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A Sense of Space: Virtual Reality, Authenticity and the Aural

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□—*This paper re-examines the history of the apprehension, consumption and production of reality by means of the aural in light of developments in virtual reality technology. It argues that virtual reality has long been a domain of audio technology and that by acknowledging and examining its roots in aural media its connections to the discourse of authenticity are made clear. It proposes that critical analysis of virtual reality must make explicit its undeclared nature as a mediated and symbolic creation.*

"Audio is a hard medium to file, it's a hard medium to wander through, and it's a hard medium to label."—Chris Schmandt, director of speech research, MIT Media Lab (Brand, 1987, p. 54)

RESEARCH and interest in virtual reality (VR) increase daily and the popular imagination appears riveted by the promise of VR technology. The scholarly imagination would do well to be at least engaged, if not riveted, also. What should we make of VR's claim to construct a world indistinguishable from that outside the virtual? We think ourselves able to place reality on one end of a continuum, and artifice or the symbolic at the other end. How will we understand our experience when virtual reality seemingly obliterates that distinction? Virtual reality calls into question our very notions of authenticity, a concept Hanno Hardt (1993, p. 49) considers central to "the critique of contemporary social thought." In the discourse surrounding virtual reality, however, technology's insertion into the discourse of authenticity goes largely unnoticed. *Whose* authenticity will be attained or challenged by virtual reality is not investigated.

The discourse about VR also tends to privilege the visual. The effort to construct reality technologically can be traced in visual media to stereographs—an offshoot of art and photography. But it also can be traced to aural media. Indeed, audio technology is very close to erasing the boundaries between the real and the recorded. That is not to claim that audio VR (or virtual audio) should be privileged in any way. It is neither better than virtual reality oriented toward the visual, nor more seamlessly "real." It is necessary to examine the current state of audio and acoustic communication technology to highlight the construction of virtual space by aural means and to

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reacquire the history of the consumption of reality through the aural. We must also examine issues arising from the implications of audio technology for public space, performance, and the apprehension/apperception of space. In the process we can better understand how an emerging technological form interlaces with one of the critical cultural categories of social thought, authenticity.

VIRTUAL REALITY/VISUAL REALITY

One of the earliest popular mentions of virtual reality appeared in Stewart Brand's *The Media Lab* (1987). Brand describes the variety of activities at MIT's Media Lab that concern, broadly, the flow and manipulation of information and information environments. The occasional mentions of virtual reality refer to it as exclusively visual, or, more specifically, object-oriented.

The Media Lab typifies the vested position of the visual in virtual reality research. Similarly, at VPL Research, operated by virtual reality pioneer Jaron Lanier, virtual worlds are visual worlds. The requisite piece of electronic gear with which one is able to interface to a computer is the EyePhone, the visual equivalent of audio headphones, eyepieces that show "you the view you would see as if you were really in that (virtual) world and turned your head in that direction" (Levy, 1990, p. 92). Note the emphasis on the visual in the following passage:

> How does "cyberspace" relate to "virtual reality," "data visualization," "graphic user interfaces," "networks," "multimedia," "hypergraphics," and other such catchwords for recent developments in computing technology? The answer: Cyberspace relates to all of them (Benedikt, 1991, p. 122).

Only in using the term "multimedia" does Benedikt seem to acknowledge a place for the aural. The very jargon of VR excludes it. In fact, the connection to computing technology (and that technology's connection to television) makes the link to the visual seem almost necessary.

VR's pioneers did not overlook other sensoria. Jaron Lanier has spoken of the possibilities for incorporating other senses in virtual reality—including the aural and tactile—by mentioning that VR technology could be used as a means of playing musical instruments. However, such an idea only speaks of VR's object-oriented, control-oriented trajectory. Even William Gibson's (1984, p. 51) cyberspace—the spiritual, if not technological, foundation for virtual reality—is rooted in the visual, that is, "in primitive arcade games . . . in early graphics programs. . . ." This trajectory is not surprising, for, as Henri Lefebvre (1984, p. 75) writes of absolute and abstract space, an "important aspect . . . is their increasingly pronounced visual character. They are made with the visible in mind." In VR, such construction is done with the aid of other senses.

Critics of the visual's primacy note that the aural must be taken seriously. Addressing the genealogy of the spectacle absent in Guy Debord's work, Jonathan Crary (1989) makes an important point about the combination of the visual and aural. According to Crary,

> spectacular power cannot be reduced to an optical model but is inseparable from a larger organization of perceptual con-

sumption. . . . The full coincidence of sound with image, of voice with figure, not only was a crucial new way of organizing space, time, and narrative, but it instituted a more commanding authority over the observer, enforcing a new kind of attention (p. 102).

VR's developers understand the combination Crary posits. Sound is utilized in VR technology to further distract the user's attention from the nonvirtual world, to solidify the technology's "authority over the observer." As Howard Rheingold (1991, p. 134) put it when he used a VR system at NASA, "3D sound via earphones removed me even farther from contact with the nonvirtual world."

Crary's point articulates with what Martin Jay (1988, p. 309) has called the "crisis of ocularcentrism." Critiquing Jacques Ellul, he points out that "the sins of ocularcentrism" are part of "a deep-seated distrust of the privileging of sight." Jay builds connections between a variety of thinkers who have criticized visual primacy, and one finds the names of many who figure prominently in communication, cultural studies, and media studies. For Jay (p. 323), as for Crary, "the crisis of ocularcentrism is by no means resolved, even in our seemingly iconoclastic era of hermeneutic suspicion of the primacy of the image."

Similarly, one finds that in the study of communication, as in the development of VR technology, the battle is far from over, and likely to be rejoined. J.W. Carey (1987, pp. 35–36), in an essay written to sharpen theoretical discussions over Walter Benjamin as a basis for critiquing visual society, observes that "[T]he definition of knowledge as a certain form of seeing, as a practice of looking rather than speaking" is a commonplace in much communication philosophy. Yet Carey (p. 33) notes that Benjamin's "larger subject (is) . . . the loss of aura (related) to the loss of aurality."

For communication theory, Berger and Luckmann's *The Social Construction of Reality* was a particularly significant point at which knowledge was defined as seeing. Widely used by theorists and researchers engaged in inquiry into symbolic processes, this book roots everyday social interaction in face-to-face encounters that focus exclusively on facial expression.

Moreover, they argue that the spatial structure of everyday life is not of concern to them, that it is the temporal and not spatial structure of everyday life that makes it real. VR technology's developers engage in determining the nature of social interaction in cyberspace, and in some ways may early on be choosing facial expression as one means of interaction. This is illustrated by the use of "smiley faces" and other characters in electronic mail, Usenet, and other electronic written communication.[1] In both Berger and Luckmann's book and in VR the emphasis is on perception by way of sight. Yet audio recording's technological history demonstrates the desire for expression in realistic ("high fidelity") acoustic environments, and so must be considered at a level alongside VR technology.

SPACE, SPATIAL LOCATION AND AUDIO RECORDING

Technics

The evolution of audio recording technology shows technical develop-

ment spurred by desire for control over spatial and temporal aural dimensions (Jones, 1992). In particular, sound recording captures (to varying degrees) not only the sound directly from the source but also that sound reflected from boundaries near the source. Sound recording thus captures ambient sound, or, put another way, the sound of the space surrounding the sound source.

There are two distinct paths this evolution followed. The first is live location recording, the second is close-miking, or recording sound in as isolated, anechoic a fashion as possible. The former seeks to capture as best it can the aural characteristics of the space within which music is performed, and the latter seeks to recreate, or create anew, the space the music will occupy. Both recording methods make claims about fidelity or realism, and thus, ultimately, about authenticity, though it could be argued that the displacement of the recording in the environment of the consumer makes such claims moot (Jones, 1992).

Indeed, claims about fidelity and realism occur at the production level, but rarely at the level of consumption. Throughout the history of sound reproduction reality was spoken of unproblematically. A reporter for *Fortune* magazine summed it up in an article about the development of stereo: "Realistic reproduction of sound is what the engineers are after" (Boehm, 1958, p. 165). There is no doubt that engineers aim for the *illusion of reality*. Roy Allison, an engineer at Acoustic Research, said in 1959, "The day is coming when we will be able, finally, to produce a consistent illusion of really 'being there' " (Hodges, 1978, p. 26). Fidelity and realism at the level of consumption are unproblematic because their transmission is opaque. As with visual apprehension of film or television, the boundaries delimiting real sound are perceptible and the distinction between real space and recorded space is made clearly.

Thus, when someone listens to a recording they do not claim to "be there." Yet recording production is invariably concerned with recording a "there" at which the consumer could "be," a kind of aural realization of Baudrillard's (1983) "simulation" which envelops the listener in sound. It is important to remember that sound recording on location was not possible until electrical recording was invented in the 1920s and the use of microphones that could record sound from some distance away became prevalent. Previously, mechanical recording required loudness to move a stylus and etch the grooves of a record. Microphones amplified sound and thus enabled reflected, ambient sound, to be recorded.

But location recording found disfavor among recording engineers and producers for a variety of reasons, among them the difficulty of controlling extraneous sound. Audience noise, sounds exterior to the performance area, and mechanical noise contributed to production difficulties; never mind that such sounds were a part of the ambient sound of the performance. Still, recording engineers and producers, as well as musicians, favored the acoustic characteristics of performance spaces like concert halls, churches, and auditoriums; it was difficult, until the advent of digital sound processing equipment, to recreate acoustic ambience

in the studio. Location recording was also of particular use to archivists and ethnomusicologists. Most recordings of blues singers and folk artists from the 1920s and 1930s were made in the field.

The growth of the recording industry and the concomitant economic realities of mass production and recording tipped the scales away from location recording and toward studio recording. Three forces were at work: cost, control, and realism (or fidelity). Regarding cost, it was less expensive to bring musicians to the recorder than vice versa, and having equipment already set up in the studio focused attention on recording as many songs as possible. Studio recording meant that engineers and producers had increased control over the recording process and over the recording itself. And the innovation of signal processing equipment (echo and reverberation chambers, equalizers, limiters) permitted the recreation of acoustic (that is, performance) space that rendered a realism beyond the acoustic limits of the studio. The introduction of tape recording cemented the studio's place as the primary site of recording; editing became the driving force behind innovation and design in recording technology (Jones, 1992).

Audio production has wobbled between location and studio recording ever since. The debate crosses over into the domain of the consumer whose assessment of a recording incorporates ideas of "live-ness," authenticity, fakery, and illusion. Paramount in recording is the production of acoustic or ambient space that surrounds the recorded music. This is accomplished through a variety of production decisions, including use of stereo imaging. For consumers, such decisions are primarily related to loudspeaker positioning and listening room characteristics and not to program content. Even surround sound systems that allow consumers to control some spatial parameters of a recorded sound source allow control only over the entire program. Such systems exist in part to allow producers an opportunity to better handle the complexity of sound sources in a recording. Binaural recording and reproduction systems intend to reproduce the human hearing system. These systems are largely unsuccessful because they require a great deal of precision and control of microphone and speaker (or headphone) location. Once a listener (or performer) moves even slightly out of the optimum location the binaural effect collapses.

Audio production, too, relies on control over individual elements within a recording to create a sense of space. Any recording made with more than one or two sound sources relies on controlling a variety of audio parameters for each source. Alten (1986) identified the parameters that can be controlled:

> Distance . . . is created mainly by relative loudness. . . . Direction of movement . . . (in) stereo . . . (may) occur laterally. . . . [F]requency also helps to establish distance and direction of movement. . . . Position is established mainly through loudness. . . . Openness . . . (is established by) echo with a longer than normal time between repeats; ambience that is extremely quiet. . . . Dimension of indoor space is usually established by means of reverberation (pp. 279–280).

Though brief and simplistic, Alten's list of parameters reveals the dimensions along which audio can be con-

trolled, and these are identical to the "cues" with which Elizabeth Wenzel (1992), designer of sound systems for NASA, defines 3D sound. Each parameter is a kind of signal or cue the listener interprets (Moulton, 1985). Such cues are the building blocks from which the listener interprets the space within which individual sounds occur and the overall sound is situated.

Technology

Elen (1987, p. 199) writes that, "Since the first days of stereo, engineers have been concerned with positioning signals in a sound-stage of one sort or another." The most prevalent current recording technique, close-miking, records little or no ambient sound whatever. Instead, by means of sound processing equipment it relies on the creation of an acoustic space for the mix (that is, blend) of sounds recorded in isolation. Audio engineers have found it difficult to simultaneously control the variety of parameters over a wide array of sound sources present from a number of microphones, electronic instrument outputs, and the like. In response recording is atomized as individual sounds are recorded one at a time onto multitrack recorders and then painstakingly recombined, again one by one.

The commonest device for creating ambient space during the recording process is the digital reverberation (digital reverb) unit, which functions to simulate acoustic environments. Those characteristics which affect the reflection, direction, and absorption of sound are malleable. Digital reverb units act to combine those aspects so that a signal passed through a digital reverb unit will sound as if it is occurring within the "room" created by the unit.

The use of quotation marks around the word "room" signifies the ensuing knot concerning reality and virtual reality. The aural cues from signals passing through the digital reverb tell the listener about sound located within a room with particular acoustic characteristics. But that room is entirely a fabrication. Various audio equipment makers even give pre-programmed rooms names, like "Concert Hall," or "Broom Closet."

Digital reverb units manipulate very precise parameters. Some units allow users to determine not only the size of a room, but such things as the type of wall coverings therein. More interesting are digital reverbs such as the Quantec Room Simulator (QRS) which use information from room measurements to recreate those rooms in the QRS. For the film "The Cotton Club," for instance, the soundtrack was recorded and processed through a QRS that was programmed with the physical characteristics of the original Cotton Club, including such details as the number and types of chairs and tables in the room.

Some of the impetus for innovation in spatial location in audio engineering has come from its uses in cinema. Movie theaters increasingly employ Dolby Surround Sound and other forms of audio playback technology. A still bigger impetus is the increased use of stereo television broadcasting, particularly via cable. Not only does that combination enhance both aural and visual components of those media; the juncture of high-tech audio with video provides a marketplace for audio productions

in addition to the audio-only media already present. Audio technology's goal is the re-creation of a sense of space, and development of that technology has fused with visual media; both technologies have a common goal (re-creation of reality). These technologies are realized in the sphere of entertainment. There the economic and artistic conditions meet and provide an environment within which audio technological developments related to spatial location are fused with visual media.

New audio technology in this area concentrates on signal processing equipment that manipulates all the parameters Alten (1986) mentions by means of a single control. That control, usually akin to a computer or video game trackball, is used to localize or "place" a sound in a part of the aural environment being created during an audio mix. The processor manipulates each parameter as necessary to achieve that localization. Some of the currently available processors include the Roland Sound Space Processor (RSS) and QSound. RSS, already used during the production of many popular music recordings, "allows engineers to localize sound within a 360-degree horizontal radius and control the elevation of the sound's vertical location" (Rotondo, 1991, p. SR1).

Nonetheless, such a system is only halfway hitting virtual reality's target, which is the creation of three-dimensional environments. In a true virtual reality, audio system sound sources would emanate from anywhere within space. As Jaron Lanier said,

> The world is out there stationary relative to you, which means it moves when you move your head, therefore you can't have true 3-D without headtracking and when you have that, the sound will actually change according to how you listen. So at some point in the future, there will be a true 3-D home stereo system that will know how you are tilting your head at the time and will move the sounds around to compensate for your head movement. So you'll not only be able to listen to a 3-D string quartet, but you'll be able to get up and walk around them (Stone, 1992, p. SR35).

Sound processing equipment like the RSS is evolving toward just such a system, and current audio research by companies such as AKG, Crystal River Engineering and Audio Cybernetics Studios shares that goal. Crystal River's Convolvotron project "provide(s) distance cues . . . by computing and presenting reverberation models" in real time (Foster, 1992, p. 94). Since it is easier to control sound heard through headphones, most audio VR systems produce their best effects with headphones. A good deal of innovation in this area evolved from binaural recording (Gierlich and Genuit, 1989). It sought a goal in common with audio VR, namely, the creation of a kind of artificial "head" which records sound in concordance with ear/body relationships. Though implementation of Lanier's "true 3-D" in recording and reproduction equipment is not near, that the goal of true 3-D sound can be reached is certain. The author has heard such systems at work in a Minneapolis recording studio. The results are surprising, as Christopher Currell recalls (Sirius and Drew, 1991, p. 23) from an incident during development of a virtual audio system:

> I've fooled myself . . . when I was checking the headphones, I heard a knock and the door opening. I turned around

and it was shut. I *made* the tape, I should know. It fooled me anyway.

It should be noted that any kind of virtual audio is still a passive experience, relying on playback of prerecorded material (Foster, et al., 1991). The recording can change little based on the listener's actions or movements, and consequently virtual audio has not reached virtual reality's twin goals, accuracy and interactivity. Nevertheless, what follows is as applicable to commonly experienced audio reproduction via stereo headphones as to virtual audio.

THE AURAL AND THE ENVIRONMENT

In *Orality and Literacy* (1982) and *The Presence of the Word* (1981) Walter Ong argues that sound and sounds are related to events. They signify an occurrence. This is why Currell glanced at the door to his studio. Yet the sound he heard, though it signified a particular occurrence, signified only its sound and not its conjuncture with a concomitant physical event external to the audio reproduction. Put another way, a sound-event occurred, its sound was recorded, and later reproduced. Current audio systems reproduce sound. The virtual audio system Currell used reproduced a recording such that it contained elements of both sound and event.

Ong also provides keen insight into the relationship between sound and space. Sound itself is spatially structuring. Hosokawa (1984) provides ample evidence of the practical side to Ong's assertion in an examination of the Sony Walkman:

> . . . there is the Walkman listener, who is found in the world of *listening to music alone*. This listener seems to cut the auditory contact with the outer world where he really lives: seeking the perfection of his "individual" zone of listening (p. 167).

What, then, when the individual zone and the environment intersect? Hosokawa (1984) provides interesting insight:

> The Walkman, in fact, has no meaningless context; at the same time, paradoxically, no context is strictly appropriate for it. Every context (or no context) can be justified, appropriated and legitimated by its singularity and autonomy. . . . The practical meaning of the Walkman is generated in the distance it poses between the reality and the real (p. 171).

Hosokawa describes use of the Walkman as a form of urban strategy, a means of imposing noise upon the noise of the city, a way to interpose an aural intercession into the environment. The result is Hosokawa's "meaningless context," sound (Walkman) and event (environment) are separated. This corresponds to Eisenberg's (1987, pp. 44–45) assertion that headphones are popular because they communicate the experience that "one is inside the music."

With a Walkman one can be both inside the music and outside, or, rather, mobile. Perhaps it is more appropriate to think of Hosokawa's "meaningless context" not as meaningless but as meaning-less, as a blank slate upon which any context can be imposed. Privacy becomes problematic, as does one's sense of localization. Virtual audio systems collapse the distinction between inside and outside, as they interiorize sound to an outside they create. It is interesting to imagine the wearer of a virtual audio Walkman going for a walk. What environment does the wearer

attend to? What sense perceptions cause reaction? As Carpenter and McLuhan (1960, p. 69) note:

> The "sudden loud sound" that Watson thought produced an instinctive (unlearned) fear response in the infant still compels our quick (conditioned) fear response when perceived as, say, an automobile horn.

To again refer to the incident during which Currell "fooled himself," it was only by a quick visual check that he was dissuaded from the belief that the door had opened. In that instance vision was a form of redundancy by which he could check one sense against another. For Currell, sound came first.

CONCLUSION: SPACE AND PLACE

The goal of virtual reality technology is creation of space, or, perhaps more pointedly, the control of the perception of space. This is a feat already accomplished by a variety of audio technologies, including ones presently available. Yet virtual reality is considered a primarily visual space. As such its creation can be understood as a part of the ongoing technological visualization and deauralization of space (Carey, 1987).

Interestingly, Biocca (1985), in an examination of perceptual change after the introduction of new aural technologies (the telephone, phonograph, radio) among avant-garde composers, argued that "the new aural technologies of the telephone, phonograph, and radio dramatically altered the perceptual and contextual relations of cultural and environmental sound" (p. 6).

Biocca sought evidence of changes brought on by aural technologies similar to changes from the introduction of printing. That search is particularly significant, as it examines the intersection of the aural and visual worlds in the technology of sound recording, a technology whose use is "part of the classificatory spirit of the analytical eye now superimposed on the yet unordered world of unclassified sounds" (p. 9).[2]

It is at that intersection, sharply portrayed in Biocca's discussion of the composer Varese, that one can understand, as Biocca does, the significant links between perception, technology and communication. Varese's unfinished project sought to do away with borders by simultaneously broadcasting a score titled "L'Espace." Communication by sound was, for Varese (as information technology is for cyberpunk partisans) the means by which to overcome space. In other words, for him the aural is a communication medium by which space in its *literal* sense is transcended. Not only is space observed across some distance, as with sight and with technologies that extend that sense, but it is, so to speak, colonized, filled with sound. Varese's "L'Espace" is not a collapsed space such as Baudrillard's (1983) "absolute space" of simulation, a flat surface. It is an abundant space, full, all around.

It is singularly refreshing to ask: what happened to that very conception of full, all-around space? Perhaps virtual audio is a form of rejoinder, an opportunity to examine issues that have been posed in visual terms by communication scholars and artists alike (in particular in the archly-titled *Being There*). At the least, it signifies potential for re-engaging in the "age-old battle between the eye

and the ear" Jay (1988, p. 323) describes.

But why not also ask: what if virtual reality were aurally instead of visually centered? The "flat"-ness associated with the postmodern "screen" or surface would arguably spring another dimension, perhaps as a children's pop-up book does.

The implications for communication are great. Writing from a position as a media practitioner in the 1960s and 1970s, Schwartz (1973) glimpsed some of those implications:

> Sound need no longer be contained within a physical environment that defines the boundaries for sound. . . . The geographic location of an audience . . . become(s) less meaningful for those who create communication (pp. 47–51).

Berland (1990, p. 186) assessed the implications of Schwartz's assertion in regard to radio and its audiences. She wrote that "social processes cannot be understood outside of space. If spatial and social processes are indistinguishable, then the production of audiences is inseparable from the production of spatial relationships." What is at stake is what Meyrowitz (1985) has termed a social "sense of place."

> . . . [T]he word "sense" and the word "place" have two meanings each: "sense" referring to both perception and logic; "place" meaning both social position and physical location. . . . [S]ocial roles . . . can be understood only in terms of social situations, which, until recently, have been tied to physical place, and . . . the logic of situational behaviors has much to do with patterns of information flow, that is, much to do with the human senses and their technological extensions (p. 308).

Through this "sense of place" we may frame one reason why Ong privileges oral culture. For Ong, it appears space and sound are connected through speech, and as Lefebvre (1984, p. 229) writes:

> In the immediacy of the links between groups, between members of groups, and between "society" and nature, occupied space gives direction—"on the ground," so to speak—to the relationships upon which social organization is founded. Abstraction has very little place in these relationships, which remain on the level of sex, age, blood and, mentally, on that of images without concepts (i.e. the level of *speech*).

The space to which Ong adheres seems closely linked to Lefebvre's "absolute space" or space linked to nature. Abstract space can be connected to virtual space most simply by way of acknowledging spatial construction by a variety of means (social, technological, physiological). Lefebvre, it would seem, opts for the social. For him, abstract space is part of "spatial practice," which defines not only places but representations of relationships.

One such spatial practice that may change when incorporating virtual audio is performance. Recording enabled the transference of a social concert space to a private, or at least less public, space, separate from the performance situation (and the performance time). Benjamin (1969, p. 222) addresses this issue: "Even the most perfect reproduction of a work of art is lacking in one element," he writes, "its unique existence at the place where it happens to be." In virtual audio a social concert space may be perceptible but not physically present.

It is more difficult to imagine the consequences of changes in the apprehension of sound and the sub-

sequent meaning-making humans perform. Ong (1982) succinctly described the perceptual change visual society induced:

> The centering action of sound (the field of sound is not spread out before me but is all around me) affects man's sense of the cosmos. . . . For oral cultures, the cosmos is an ongoing event with man at its center. . . . Only after print . . . would human beings, when they thought about the cosmos or universe or "world," think primarily of something laid out before their eyes . . . a vast surface or assemblage of surfaces (vision presents surfaces) (p. 73).

Virtual audio re-centers the listener by providing a sense that audio is no longer a "surface" projected from a speaker (or stereo speakers). It is once again "all around," and that all around *moves* with "me."

To return to Ong's remarks about the "centering action of sound," it acts as it does because of the space it has as its context. Moreover, sound is evaluated as an external occurrence in relation to the internal self and the self's ability to match what is heard to occurrences creating sound. For instance, musicians may often hear music "in their head" before they play it, and subsequently externalize that sound, by use of voice or instrument. In such cases sound is constructed mentally, by the imagination, with no necessary analogue in physical, external, space. External sound is reconstructed internally to correlate with known constructs regarding what "makes" sound and where sound "comes from." Virtual audio operates precisely on those assumptions, that we will "make" something of the sounds we hear, and not necessarily as we make sense of visual perceptions. Sound "comes from" all around us *and* from within us. Analogies to visual experience break down, for the visual *only* comes from within us when we are hallucinating.

That sense of space arising from the aural correlation of the external and internal is recontextualized by virtual audio, giving space motion and reproducibility, while allowing the physical body to be motionless and *feel* motionless. This suggests an interesting connection between sound, public space, and motion. Sennett (1978, p. 14) writes:

> The erasure of alive public space contains an even more perverse idea—that of making space contingent upon motion . . . the public space is an area to move through, not be in . . . public space has become a derivative of movement.

For Sennett movement was related to and contingent upon physical motion, but in virtual reality (visual as well as aural) the body assumes the motionlessness of instantaneity. As such VR can be connected to modernism in terms of its espousal of such instantaneity, speed and motion, and it is here that the visual and aural are most closely linked in VR, as they are both meant to operate in the service of ordered (and orderly) motion.

Biocca (1992a, p. 15) notes another of VR's connections to modernism, as it is "reshaping our work, power, and leisure." He makes clear the connections between virtual environments and public spaces, or, as he and Jaron Lanier call them, "virtual commons." It is therefore arresting to think of virtual reality, and virtual audio in particular, as technologies that thus reconstitute nature in a particularly natural way, yet recon-

stitute the public in a particularly private way (for though engaged in a form of public discourse, we maintain physical distance, and may even maintain separate VR identities). Also, given Lefebvre's notion that abstract space represents relationships, the ability to move through abstract space is an ability to reorient those relationships, and is thus in turn another comment on VR's connection to modernity by way of the illusion of social, class, and other mobilities.

Indeed, in this case virtual reality can be considered a particularly modernist endeavor. Manfred Stanley's (1978) observations of modernism and medieval life are notably applicable:

> To the men of the medieval period, nature appeared to be divinely ordered. To the modernist mentality nature appeared indifferent in the sense that natural laws seemed irrelevant to human moral aspirations. His passions forced back into the relativistic domains of his subjective psyche, modern man became more and more of a spectator of an objective world to which he could respond only with contemplative passivity or with technological activism (p. 22).

Virtual reality is perhaps the ultimate such technological activism. It is all the more modern since it concentrates not on nature per se, but on human nature, on the means by which nature is apperceived. To a degree it relies on the notion that humans are hardwired, so to speak, that they will respond to stimuli (in this case visual and aural) in a predetermined fashion. Crary (1989, p. 103) identifies such projects as originating with Walter Benjamin, and with Henri Bergson in particular. "Bergson . . . fought to recover perception from its status as sheer physiological event." Yet the development of 3D sound seeks to render auditory sensation physiological using audio systems developed from complex measurements of the shape of the ear, head, and the body (Wenzel, 1992). As Biocca (1992b, p. 41) notes,

> Each one of us hears slightly differently, and our individual differences can affect the success of an illusion. Each pair of human ears has slightly different acoustic properties, but an acoustic imaging system needs to be designed for an "average" set of ears.

He goes on to footnote that passage by claiming that, "It may be possible to calibrate systems in the future to adapt them to individual users." Not only will this be necessary for physiological reasons, as Biocca implies, but for psychological, psychoacoustic, reasons. Wenzel found that "people make a variety of errors in sound localization" (p. 91) for which many mathematical algorithms are created to compensate, thereby creating the calibration to which Biocca refers. The inclusion of algorithms to compensate for human error is a particularly interesting element of VR research. It is not just that it admits human complexity, but that it reveals the desire for order and power, in motion, of and over error.

This physiological dimension lets VR elide the discourse of authenticity, for it is implicit in the technology that one and all will attend to and perceive the constructed reality the same way. Put another way, virtual space is authentic in its very constructedness—the design that goes into it to make it real in anticipation

of and in reaction to physiology. Authenticity is not only implicit in the term "virtual reality" (for in virtual space we have knowledge of reality's construction and thus its authentic existence), but this phrase problematizes the word "virtual" more than "reality." Consequently, the social and technological dimensions to the construction of reality (and authenticity) are combined in VR with a physiological dimension that gives VR a particularly powerful pull on the psyche. It would appear as if the construction of reality has added a human dimension, or at least one acknowledging the role human physiology plays in that construction. But that addition is an illusion; it has no room for the symbolic, and thus in practice acts as a reduction denying the social construction of reality its rightful place. It takes a mechanistic turn privileging the physical.

VR bears the strong imprint of a technology that seeks to revivify life, in a time when life seems to need revivification. It is another development, albeit a more sophisticated—and, as mentioned above, less "flat" one—in the interplay of "technology and the pastoral ideal" (Marx, 1970). VR is another canto in Carey and Quirk's (1989) "Mythos of the Electronic Revolution" and part of the modernity discourse Jensen (1991) identifies. Other technologies assessed within that tradition (radio, phonograph, tape recorder, television, computer) have been critiqued for the uses to which they have been put (escapism, perceived negative effects, propaganda, and so on) and for their ultimate result in inauthentic experience. It will be interesting to see how virtual reality technology fares as its uses become more apparent. Such critiques have focused on the boundaries and perceptual limits technology establishes. Thus they are part of a discourse concerning reality and authenticity, and in particular a discourse concerned with control, manipulation, the suspension of disbelief, and a variety of issues with which mass society and mass communication have grappled.

Most ironically, critiques of VR have emerged even though the technology is not yet in place. The goal of VR combines the promises of almost all preceding media technologies, as if VR's inventors skimmed the utopian landscape of Carey and Quirk's "Mythos," and incorporated its contours into their aspirations. VR is critiqued so early in its life because this technology and its goals look familiar—the "same old thing in brand new drag," to borrow from David Bowie. But instead of finding comfort or even contempt in that familiarity, we question it, having been let down before by its predecessors.

NOTES

[1]Elizabeth Reid's (1992) research on virtual communities provides an interesting discussion of the use of emoticons on electronic networks.

[2]Developments in digital recording systems that link musical instruments and recording devices are oriented visually for the purposes of editing and other manipulation. In that fashion sound itself has become deauralized and made visual. One may argue that even early on musical notation worked toward a similar goal, but notation does not record *sound* as audio recording does.

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