On the Desire to Not Kill Your Players: Rethinking Sound in Pervasive and Mixed Reality Games

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ABSTRACT

A commonly encountered argument for using sound in games is that sound increases the sense of *immersion* of a game. Immersion refers to an experience of being drawn into the game world, a process is centrally dependent on the players' simultaneous removal from everyday life also called disassociation. The immersive power of sound has been linked to its capacity to disassociate: to transport the player into a virtual reality which feels more real, more plausible and more consequential than his/her real physical surroundings, which is problematic especially for in mixed-reality and pervasive gaming. This paper draws on literature to trace exactly how sound contributes to immersion, and proposes how sound design can create immersion without disassociation. It also identifies engaging aesthetic opportunities that require non-immersive sound, which are currently being overlooked because of the assumption that good sound needs to be immersive.

Categories and Subject Descriptors

H.5.1.[**Multimedia Information Systems**]: Artificial, augmented, and virtual realities; Audio input/output.

General Terms

Design, Human Factors, Theory.

Keywords

Game sound; pervasive games; mixed-reality games; sound design; immersion; eversion; disassociation.

1.INTRODUCTION

The *immersive* power of sound has been linked to its capacity to transport the player into a virtual reality, and to make the game world feel more real, plausible and consequential than his/her real physical surroundings. However, this capacity can also be problematic in mixed-reality and pervasive gaming. In particular, many authors have pointed out the potential safety concerns relating to pervasive sound experiences when players become so engrossed in the game as to loose awareness of their surroundings [44][16][47]. Nevertheless, few strategies have been proposed to mitigate these risks and surprisingly little notice is being paid to the fact, that the situation is the direct result of basing the design on an effect that aims to distance the player from physical reality.

This paper suggests to take a closer look at the impact of adopting immersion as a design goal for sound in pervasive and mixed-reality games. The current discussion within pervasive game sound revolves around not *whether to* create immersion in these games, but rather *how* to do it. As such, immersion is taken for granted to be the only reasonable goal of design. The desire for immersive sound propels design, and also directs technological development, such as the personal augmented-reality audio [1] [22]. Current development has failed to consider the possibility that sound aesthetics originally developed for different contexts might not be equally useful for pervasive and mixed-reality gaming. Yet immersion promises to perform functions that become acutely problematic in the real-world context of pervasive and mixed-reality gaming. In particular, the blurring of boundaries between what is a game and what is real, and the removal of the player from their physical context become potentially lethal in a real-world context.

The topics that must be addressed are, to what extent immersion equals quality in sound design, and whether pervasive and mixed-reality game sound can be immersive in the first place. More specifically, the relevant questions can be formulated as follows:

1: What are the implications of adopting immersion as a design goal for pervasive and mixed-reality game sound, and why is immersion problematic?

2: Are there sound design techniques for immersion that work in pervasive and real-world gaming and can sound be immersive without simultaneously also confusing the line between real and non-real?

3: Are there engaging aesthetic opportunities that require non-immersive sound, which are being overlooked because of the assumption that sound needs to be immersive?

This work is organized as follows: The next section will present the design context of mobile gaming, and summarize the current discussion on immersive sound in mixed-reality and pervasive gaming. By pointing out the problems these games have encountered (question 1), I will make apparent why I think immersion—as it is currently used—makes for a troublesome sound design goal. Sections 3 will then delve deeper into the definitions and experiential components of immersion, and section 4 looks at precisely how sound creates and strengthen feelings of immersion in games. Section 5 and 6 then return with this information to re-examine the present and mixed-reality game setting, and identifies how strategies for immersive sound design are applicable in the real-world playing context (question 2). Section 7 looks beyond immersive techniques and offers examples to illustrate the existence of engaging sound aesthetics that do not involve immersion (question 3).

2. A CRITIQUE ON IMMERSION

The word "immersion" is frequently encountered in texts on gaming. When describing the experiential quality of gaming, calling something immersive is usually implying successful design. Game boxes make promises of "immersive gameplay" and in casual talk this suggests that the game is meeting a vast range of quality characteristics: that the game is both well designed and flawlessly executed, that assets are sensorily pleasing, or that the game characters are emotionally engaging. For example, the term frequently appears as a positive descriptor in game reviews, and is used particularly to describe story content and narrative [56].

Given how readily immersion associates to quality, a casual definition of immersion has become something of a beacon for good design. The term has also penetrated academic discussions about gameplay experience. The concept can be found explicitly listed in game design heuristics, and design instructions e.g. [40] [53]. For example, immersion appears among the required criteria for creating "game flow", where it stands for a experiencing a "deep but effortless involvement in the game" [53, p.6]. Other authors see immersion as the end goal of design. Brown and Cairns define "total immersion" as a state of deep and all-encompassing engagement with the game content, and position this experience as the ultimate extent of game engagement [8].

Like other areas of game design, also game sound design has become dominated with the goal of creating immersion. Quite often the main purpose of using sounds in a game is linked to its immersive property [12]. The predisposition to think of sound as inherently immersive is so ubiquitous, that it is rarely questioned at all (for a rare exception, see [37]). Instead, research has rather focused on asking how immersion could be maximized through sound design [20][24][35].

2.1. Immersion and disassociation in mixed-reality and pervasive game sound design

Contemporary mobile games are seldom considered very immersive. Nevertheless, as a design goal, immersion is ubiquitous and the open question has become how, or rather *to what extent,* the devices with their tiny screens can offer immersive experiences [33]. Indeed, designs as well as technological development all seem guided by a common determination that eventually, even mobile content will reach proper immersive capacity. As an illustrative example, immersion appears also in pervasive game literature, e.g. we find it used as a core component in the "pervasive game flow" model [25].

In terms of adding to the experiential impact of mobile gaming, there are a number of factors that make sound especially promising for this particular domain. Pervasive and mixed-reality designs could clearly benefit from the introduction of alternative modalities that allow eyes-free and hands-free interaction. Sound information could play a major role in these game forms, as audio can present game content in a way that minimally interferes with players' normal interaction with the environment. Such developments would make sound functionally central for embedding gaming into everyday life. Sound is also envisioned to play a major role in shaping the aesthetic impact of pervasive gaming. Liljedahl [35] discusses the particular power of sound to invoke imagination—and to immerse—regardless of display size, making a point about how sound quite factually blurs the border between the real and the fictive as "the game-generated sounds blend with the sounds from the gamer's physical environment, creating an inseparable whole". And when McCall and colleagues [38] investigated ways to support players feelings of presence in mixed-reality game worlds, they found that audio was in fact contributing more strongly than graphics to the sense of presence within the game world.

Nevertheless, it turns out that constructing immersive sound in pervasive or mixed-reality games is quite a demanding task. To date, the work has revealed that contextual factors play a significant role in shaping the aesthetics of the mobile sound experience (e.g. [3] [4] [15] [16] [43] [44] [47]). For example, players report that their feelings of immersion increase or diminish by location [44] and the same sound would be assigned different interpretations depending on where it was heard [16]. Writing on locative sound, Behrendt identifies an acute "need to consider how immersion works in locative media, where we are both 'here' and 'there' in hybrid spaces" [3, p. 288].

Within pervasive mobile gaming, the goal to craft immersive experiences has also created a dilemma. The way immersion is defined to be drawing the player into the fictive world (this will be addressed in more detail in the next section, depends simultaneously on distancing the player from the real world, an effect termed disassociation. This is not a minor side-effect. Disassociation is central to immersion, as it is one of the defining characteristics of the very concept. For example, the immersion questionnaire (IEQ) developed by Jennett et al. [26] involves a total of 31 items, of which roughly a third directly relate to aspects of disassociation. The quantification of immersion, then, relies on questions such as "To what extent did you lose track of time?", "To what extent did you notice events taking place around you?" and "To what extent was your sense of being in the game environment stronger than your sense of being in the real world" (see [26, p. 42–43] items 5, 9, and 43, respectively).

Now, for a pervasive or mixed-reality game, it is not hard to see how adopting immersion as a design goal can become problematic, both in general and for sound. Disassociation is certainly not a healthy state to be in for example when one is crossing a busy street where one should be paying attention to the traffic. If "the player gets immersed in a personal sonic space, which disconnects him/her from outside world" [13] or when sound is "blurring the known with the un-known" [10] we may find ourselves questioning whether immersive sound really is a desirable scenario. Nevertheless, these precise quotes are examples of the type of sound experiences that are sought for real-world contexts.

The uncritical adoption of immersion as a design goal has unintended consequences on the viability of designs for actual use. If immersion comes at the cost of distancing players from their ordinary activities, it is the main reason for a number of practical and ethical problems. The safety concerns regarding pervasive and mixed-reality game sound mentioned in the introduction provide an acute example of where such unintentional side-effects have already become critical. Importantly, by tracing these concerns back to the objectives of the design process, we can also start addressing these concerns in a more constructive manner.

Furthermore, applied to mixed-reality and pervasive games, the only reason why these techniques are not currently making games both confusing and outright dangerous is that—for the moment—immersive sound quite obviously *fails to achieve its goal* of completely confusing the barrier between physical real and fiction. Nevertheless, if designers were to succeed in creating total immersion (that is, they would manage to fully disassociate players from their physical environment) playing mixed-reality or pervasive games out in the real world would become a lethal endeavor. The paradox is apparent: the designs succeed only as long as the design goal is never met.

2.2.Re-evaluating immersion as a design goal

If immersion fails as a design goal for pervasive gaming, what does that imply for design? Within the larger scope of game design (but notably, not within sound design), the utility of immersion as a guiding principle for design has received some critique. For example, Calleja [9] proposes to replace the unidirectional plunge of immersion with the concept of incorporation, in order to better take into account the bi-directional process of game engagement; In addition to transporting players into the fictive environment, the game also represents the player within that game world. Lankoski [32] also abandons the notion of immersion, arguing that character engagement involves multiple psychological processes that variously depend on internalizing different aspects of the game world, and are not directly attributable to a player's sensation of being transported into the game world. In their influential book *Rules of Play,* Salen and Zimmermann [48] challenge the implicit equation of immersion to quality. They describe what they call *the immersive fallacy* as "the idea that the pleasure of a media experience lies in its ability to sensually transport the participant into an illusory, simulated reality" [48, p. 450]. Instead, they propose that game engagement is characterized by active participation within a constructed reality, depending on players' *knowledgeable interaction with the artificial meanings of the game.*

Similar lines of thought are echoed among many designers. At a recent talk at Game Developer's Conference, Richard Lemarchand argued that immersion is a misleading design goal since player enjoyment depends on the player realizing that what they do in the game is not happening for real [34]. Designer Raph Koster empathically argues for approaching immersion as a style, not a design virtue [30]. And finally, game designer Jeff Knowlton [29] examines the territory of immersion from the perspective of pervasive gaming. He holds that pervasive designs should abandon the way of thinking that wants to transport players away from physical reality. According to him, designers should instead aim to create virtual content that actively involves and addresses (rather than ignores or suppresses) the physical constructs of the surrounding environment. Knowlton calls this design concept *eversion*, and posits it at the exact opposite of immersion: instead of transporting players into a virtual world, it is bringing the virtual content out into the real world [29].

To summarize, the main problem with immersion for pervasive game sound is that it operates by disassociating players. As a case study, pervasive sound exemplifies the kind of problems that arise when "immersive" is taken to signify "good". For pervasive and mixed-reality sound, the presumption that immersion is always beneficial creates a situation where designs are striving to meet a design goal that, nevertheless, cannot be fully realized without literally jeopardizing the safety of the players. These problems, however, are also representative of a larger critique within game design, questioning whereby immersion is a reasonable design goal for game design in general. Whereas that particular discussion is beyond the scope of this paper, the case of pervasive game sound serves to illustrate the type of practical problems that immersion-driven design can create, and also demonstrates the importance of seeking alternative design goals.

In this paper I will explore two different solutions to this dilemma. The first is to ask if there are ways to design immersive sound that do not rely on disassociation. Answering this question will require looking at the specific techniques employed by sound design to create immersion, and identifying sound elements which are capable of immersing the player with minimal related disassociation. The second is to ask whether, by focusing on immersion, designers are unintentionally excluding other engaging sound aesthetics from their designs. To answer this question, I will look at the type of aesthetic devices that rendered impossible by immersion, and give a few examples of uses of sound, where the effect is dependent on sound remaining non-immersive.

3.IMMERSION

What kind of experience is implied by immersion, and why it should be considered such an engaging design goal? Within research, we find immersion is used to signify slightly different aspects of engagement with a (game) system, which also bring with them different implications for design. In the following I will provide a brief overview of alternative constructs as they have been proposed within research on virtual environments, and games. This is not intended as an exhaustive overview, but as a way of setting the stage for the more important discussions regarding how the qualities of sound are involved in shaping the immersive experience.

3.1.Presence and Immersion in Virtual Environments

Among researchers of virtual reality, "immersive" has been adopted to denote a property of the technology, describing the technological capabilities of the systems to surround the user with stimuli from the virtual world [51]. Immersive representations of virtual environments allow subjects to feel *presence*, or *tele-presence*, a state of being totally absorbed by the mediated environment, experiencing a detachment from their physical environment and fully embracing virtual reality [49]. Lombard and Ditton [36] define presence as the artificial sense that a mediated environment is unmediated. From a systems perspective, the term "immersive" refers to the technical and representational qualities of the system, and immersion depends on how the system provides sensory output and how it responds to user action. A few examples of important factors to consider are the number of sensory modalities engaged by the system, the technical quality and granularity of information (wide field-of-view of surround sound), and the level of realism verisimilitude of the portrayed virtual environment (realistic shadowing or accurate acoustic modeling). Responsiveness has been used to refer both to the sensitivity to user input [46] as well as the extent to which the user is provided with an ability to modify the virtual environment [50].

3.2.Immersion and Game Engagement

The definitions of immersion as system properties do not seem to fully account for the subjective experience during gaming that many players call immersion. The characteristically absorbing combination virtual content and game challenge have prompted the development of new models that better detail the engagement found in play behavior. Within game research, immersion has come to signify a combination of engaging with content in imaginary worlds (similar to presence), and also of becoming engrossed with performing game-related tasks, including overcoming motor and cognitive challenges. This has shifted "immersion" from something that can be conceptualized as a system property, towards defining a mental process, state or perception.

Thus, Lombard and Ditton [36] describe immersion as a form of engagement with the virtual environment; a combination of perceptual immersion (which is directed by the representational qualities of the system), as well as psychological immersion. Many models of game immersion operate with similar components, for example, McMahan [39, p. 68] discusses diegetic immersion—getting "caught up in the world of the game's story"—and nondiegetic immersion "love of the game and the

strategy that goes into it". McMahan also updates the responsiveness requirement first presented as a system requirement within virtual environments research by proposing that immersiveness requires that player action has non-trivial impact on the game world [39].

Two models that aim to understand immersion in the players' terms, and are based on player commentaries on game experience, are the SCI-model by Ermi and Mäyrä [18] and the process model by Brown and Cairns [8]. The SCI-model [18] breaks down immersion into three components: Sensory, Challenge-based and Imaginative immersion (SCI). This combines many of the aspects of previous models into one single construct, for example, sensory immersion bears strong similarities to the description of presence originally developed within Virtual Environments research. Furthermore, the SCI-model also manages to explain the engaging qualities of systems that are non-immersive in the sensory representation, but somehow still absorbing. For example, imaginative immersion explains how the way a player can become totally consumed with the experience when playing a text-based role playing game and challenge-based immersion accounts for how a game of Tetris can feel immersive.

Brown and Cairns [8] call attention to the temporal nature of immersion, suggesting immersion is rather a process than one specific state. They suggest the player initially experiences engagement, a state that may or may not progress to engrossment, and ultimately, to total immersion (which the authors equate to presence). The process towards higher immersion is moderated by boundary conditions that relate both to game characteristics as well as players' investments (time, attention, effort). The model thus views immersion as the extreme end point of a experience continuum, something that is incrementally constructed on the foundations consisting of other, less immersive, forms of game engagement.

4. IMMERSION AND SOUND

The most thorough investigations on game sound immersion look at sound in console and pc gaming. The following section uses that literature to identify the game sound qualities that make sound-involving experiences immersive. The next section will consider how the presented aspects of design apply to pervasive and mixed-reality designs.

Grimshaw [20] links sound's role to immersion through the SCI-model [18], and identifies sound functions in each of the three categories: sensory, challenge-based and imaginative. Grimshaw's focus is on first person shooter games, a genre commonly considered highly immersive. He proposes that within this genre, the most important immersive function of sound resides in its capacity to create sensory immersion that tricks the mind into interpreting the virtual reality of the game world as real. Sound immerses by enveloping the player with sounds of the game and by blocking out the sounds of the environment. In addition, Grimshaw finds sound central in providing feedback establishing the player's non-trivial impact on game world, manifested through action sound. [20]

In order to successfully transfer the player into a fictive environment, a sense of realism must be created. The question then becomes, what is enough realism to enable a "suspension of disbelief"? Doornbusch and Kenderine [14] state that immersion requires that a space "faithfully reconstructs the expected acoustic image of the presented visual image and the location of the sounds". McMahan recognizes that the representations in virtual reality are not evaluated in terms of factual representations. Rather, in order to seem plausible, representations need to fulfill the user's expectations and follow the established conventions of the medium [39]. User reactions to game sound are similarly judged based on how well sound adheres to the stylistic traditions within the given genre [12] [17]. Rather than adhering to physical reality (e.g. proper acoustics), immersion necessitates following specific codes of realism, a "reduced realism" that merely approximates how sound works in the physical world [20].

The popular use of immersion as a descriptor of game sound is explored in more depth by Huiberts [24]. Huiberts collected examples of sound that players felt were either highly immersive, or not immersive. His material demonstrates how widely different opinions and interpretations players hold about what constitutes an immersive experience. However, even if players' use of "immersion" may be inconsistent, the material is interesting as it provides a glimpse into what functions of game sound players find experientially meaningful and engaging. In Huiberts' material, two of the categories map to rather traditional views on sensory immersion, using sound to 1) build atmosphere and 2) make perception more intense. Sound is also involved with action-related immersion (c.f. the challenge-based immersion quality of the SCI model) through 3) supporting the pace of gameplay, and 4) increasing concentration on gameplay. However, beyond these functions, sound was described as immersive also simply for being 5) effective for inducing emotion. This aspect is much less straightforward to map into any previously suggested categories of immersion. On the other hand it resonates well with musical experiences being described as immersive (e.g. [4]).

Huiberts also investigated when sounds decrease immersion. The list illustrates the complex and multifaceted dependencies that together shape the experience of sound: Immersion can fall by wrong type of music, ugly or unpleasant or unrealistic sounds and bad voice acting. It can also decrease because of non-responsive audio feedback, because sounds provide too obvious response to gameplay, or because sounds are too repetitive or boring. Lacking audio is detrimental to the immersiveness of a game, as is hearing sounds from the players' physical environment [24].

Huiberts' and Grimshaw's work provides a general sense of what types of game sound is considered immersive. The next step is seeking to explain why, and how, sound contributes to immersion.

According to Brown and Cairnes [8], unlocking the final barrier to total immersion depends on achieving empathy. This requires narrative comprehension. The functions for achieving empathy through sound are linked to questions of **representational realism, narration and emotion**. However, only part of a game's sound design is about **creating and maintaining diegesis** [17] [27]. Ekman [17] points out that diegetic sound is particularly necessary for story comprehension and the emotions of narrative. However, whereas Grimshaw [20] emphasizes realistic **diegetic sound**, narrative comprehension can equally be strengthened by **non-diegetic sound** such as music, which provides complementary information about the scene, and directs attention to story-relevant elements, for example through conveying the mood of the scene, or drawing on associations and sound symbolism (e.g. [2] [11]).

Huiberts [24] notes that realistic sound gives sensory proof for the game world by **confirming the information derived by other senses**. Importantly, sensory confirmation relies on deeply rooted perceptual expectations that environments have both image and sound. However, these processes can be triggered **regardless of whether the sound matches the image content**, indeed, diegetic and non-diegetic sounds have proved equally adequate for this purpose and both are widely used to create continuity across scenes and mask visual cuts [2].

A central theme for immersion is the access sound provides to the fictive environment. This is referring to responsive feedback offered by the environment. Oftentimes this feedback is considered primarily in terms of game sound facilitating meaningful play by **providing necessary information, pacing and structuring gameplay** [12] [17] [24] [24]. Furthermore audio features modulate flow state to **influence challenge-based immersion** [24].

Action sounds also increase immersion by manifesting **the player's non-trivial impact on the game world** (c.f. [20] [39]). However, this is not simply about providing action feedback. Hug [23] discusses how sound also shapes and defines the players' sensation of power over the a fictive environment. Moreover, **action sounds also have a narrative function** which links back to **imaginative immersion**. Sound feedback provides information not only about the action itself, but also about the object that is being manipulated (e.g. shaking a canister containing liquid).

The most difficult aspects of sound immersion are the ones suggesting that sounds' immersive powers boil down simply to **properties of the modality**. For example, Liljedahl [35] proposes that sound is more immersive than visual information. Huiberts [24, p. 56] also suggest sound qualities that, at their most defined, relate to that sound **offers sensory gratification**. Sensory gratification, in this case, refers to the dynamics of sound, to the engaging experience with spatial audio, or to appealing audio more generally. A partial explanation could be that sound's power to stir emotional response is **bodily engaging** the player [28].

To summarize: We note that only a small part of the engaging immersive qualities of sound relate to maintaining a sensory or mental experience of a fictive environment, which might cause disassociation. Even within sound's narrative functions, we find non-diegetic realizations of sound that nevertheless support story comprehension. Action-related immersive qualities offer several more sources for engaging experience, including (goal-driven) gameplay, and agency. Finally, the sensory pleasures of sound are accessible simply by using enjoyable sound in the interface, and does not necessitate disassociation for becoming rewarding. We will now return to immersion in mixed reality and pervasive gaming and see how these techniques can be used to support immersive engagement which does not necessitate disassociation.

5. IMMERSION IN MIXED REALITY

Traditional definitions of immersion suggest a clear boundary exists between real and virtual. Waern, Montola and Stenros [55] state that "quite often the immersive power of a pervasive game comes from the players' genuine lack of understanding of where the game ends and the ordinary reality begins." Identifying the drawbacks of disassociation, McCall and colleagues [38] suggest mixed-reality immersion might come instead from meaningful actions within the game. Benyon [6] similarly points out how engaging with mixed spaces differs from the traditional virtual environment experience: "We want people to feel present in a blended space and to understand that the blend is a mixture of real and digital." With mixed reality, the aim is to bring both domains together and create a mixed frame of reference where both can exist at once.

Benyon suggests that engaging in mixed reality is constructed through finding and shaping the correspondences between the physical and the digital spaces [6]. Designs for mixed realities typically aim to augment, or enhance the physical environment. However, the means for successfully doing so with sound, instead of causing confusion, are not adequately understood. Gustafsson and colleagues [21] suggest that audio works so well in pervasive designs precisely because it allows shifting focus between the

fiction and environment and supports blending the two environments together. Nevertheless, Kurczak [31] found that while ambient sound increased feelings of immersion, a slowdown of performance could be attributed precisely to the increased effort of switching back and forth between worlds. What appears to have become the primary solution for overcoming this shift of focus is to blur the representational boundaries between fictional world and physical world, attempting a seamless audio integration. Viewed as a technical challenge, such Augmented Reality Audio technology might, for example, utilize transparent headphones, head position tracking and advanced sound processing to position sound seamlessly into the 3D audio environment [22], and selecting audio content that optimally blends in with the surrounding environment [44].

6. SOUND AND THE 360 ILLUSION

Representational blurring is rather demanding, both technically and from a design perspective, as it is extremely hard to recreate a fictive representation that is truly undistinguishable from physical reality. However, there exists another way to blur boundaries that requires far less representational fidelity, and that approach is also less disassociating in that it minimally affects players' perceptions of their surroundings. Rather than disassociation from the environment, and try to recreate a virtual world, Waern Montola and Stenros [55] suggest drawing on the tangible reality of the everyday to flesh out the experience. Instead of creating immersion by drawing the player into a game, the fantasy takes advantages of the reality around the player, creating a 360 illusion [55]. The design follows the idea that one can change the perception of reality by interjecting elements of fiction into everyday life to twist the perception of reality [21]. Once created, the illusion is maintained primarily through the design of action, by allowing players to interact with the game in ways that blur the boundaries between playing and real-world action.

In practice, this approach signifies a distinct shift in design thinking: from designing whole representations of fictive worlds, the game designer is rather designing game devices that merely provide glimpses of fiction when used. The design of these game props creates an immersive experience not by suppressing the real world, but by bringing fiction into the physical environment. Whereas one can argue that these props still try to disassociate, with props, the virtual is held together very locally, which confines disassociation to the particular actions with the game props. The fictive world is revealed only through interaction with these props, communicated through the interactions they enable.

The prop-based approach offers a lot of potentials for using audio, but until now prop-based design has received little dedicated exploration within game sound. Documented use of audio props can only be found for a few pervasive games. Prosopopeia Bardo II: Momentum [52] involved a modified reel-to-reel tape recorder with a hidden cellular phone, the "EVP machine", that was used to listen for ghost voices. Backseat Playground [21] gave players a "directional microphone", which they could point towards different spots in the environment along their journey, to listen to an unfolding interactive narrative. A few studies have also sought to include the mobile as a prop in the game design.

The notion of using the mobile phone as a gaming prop is developed furthest within gestural audio interfaces such as *Audio Flashlight* [54]. Here, the mobile device is portrayed as a device, and pointing/sweeping gestures with the device are translated into listening to the game world. Within pervasive mobile gaming, Ekman [15] [16] portrayed the mobile phone as a magic shaman drum, and Paterson and colleagues [43] [44] used the mobile as a multitool for paranormal investigation (including EVP recorder).

However, it remains unclear whether prop-based designs can fully replace disassociating immersive techniques in these games. Most prop-based game designs have simultaneously involved also other immersive sound techniques, and for example, props have been used together with constant background sound, and the designs still suffer from disassociation. Further investigation is required to understand the full immersive capacity of purely prop-based sound designs.

7.NON-IMMERSIVE SOUND AESTHETICS

If it is accepted that immersion or non-immersion are not purely qualities of modality—that sound does not automatically imply immersion—there must also be an option to choose whether or not sound is used in an immersive fashion. The question then becomes this: is non-immersive sound simply bad sound, or are there aesthetic choices related to non-immersion that are not inferior, only different, from immersive design? What kind aesthetic choices does abandoning immersion imply?

To answer this question, it is necessary to consider exactly what aesthetics immersion excludes. The non-disassociating forms of immersion discussed previously achieve immersion by blurring the borders between physical and virtual reality. Immersion also seeks to blur the interface, either perceptually by creating a seamless and immediate interaction with the virtual content, or conceptually, by making the actions needed to play the game undistinguishable from real-world action. Thus even the prop-based designs for 360 illusion rely on blurring the border between what is real, and what is virtual.

The recognition that immersion depends on blurring boundaries suggest one direction where to look for alternative aesthetic qualities: the cases where boundaries are actively part of the design. The removal of a distinction between real and virtual is not always a desired outcome of design. For one, without clear differentiation, annotations and references become impossible. Thus, for example, Rowland and colleagues [47] detail how they opted on non-immersion for a pervasive sound experience for bicyclists and how, instead of blurring borders, they wanted to use sound to make explicit annotations and commentaries about the environment. Likewise, Fraser, Cater and Duff [19] found that children had a hard time using a immersive "here" model of locative media. Instead, the children wanted to have a way to interact that enabled a "there" location model, a pointing function not entirely unlike the focus discussed by Rowland and colleagues [47].

Within pervasive gaming, there exists a notion of *seamful* designs [5]. These designs attempt to make the boundaries (for example technological boundaries such as GPS or WiFi signal strength) both visible and accessible to the user. Instead of hiding the technological boundaries, players are invited to use technological 'glitches' actively, for example as part of gaming tactics. Contextual design approaches allow a user activity that explores the borders between the physical and mediated experience. Behrendt describes somewhat similar experiences when she discusses how navigating within a placed sound environment takes on characteristics reminiscent of mixing [4]. Here, too, in order to mix, the user must perceive the boundaries of the material and interact with it in a conscious fashion. In this sense, contextuality is seen as a very desired outcome of both pervasive and augmented reality experiences and a design choice whereby the product can actively address, provoke or involve the physical world as part of the mediated experience (e.g. [41] [42] [45]).

Most pertinent to gaming, probably, is the discussion about whether an experience can actually be a game, if the boundaries are not recognized and if in-game behavior bears no distinction from real-world action. The way sound is used to support gameplay and the unproblematic deviation from diegesis in functionally significant game sounds [27] suggests that boundary blurring is not the only source to play and engagement. More practically, we can assume that in a long-term play setting, players are bound to develop an understanding about fictive elements as the experience progresses. If the engaging quality of the actions is dependent on boundary blurring, the design will not resist time; it loses its allure at the moment the secret is spoiled.

Precisely what boundary aesthetics will bring to mobile game sound remains an open question. However, I will offer two examples from film sound to illustrate a particular aesthetic effect that cannot exist without breaking immersion.

A romantic film follows the main couple through a scenes depicting everyday events, picking up groceries, waiting for the bus, walking hand in hand, all while accompanied by a swelling orchestral score. Suddenly the camera pans over to reveal a symphony orchestra playing by the sidewalk.

The shaky mobile camera shows a group of youngsters running to take cover from a crowd of enraged elephants. The microphone is picking up a lot of noise during the run, and it is hard to properly hear what the young people are shouting to each others.

Why is the first example humoristic? What is it that lends a sense of reality to the second scene? Both examples utilize a technique called *hypermediacy* [7], and in both cases, the sound is making references to its own constructed nature for rhetoric or aesthetic effect.

The comedic effect in the first example uses hypermediacy to surprise. Seeing the orchestra on the sidewalk it is humorous, because we know that hearing the sound of a symphony orchestra does not conventionally mean that the orchestra exists in the story space of the film. The effect is created by means of boundary negotiation, which at that moment is drawing focus to the non-authentic, non-immersive quality of the score by showing viewers something they would not normally expect to encounter while they are immersed in the film world.

The second example uses hypermediacy to attest to the authenticity of the scene. The representational imperfections serve as "proof" (sometimes constructed) to the viewer that what they are viewing and hearing is a recording of an authentic situation. The shaky camera and noisy location sound all attest (of course, within the media conventions we are accustomed to) to the reality of the source material. Here, hypermediacy becomes a way of acknowledging that "we know that you know" that the immediacy created in immersive representations is fake.

These types of boundary aesthetics have not been explored in gaming, and even less so within mobile games. However, they go to show that there are whole genres that are excluded if design focuses only on maximizing immersion. In order to make rhetoric reference to boundaries, they must be made visible. If all boundaries are blurred, we loose access to them in design, and any aesthetics that use boundaries will be impossible for lack of material.

8.CONCLUSIONS

Designers need concepts such as immersion to facilitate communication about designs. However, when these concepts grow too vague, they become useless for design. Commonly accepted design goals may also fail when they are applied to new contexts. If goals become too ubiquitous as to influence design

only explicitly, it can be difficult to step back far enough to realize that it is in fact the design goal that is the cause all of trouble.

Game designers have long cautioned against equating immersion with quality. The main critique has been that immersion is a poor design goal, as it is not specific enough to actually inform design. However, the safety concerns encountered with pervasive and mixed-reality game sound is a concrete example showing that immersion can also become outright detrimental to design. In the case of immersive sound, the problems to design can be traced to the component of disassociation that is a core element of the main concept of immersion. As many of the techniques employed within sound design for static pc and console gaming operate (in part or primarily) by disassociating players, these techniques are unsuitable when designing for pervasive and mixed-reality games. This is not to say that even pervasive and mixed-reality games cannot tolerate some disassociation or that these techniques are completely useless in this context. However, because of disassociation, uncritically adopting immersion as a design goal is highly problematic.

This work goes on to provide a deeper analysis of immersion, tracing disassociation to specific techniques and also identifying ways to tap into immersion without disassociating the players. The present work identifies one particularly promising venue for creating immersion in pervasive and mixed-reality gaming—the 360 illusion originally proposed by Waern, Montola and Stenros [55]—and outlines how specific sound techniques map into this approach. Specifically, sound can support non-disassociative immersive experiences by focussing the design on elements that retain a strong correspondence across physical and virtual world. Focusing on action sound, sonifying movement and gesture, and exploring artefact-based gaming offer means of creating immersion with minimal disassociation.

Finally, since immersion does not equal quality in sound design, it is up to the designer whether they choose to aim for immersion, or rather use non-immersive sound. If they choose immersion, they can do so using the techniques detailed in this paper. It is also possible that there are further practices that create immersion that we do not know about yet. However, if designers choose to rather work with non-immersive techniques, they are entering an area that is not as well laid out. In this paper, I have merely hinted at the aesthetic opportunities that become available when adopting a non-immersive design approach. The potential of this design approach is not conclusively covered within gaming. Indeed, the examples using hypermediacy that I have presented in this paper are taken from the domain of film, not games. They nevertheless illustrate the importance of looking for aesthetics that go beyond the popular notion that engaging sound should always be immersive. It is a topic for further work to explore how these particular techniques apply to game sound design, and also to determine the full scope of non-immersive sound aesthetics available for games.

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