawn may be not too differentiated in visual terms, the effect of having acoustic zones defined by different sounds, such as the train station zone, construction zone, and a zone with urban and traffic sounds, highlighted the orientational quality of the otherwise less defined site. The site was also characteristically much less crowded compared to the plazas. Because of this, hearing many sounds implying human presence and activity resulted in a big drop in the personalness and intimacy rating, and also negatively influenced familiarity ratings. This effect and other phenomenological aspects of the synthesized soundscape experience will be discussed in detail in the following section where subjective feedback from the participants will be analyzed.

6.4.2. Subjective Feedback

The ratings collected in the structured surveys indicated a strong interaction between the sonic and visual environments in shaping the perceived character and ambiance of a place. Because of the inherent limitations of quantitative analysis and pre-structured questionnaires, individual responses from the participants were also collected through allowing written comments and letting the participants talk about their experiences in their own terms in unstructured interviews. Written and verbal forms of subjective feedback provided fuller insight towards the individual phenomenological aspects of the participants' experiences of the environments. Evaluations regarding the interface itself were also assessed, since the numeric ratings themselves do not question the effectiveness of the mobile audio-augmented reality system in delivering the artificial soundscape.

In the discussions that will follow quotations from the verbal and written responses of the participants will be used. Participants will be identified in parentheses with their numbers from P1 to P12. Location names where the comments were recorded will be abbreviated as follows: Campanile Esplanade (C.E.), Memorial Glade (M.G.), Upper Sproul Plaza (S.P.), and Lower Sproul Plaza (L.S.).

Subjective influences of soundscape on place experience are grouped and discussed under 5 areas that were possible to identify: Emotional and synaesthetic effects associated with the soundscape; effects on attention, gaze and behavior; effects on

spatial orientation and sense of scale; influence of audio-visual congruence on sense of place; and perception of personal and social space.

6.4.2.1. Emotional and Synaesthetic Effects

Sound can transform the emotion or mood associated with a place. In some cases perception of sound can also trick the other senses and induce synaesthetic effects. In the surveys with audio-augmented reality these effects were commonly verbalized by the participants.

Some participants reported that artificial sounds made the environment seem cooler or warmer, at a different climate or time of day. This effect was especially common at the Campanile Esplanade. Despite the fact that the numeric ratings for the site showed no significant effect caused by the augmented soundscape, subjective evaluations hinted at more subtle impressions:

> It sounds like being in a public yet quiet park… Full of fountains and waters, full of trees as you hear plenty of birds. You still can hear the campanile. I raised my head to look whether the bell was ringing or not. The birds singing made me feel as if it was a sunny day, yet today is a very cloudy day… The Campanile [Esplanade] feels like a sunny day, like Alhambra Gardens. (P2, C.E.)
>
> The water sounds made it seem physically cooler. (P9, C.E.)

At the same location the discrepancy between the visually apparent activity level and the vibrancy of the sounds made some participants suggest that the experience felt like being transported in time:

> The birds and bells make me feel like it is morning (I am taking this [survey] mid-day) It makes me feel somehow optimistic for the day. I kept looking up at the branches of the trees, noticing how they formed a canopy, looking for the birds… The sounds blended with the environment, but some had their sources missing. It was like being in the same place in a different time. (P3, C.E.)

At Memorial Glade, where the overlaid soundscape was that of an urban street environment, with construction and heavy traffic, the effects of the audio-visual discrepancy were not as pleasing. Anxiety due to sounds of traffic and construction put almost all participants on alert and made them look out for vehicles that may be around. Some participants experienced a feeling of uneasiness because of this. Others reported that they literally became concerned for their personal safety:

> Construction place – also sound – hinders visual atmosphere [which is] peaceful. Also [being] inside the construction makes me nervous… Car sounds make me nervous. Cars and construction made me feel in a dangerous place, and made me feel nervous – continuously watching for something. (P6, M.G.)

> The traffic sounded more constant, steady. Sounded like I am somewhere in the middle of the street. I did not like hearing traffic sounds. They made me have to be real careful. (P6, M.G.)

An opposite effect was observed in Lower Sproul Plaza. In contrast with the traffic sounds played at Memorial Glade, the sonic ambiance of a seaside superimposed with the visual experience of the Lower Sproul had a physically comforting effect. One participant described the sounds as being “depressive, in a positive way”:

> … they lower your heart rate down… The ocean sounds are very soothing. In fact, I listen to these same sounds on my sound machine at night. Although Lower Sproul is not an active space – it can feel quite isolating. Yet I felt safe. The water crashing on the shore is a safe sound for me. The vastness of Lower Sproul reflects the bigness of the ocean but the familiarity of the sound made the space seem more intimate and personal. Also this type of sound – and therefore the space – is intimate in the sense that it encourages introspection of the self. (P11, L.S.)

The sound of ocean waves or other wide-band sounds like waterfalls or even pure white noise itself have a proven effect of relaxation and inducing sleepiness on the listener. Noise machines like the participant uses actually work thanks to this phenomenon. When asked about how she felt about the masking effects of such sounds the participant explained: “More than external noises, they mask the ‘internal noise’ of your mind, they make you stop thinking.” (P11) Yet another participant referred to the distractive quality of the ocean-wave sounds negatively:

> The sound of ocean waves were more of a distraction in my mind. No distinct impression… the waves sounded dissonant and did not construct a sense of place. The sounds bored me, did not enhance the place at all. (P8, L.S.)

Aesthetic preferences and semantic interpretations of sounds can sometimes vary from one listener to another. In one instance, a participant misinterpreted the traffic noise at Memorial Glade as wind, possibly because the sounds had a continuous low frequency hum just like the wind on a microphone. There were also no visual cues to indicate that they are coming from a street. Mistaking the sound for wind, the participant reported that she felt chilly because of the sound. Moreover, the sounds made her imagine visual cues in support of that physical feeling:

> I could not tell if I felt more wind or if it was the sound of the wind that made it feel windier… It really felt like the grass was moving, although I could see that it was not. (P7, M.G.)

The influence of soundscape on mood and other subjective feelings about a place is arguably the most difficult aspect to study and the hardest aspect of soundscape experience to generalize from. However, overall, the inherent aesthetic characters of the sounds were shown to be the strongest factor in shaping these subjective responses

regarding mood, emotion and aesthetic judgments related to a place. Semantic and cultural disparities between acoustic and visual inputs were also operative but their effects were comparatively much less pronounced.

6.4.2.2. Effects on Attention, Gaze and Movement

Whether they may be perceived as fully realistic or overtly artificial, foreground sounds made the participants attend to their perceived locations in search for their potential sources. The participants experimented with the virtual sound environment by turning their gaze and bodily orientation towards the sounds and walking around the space to move towards locations where they thought the sounds may be originating from:

> The sound of the Campanile made me want to look up. Even though I knew that it was not really playing I looked up to see the source of the sound. (P2, C.E.)
>
> Even it's a well designed park, very symmetric and directed, I feel like the wild. I would like to sit and be quiet. The presence of the campanile and the bell sounds made me look up to the sky. Feels good! (P4, C.E.)

The sounds were designed to be in overall harmony with the environment on the Esplanade yet it is clear that they highlighted certain aspects of the place and suppressed others. Sounds directed the participants' attention, gaze and movements towards particular details, objects and locations. The naturalness of the soundscape was perhaps too exaggerated making it seem too "wild" to some. Certain features of the environment, such as the shape of the trees forming a canopy or the verticality of the space that would otherwise go unnoticed came into the attention of the participants while they were looking for the sources of the sounds.

> The noise is making me look for the things in the place. If there were people talking trying to recognize who. If there is a construction, I randomly see a construction cone. If there are children I look for a mom with her child. If there are some Arabs talking I look at some Arab girls… The sound is related to the crowd of the space. (P4, S.P.)

Being in physical interaction with the soundscape made the acoustic environment feel more real, than a screen based virtual environment. Sounds were "materialized" and mapped onto physical space through interaction and movement, their presence was enhanced by embodied intentional interaction.

6.4.2.3. Effects on Spatial Orientation and Sense of Scale

Sound localization worked best when the sounds were matched with existing visual objects. The phenomenon, visual anchoring of perceived acoustic source-location, is referred to in psychoacoustics as the "ventriloquist effect." This effect is seen when location information obtained through vision seems to strengthen or override the location information available to hearing when the two are in conflict or when there are not enough psychoacoustic localization cues available. This is why in a movie theater the talking actor's voice seems to be coming from the screen even if the speakers may be located behind the audience. Virtual carillon music coming from Sather Tower was an excellent illustration of this phenomenon. Nearly all of the participants reported that they felt the bell sounds were very strongly localized. They could not tell whether the music was coming from the carillons above, or their own headphones:

> I could not tell whether the Campanile was really ringing. I thought it was from the speakers but I could not tell, really. It was hard, until I sort of removed [the headphones] to check. The directionality was really nice, that is why I was surprised. (P5, M.G.)

> The Campanile was REALLY here. It felt more strongly spatialized. (P9, C.E., original emphasis)
>
> The noises of the bells make me want to look up… Because it is not the Campanile, right? Are you listening to that? ... See it is twenty-to-twelve, so it is not campanile. (P4, C.E.)

Psychoacoustic cues to account for the vertical elevation of the sound source were not implemented in the experiment. Nevertheless the participants almost naturally raised their heads to look up towards the campanile when they heard the ringing of the bells. Some participants were pointing upwards, towards the direction of the top of the tower indicating that is where they hear the sounds to be coming from (Figure 6.8).

Figure 6.8: Participant pointing towards Sather Tower at Campanile Esplanade

Precise sense of localization similar to that of the Campanile was not attained when there are no visual cues to anchor sounds in place. This was mainly due to two reasons. First, because of the technical limitations of the location-tracking system it was only possible to achieve a low accuracy representation of source azimuth. Second, the absence of visual sources to match the sounds made them ecologically invalid, or “ghost” sounds.

Being contextually unrelated and visually unaccounted for, such sounds did not blend in with the environment and anchor to a specific spatial location. Even so, the study participants were able to correctly describe the general location that the virtual sounds were originating from. They were able to turn their heads freely and move around the space while the soundscape that surrounded them stayed spatially stable. This helped them attain an overall feel of how the sounds are distributed in relation to each other, and to construct a mental map of their locations. These 'invisible' sounds were registered as ambient sounds, defining an area rather than a point in space:

> Sounds stayed at the same location when I rotated my head. This was very useful for orientation. (P10)
>
> I was able to map their sources in space because sounds changed as I move. (P9)
>
> The more you approach (get closer) to the library the more you hear the noises of buses and traffic – as if the library was the hub of the bus station. While the far you walk from it, the calmer the noises become. (P2, M.G.)
>
> I found myself trying to localize the ironsmith shops and the spatial configuration of the tables at Sproul help associate some kind of SCALE to the sounds. (P9, S.P.; original emphasis)

Ambient sounds were interpreted as spatial zones that were experienced from within, rather than objects or events at a distance. This was more of the case when the sounds had a background, 'keynote' character to them. Some participants associated these kinds of sounds with architectural or functional meanings. Existing buildings and objects were used as loose points of reference to define these zones. Sometimes participants relied on such physical cues to define scale, location and orientation of the sounds that they were hearing.

6.4.2.4. Effects of Audio-Visual Congruence on Sense of Presence

In real environments, as opposed to virtual or augmented ones, acoustic and visual inputs are in natural synchronization and ecological congruence. People, cars, animals, plants and objects make noise as they move, when they touch, hit, or brush etc. against each other. Sounds are the result of mechanical vibrations that are caused by physical events that are in most cases also visible to the eye. In synthetic experiences created by movies and computer games, acoustic information can be divorced from the visual. In these media, "suspension of disbelief" has to be maintained through matching what is happening on the screen and what the audience or the user hears. Non-diegetic and off-screen sounds are two exceptions to this rule. The former is reserved for narration or music that is intentionally separated from the story space. The latter is used to enhance the representational realism of the film or computer game by extending the perceived space to the area outside which is seen by the camera.

In the case of the augmented reality simulation that was carried out in this study the separation between the visual information and the audio was part of the design. In three out of the four sites, the artificially generated soundscape was not semantically in tune with the visual landscape. Thus a complete representational realism was not an expected outcome. Nevertheless the participants were asked about their feelings on how well the sounds blended with the visual atmosphere. They were also asked to provide feedback on the interface:

> I was totally in one place in the first one.. It was like really compelling, dissolved in one… Maybe because it is because of the bells and the Campanile. And the shades

> of the trees were really low on the first one, so I thought you could hear the birds… (P4, C.E.)
>
> The sounds were natural, but the floor was concrete. Disassociation of visuals and audio did not make sense. In Sproul, this made sense because there were people around and I heard people. (P10, L.S.)
>
> I could not tell whether it was real or not, when the sounds matched the visuals. (P6)

On Campanile Esplanade, where the augmented soundscape was in tune with the visual environment, the participants reported that their sense of place was sustained. They could not detect the artificiality of the soundscape. At other places augmented sounds felt more artificial and sometimes distracting. Respectively in these situations of audiovisual incongruence headphones felt more present to the user.

When the participants heard noises of things or events that were not visually present, they tended to construct meaning to make sense of their environments. Interestingly, the effect was not completely detrimental to the sense of place. Instead, the resulting feeling was similar to how the audience interprets off-screen sound in a film. The invisible sound sources were either thought to be coming from the space behind the observer, or to be occluded by objects, buildings or landscaping in between:

> The sounds made it feel quite busy. Feel like there must be a lot going on behind the trees that border the glade. (P5, M.G.)
>
> But then when I was here, in Sproul, there were all these diverse [sounds] outside, for sure, not American sounds it made me feel that it was not there. So it was not that compelling… But then I thought maybe it is in my back. (P4, S.P.)

6.4.2.5. Effects on the Perception of Personal and Social Space

The perception of sonic objects and events that are not emerging from the visual atmosphere influenced the overall sense of place reported by the participants. However not being able to hear the sounds of the actual environment also influenced how the environment is experienced. The participants reported a decrease in their connectedness with the environment:

> You usually hear things in the environment like footsteps and other details. They disappear with the headphones… The people seemed to be on 'mute' – you could not hear the sound of a new person coming to sit, or a person opening or closing a lunch box, or two people having a conversation. (P9, C.E.)
>
> The sounds of nature were nice, but it isolated me from what really is around me, it was a bit scary. (P2, C.E.)

Being detached from the actual acoustic atmosphere of a place induced a feeling of personal isolation and spatial alienation. However this was not always commented upon as a negative phenomenon. Some people liked the sense of acoustic disconnection, and others mentioned that they preferred listening through the headphones to the actual soundscape of the places.

> Very interesting experience. I felt more relaxed and felt that Sproul was intimate! The effect of the sounds in my ears created a bubble for me – I felt detached from my surroundings, in a positive way. A similar experience to when I run with my iPod. I usually don't listen to music when I am walking through Sproul and I usually feel harried and harassed. (P11, S.P.)
>
> The sounds with the headphones felt like actual Sproul. When I took the headphones off it felt too silent, inactive. (P1, S.P.)
>
> The place feels mundane, after taking off the headphones. (P6, L.S.)

It was observed that people who reported that they regularly use personal stereos (iPods and alike) experienced less trouble adjusting to the artificial soundscape compared to people who do not wear headphones or earphones on a daily basis. Although there is correlation between previous personal stereo use and likeliness to better adjust to the augmented audio system, a causal relation between the two can not be inferred given the available observations. Relative ease with using headphones may be explained either as the result of a learned behavior due to previous habituation with the use of personal audio devices or as a general preference of whether the participant likes or dislikes using them.

6.5. Review of the Experimental Procedure and Findings

The soundscape of an environment is above all an aspect subject to aesthetic, semantic and cultural interpretation. Therefore its perception is subject to unpredictable factors such as tastes, values, expectations specific to personal, cultural, geographic and temporal contexts. In a study that uses artificially induced soundscapes to assess their influence on environmental perception, subjective preferences towards the sounds that are chosen becomes an important factor. According to Yang and Kang, preference ratings of individual sounds can be influenced by factors operating in three levels (Kang, 2007; Yang and Kang 2005). The first level is that of *basic preference*, determining the general types of sounds that people prefer over others, for example, sounds of nature over urban sounds, mellow music over engine noise. At the lower level of *macropreference*, cultural differences come into effect. Certain sounds that are familiar to and preferred by one culture may be alien to or disliked by another. At the lowest

level, personal preferences or *micropreferences* exist. These are determined by specific tastes, personal background of the listener.

The initial classification of the augmented soundscapes in terms of their aesthetic, semantic and cultural aspects were made with basic preferences in mind. Since all participants were selected from the same professional sub-group of students, and they were around the same age, they can also be assumed to belong to the same macropreference group. However individual preferences were impossible to avoid. Results of these personal differences in aesthetic interpretation caused unexpected but interesting results in a small number of situations.

It has been demonstrated through this study that sounds influence characteristics of place experience, in physical and emotional terms. Synaesthetic influences of sound on other senses were shown to alter the experience of the same environment to feel physically different, colder, windier, chillier or sunnier and warmer than it is. An example of the emotional effects of soundscape is the influence on the stress level. When the sense of personal security is threatened by an intrusive or dangerous sonic environment the overall experience of the environment was characterized as being stressful and even intolerable for some. Contrarily, sounds that are mild, natural and unthreatening comforted the perceiver and this translated positively to environmental experience. In some of the subjective responses, soundscape experience was linked to temporal subjectivity induced by the environment. Some participants felt that their sense of time felt manipulated in the presence of sounds from another time in the same environment as flashbacks or flash-forwards.

The geo-locative nature of the audio-visual simulation allowed the participants to interact with the acoustic environment with their bodies in addition to their ears and eyes. Sounds were shown to influence attention, behavior and movement within the environmental context. Gaze, head and bodily motions were all visibly correlated to elements of the augmented soundscape. Overall, sounds were weak orientation cues when strong visual orientation already existed in the environment, but were shown to increase the sense of bodily orientation where the visual environment lacked a defining character. The spatial configuration of physical cues in space such as buildings or landscape elements provided anchoring and sense of scale to foreground sounds. Sounds with an ambient character were perceived as acoustic zones with different characters or functional identities rather than as sonic events or objects with specific sources.

Acoustic perception was shown to be inducive to the conceptions of geographic, social and personal space. Sounds which appeared to be originating from outside the frontal visual cone, or behind the extent of the visual field, expanded the participants' scope of awareness beyond what is immediately available to the visual sense. Environmental sounds could increase the sense of peripheral and surround awareness, change the awareness of the acoustic horizon. The perception of human sounds was related to the construction of a social sense of space. When noises of people were missing from the augmented soundscape, in the presence of actual people around, the result was a mostly-unwelcome sense of bodily and social insulation from the place.

The preliminary classification of the augmented soundscapes included in this experiment in terms of their aesthetic, semantic and cultural characteristics were later correlated to

the type of effect they induced upon the sense of place. Aesthetic qualities associated with the sounds themselves were the strongest factors which in turn influenced emotional responses towards the environment. Semantic compatibility was found to be the most influential for judgments related to audio-visual congruence. When their informational content was not in tune with the visual environment, sounds attracted attention to themselves and became distractive. Audio-visual incongruence resulted in a level of anxiety and sense of disconnectedness even when the sounds were aesthetically pleasing in themselves. Cultural factors played the least important role in the context of this study, although it can be argued that this finding is caused by the international character of Sproul Plaza naturalizing the effect of the culturally alien soundscape and making it sound more familiar than it actually is.

The study employed an experimental procedure using bodily-spatial localization of artificial sounds with an attempt to construct stable, complex, virtual soundscapes that are experienced through interactions with existing physical spaces. Overall the performance of the designed prototype was found to be effective for the purposes of this study. Certain observations were made on the localization of sound in ecological settings. First, it was observed that people can get a fair judgment of location, distance and scale of sounds by moving around them in space. Second, the types of localization judgments were found to be ecologically shaped. Sounds that have an ambient character were not precisely localized and rather accepted as acoustic ‘zones’. Sounds that have a foreground, object-event characteristic to them were found to be the ones that required localization cues the most. Finally, for these foreground sounds, it was observed that

visual cues magnetically attracted sounds to themselves, resulting in an illusion of acute spatial localization.

The real-time multi-source localization algorithm that was employed worked effectively for the purposes of this study. However, improvement of the system for future applications is possible by refining the localization accuracy. The digital compass used in this study had a maximum refresh rate of 20Hz, which was enough to trace slow head movements, although it may be considered substandard for psychoacoustic research. Due to the design limitations of the worldwide GPS system, the accuracy of user location information was limited to approximately ±6ft at best. The location information was gathered at a refresh rate of 1 update per second. These hardware limitations reduced the overall accuracy of the motion tracking, making it more difficult to precisely localize near-field audio. More accurate localization processing involving frequency based filtering methods such as Head-Related Transfer Functions (HRTF) as described by Begault (1994) were not used because such precision would be redundant given the low motion-tracking accuracy. In addition the computational requirements of these techniques would have made it difficult to present a real-time multi-source scene. Also, the psycho-acoustically based method that is employed was found to produce more realistic results compared to Ambisonics, a technique which is also used in similar acoustic scene simulation systems.

All four locations included in this study were open air, outdoor environments. Even though it would have been interesting to include indoor environments in the study, this was not possible due to the reliance of the GPS on satellite connection. Future versions

of the same study can be carried out with more sophisticated forms of position tracking, like differential GPS for better outdoor localization accuracy, or an electromagnetic system that would enable indoor use.

6.6. Conclusion: From Soundscape Experience to Sense of Place

The introductory chapters classified the descriptions of the concept of sense of place from four main approaches. The first of these described sense of place as the inherent spirit of the environment, as a background preceding its human encounter. The second formulated sense of place as the cognitive image of the environment. This image, even though it is subjectively formed, was said to have socially shared inter-subjective traits allowing one to speak of a place's community image. The third approach defined sense of place as the human experience of the environment. This view was shaped predominantly by the phenomenological approach to perception and space, and that formulated perception as an ecological process centered within the contextual specificities shaped by the place of perception. The final approach was from cultural geography, which defined place as a socio-cultural process generated by lived experiences of space as much as perceived and represented realities.

All of the above four approaches carry equivalent significance when it comes to defining how places are situated within the full extent of human experience. Therefore it would be an elusive task to try to achieve a comprehensive description or representation of any place. Inclining towards the ecologically-centered approach, this case study investigated the role of a particular sense, hearing, in generating place experience by combining

existing physical places with virtual soundscapes. However, as expected, the findings of the experiment indicated the sonic sense of place is influenced by factors far greater than plain psychoacoustics of perception. This was mainly due to two reasons, one related to the acoustic content and the other related to the medium chosen for its delivery.

The *content* of acoustic perception proved to be more significant than any other attribute associated with it. Any form of soundscape is imbued with meanings and associations related to past experiences of places, events, and thus carried cultural significance, rather than being neutral. The three attributes of congruence based on cultural, semantic, and aesthetic properties, aimed to anticipate and investigate these influences of soundscapes within these specific aspects. Seven different analytical evaluation criteria, namely relaxation, vibrancy, pleasantness, noisiness, orientation, intimateness and familiarity, were used in the feedback surveys to provide a framework as a basis for quantitative deliberation on the effects of sound on the sense of place. The list should not be seen as an exhaustive description for the sense of place, but rather as a way of assessing of some of its subcomponents. Qualitative feedback from participants collected in the form of freeform interviews provided deeper and more interesting insight about many other aspects related to sense of place and presence some of which were initially not accounted for. Again, these responses were classified under subcategories that specifically addressed issues such as the emotional and synaesthetic effects caused by the introduced sounds; their influences on the users attention, gaze and movement, spatial orientation, sense of scale, the role of audio-visual congruence, and finally the effects of sound on the perception of personal and social space. All of these subcategories were seen as potential contributors to the whole, the sense of place for that

location and that particular context. However a comprehensive assessment of any individual's subjective sense of place was not intended or achieved in this experiment.

The second reason was due to the inherent affordances and limitations of the selected *medium* of delivery. The headphone augmented audio system, while successfully introducing the intended soundscape to the participants, in practice, acoustically isolated them from the environment. As explained in the soundscape chapter, personal and mobile media can often generate an isolating effect on the user. Using the terminology of Edward T. Hall's (1966) classification of the proxemic spheres, the "intimate" and "personal" spaces may have been heightened by the use of the augmented reality device in this experiment, however "communicational" and "social" spheres are negatively influenced. In the augmented audio world, the sound-fields corresponding to those larger communicative and social scales were replaced by virtual soundscapes. The negative effect of this isolation was most profoundly seen in places in which human activity was present in the suroundings.

The use of augmented reality in these conditions did not result in an enhanced sense of place, as in feeling attached and present within the environment, but rather a reduced one. Only in places with little or no human activity, people did not seem to notice this disconnect. The overall sense of place within empty plazas was enhanced by the addition of sounds of nature. Participants noted that the Campanile Esplanade felt more "present" with the artificial sounds introduced. This is a plain demonstration of the important role social interaction plays in sense of place. The social and inter-subjective aspects of

perception and sense of place need to be taken into account in the future versions of similar experiments.

The virtual acoustic experience that is delivered through the headphones nevertheless managed to generate a geographically situated sense of place, albeit a kind of its own. Rather than being presented exhaustively as a complete image, this mediated audio-visual landscape was explored in bits and revealed in time and space through spatial and embodied encounters just like an ancient city which reveals itself to its visitor street by street and never fails to surprise. These acoustic encounters, which may have initially been vague in themselves, were quickly and naturally interpreted into lived events, and adopted as personal memories by the participants. Using the perceptual stimuli provided by the environment as their starting point, the participants became active contributors in the making of their own senses and stories of place. This further proves that sense of place is neither a “spirit” to be found out there in the world, nor an “image” residing inside our minds but the merging of the two, brought to life by an embodied, lived, culturally constructed and socially shared experience of a place.

7

Conclusion

New media technologies redefine how places are made and provide new ways in which they are experienced. The potentials offered by new media for the field of architecture require traditional paradigms of placemaking to be reconsidered. Uprecedented forms of place experience are now possible: In addition to physical places one can speak of virtual and augmented place experiences. Through engaging with these new forms of media and studying how they can engender a genuine sense of place, one can get insights into how place experience emerges in general: within physical space, as well as within its virtual and augmented counterparts.

This dissertation took the opportunity to study virtual and augmented environments with a particular research question in mind: How does sound influence the generation of a sense of place?

For virtual places, it was argued that in addition to the immediate foreseeable benefits of implementing 3D sound, such as a substantial increase in immersivity, there are qualitative gains associated with the phenomenological completeness of the environmental experience. In resonance with the introductory theoretical discussions carried out at the first-half of the dissertation, it was argued through a case study that a

multi-sensory representation can enhance the sense of presence within a virtual environment. The inclusion of a realistic soundscape helps the virtual environment to engender a place experience in a more complete, direct and engaging manner. Sounds increase bodily-spatial awareness in virtual place, contribute to the sense of social co-presence and convey the multi-sensory complexity of the environment.

Virtual places on one hand have an experiential drawback due to the necessity of mediated presence; on the other hand they offer limitless representational and interactive possibilities. Physical places are limited in interactivity, yet they provide direct, unmediated phenomenological experience. Augmented environments offer the best of both worlds. They are both representationally versatile and phenomenologically direct. For this reason a mobile audio-augmented reality system was implemented for the empirical section of this study. The results of the experiment that was carried out quantitatively and qualitatively reinforced the argument that sound influences place experience. Moreover, the ways in which sound interacts with other modes of perception to shape our perceptions of place were identified and discussed, with the help of user evaluations. Instead of studying soundscape perception in isolation from the other senses the augmented reality experiment allowed to evaluate how visual and acoustic senses influence each other within an environmental setting.

The enactive approach to perception supported by contemporary phenomenology served as a guiding framework for this study. In spite of the fact that existing considerations of the theory are predominantly directed towards visual perception, the case studies are examples that the theory also applies for hearing and other senses as well.

The outcome of this study offers some insight into the characteristics of the acoustic dimension of place experience that has not been fully investigated before. This work also intends to point towards the possibilities of new media that may help architecture reconsider and re-embrace dimensions place experience beyond the visual. Sound is only one of the many aspects of place experience that can be explored through the help of digital applications. The novel ways of placemaking offered by new media goes beyond the medium of visual representation; they are only bound by the limits of imagination.

8

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