**A Communicational Perspective on Computer Mediated Sound Design**

# The Value of Acoustic Communication in the Computer Mediated Environment

**Keywords:** Ecological Acoustic Design, Augmented Reality, Sonification, Auditory Display

**Mark C. Brady**

mbrady@sfu.ca

mbrady@inter-mission.org

Stu#: 200113882

**April 21, 2003**

## Introduction

The ways in which sound touches and sways both the body and mind makes sound an effective communication medium. So it is curious that such little attention has been focused on the art and craft of audio design as an interface between computers and humans. Audio work has long played second fiddle to the prevailing cultural orientation toward visual media (Khan, 1990). The context of this text is the contemporary visually dominated computer mediated environment (CME). This is an environment which is being saturated with “smart” products -- mobile and ubiquitous computing devices which are increasingly (Thackara 2001) bundled and sold in the post-industrial consumer oriented society. These devices include desktop computers, but are also taking new forms - a range mobile forms such as PDAs (Personal Digital Assistants) and wireless phones and embedded forms such a “smarts” in doors and rice cookers. The audio design present in these devices is often poor because the correlation between the events represented to users and the sounds the devices make are often unclear. The sounds themselves are typically harsh or implemented as boring reproduced samples with no variation.

The audio design is characteristically non-linear. It is described not on a timeline, but in reaction to events and state changes, which are algorithmically interpreted into a realtime performance. The audio designer does not know the arrangement and context that the design will be played out in. This makes the designers desire - to communicate these events through sound, difficult. An understanding of acoustic communication is needed.

This document presents an overview of richly developed perspective on acoustic communication and highlights the values that this perspective can bring to design in the computer mediated environment.

There are two major reasons to enlist this rich communicational perspective in the context of audible design in the CME: Firstly the ubiquity of these computing devices has moved their impact from the lab, to the workplace, to the home into the streets. Here is my motivation for using the term computer mediated *environment*. Our everyday environment is permeated with these devices.

The second major reason is to develop design criteria in this field and stems from the fact that these devices are not only often difficult to use but more often unsatisfying to use because they lack responsive feedback (Normal 1988, p. 27). Sound is expressive mode of communication. Natural sounds are adept in reflecting the complexities of the invisible interaction of the physical world (Norman 1988, p. 103). Perhaps synthetic sounds, modeled on the communication of natural sounds, might reflect the complex interactions of the invisible virtual world. This is a role sound can play in the CME, where computing devices function not only as bridges between people and places in the physical world, but also as bridges between the physical and the virtual worlds. These CME devices function as intermediates between people and the virtual environment. A world of the electronic message, the world wide web, virtual realities and large transactional databases (e.g. stock markets). As processes in the virtual environment become more complex and more important to people, whose daily lives intersect with this realm on a daily basis,

they will need more than just windows into the virtual space, they will need to physically touch and be touched by important virtual events. We shall explore the idea that sound touches us, where sight does not and can mediate (Traux 1984, p. 12) between listeners and the environment, making the invisible perceptible.

The current difficulties of computer based audio design can be witnessed in observing that the off-switch is the most popular feature on desktop computing devices. Norman (1988, p. 103) cautions us that sound can be 'cute and not useful' or even annoying. Conversely the potential of audio design can be witnessed in the degree to which film and computer gaming media rely on audio design, by interacting with these mediums without sound.

When Nicholas Negroponte (1995, chp 11) muses in his book *Being Digital* on *voice as computer interface*, he observes, 'There is almost no way to use a computer in passing' and he expresses the desire; 'I want to have a computer be within earshot' (Negroponte 1995, p. 138), he encourages his readers to envision a more vocal and attentive computer engaging with people in casual dialog. Negroponte describes his desire for a richer experience with his computer, interacting with a discrete "digital butler". In particular we can extract two characteristics of this experience:

- Multiple Redundant Modes of Communication (Negroponte 1995, p. 143)

  Negroponte explains with reference to an anecdote, in which his imagined non-french speaking readers are visitors to France, and are asked at a restaurant by a French speaking waiter if they would like more wine. The waiter's meaning is easy to understand from the context; the wine glass the waiter is looking at, the wine bottle in the waiters hand and the vague correlation between the English noun 'wine' and French *vin.* The point is that meaning can be inferred with the aid of context. Context is built up by multiple redundant modes of communication. We will fully explore this role played by sound.

- Active Proxy (Negroponte 1995, p. 151)

  In a second anecdote Negroponte, describes his interaction with a Japanese secretary who acts as a proxy between Negroponte and his Japanese host who addresses Negroponte with one expressive word. The secretary translates this into a detailed message to surprised Negroponte. Here the point is that the proxy (the secretary) is so familiar with his employer's affairs, it is easy for the secretary to know what his employer needs translated into English. A proxy needs not only knowledge about the subject at hand, in this case in English and Japanese, but should also know his client. This is a new potential, for actively enhancing communication, which can be explored in the CME.

In the following sections we will see how the natural acoustic environment provides context for listeners in the soundscape and we will pick up a variety of guidelines to promote acoustic communication.

## The Acoustic Environment

Communications scholars, B. Truax and R.M. Schafer have use the term *soundscape*, to describe the communication effected by audible sound events (see glossary) in an environment, and have studied how the soundscape mediates between people and their environment. This relationship is illustrated in Figure 1.

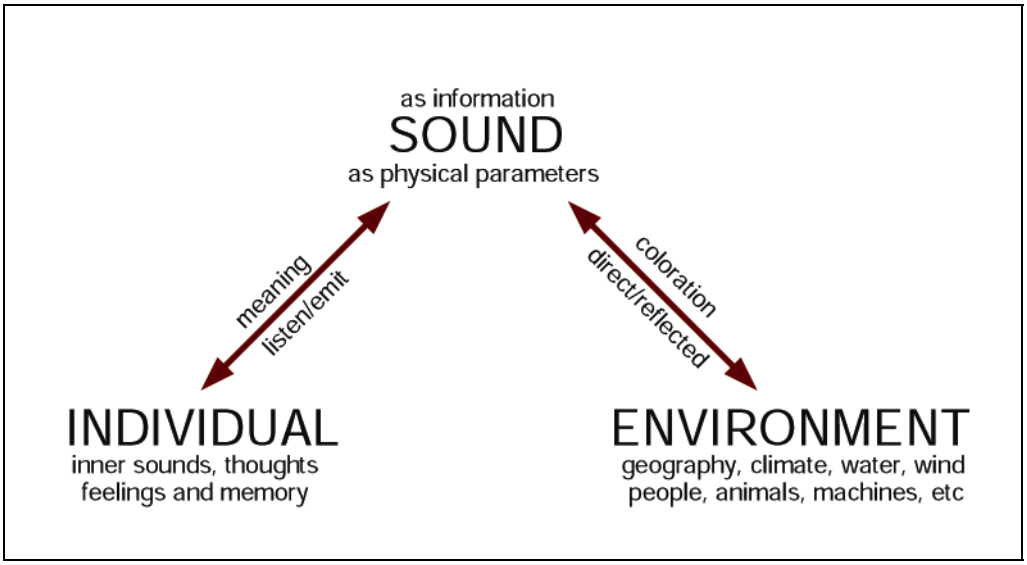


Figure 1: The Mediating Role of Sound

Central to understanding the functional relationship between sound makers in the acoustic environment is the idea of masking. Loud sounds mask quieter sounds[1]. In a narrow frequency range low frequency sounds mask higher frequency sounds. This means that for a sound to be heard it needs to be uniquely distinguished by time, frequency spectrum or intensity. In the natural acoustic environment, the soundscape can be viewed as a rich ecology of sound, where sound makers place their sounds in differentiating niches of time or spectrum, to avoid masking, and thus be heard. In the natural acoustic environment the sound makers' ability to increase their sound's intensity is limited by their available energy resources, so soundmakers cannot just "shout" louder and louder. The soundscape can be viewed as valuable resource that is shared among the sound makers. In order for communication to occur a functional equilibrium (Truax 2001, p. 76) is formed while masking is avoided. Similarly in conversation two people do not talk at once if communication is desired. In this ecology of sound the variety and complexity of sounds increases but is limited by the available *spectral*, *spatial* and *temporal* space in the functional equilibrium. Such a soundscape, where all sounds can be heard clearly and are not masked by other sounds has been termed a *hi-fi* soundscape. Systems which exhibit these hi-fi characteristics may be viewed as being well designed. Finally, if sounds are clearly heard, listeners with some training can identify the sound's sources; so one may also think of a hi-fi environment as one in which sounds have discernible sources.

[1] Except if the two sounds have partials of very similar frequencies, which causes a beating sensation to be easily heard.

The use of sounds and the identification of their sources in such a hi-fi environment effectively increases a listener's range of awareness. The listener becomes aware of her or his position relative to other sound makers and their identity. Furthermore, since sounds are variably reflected, refracted and absorbed during their propagation to the listener, the state of the environment itself in encoded into sounds. This acoustic *coloration* affords navigation of the environment and fosters a sense of the listener's place within it. For example (Truax 2001, p. 17) a listener can determine the size of the room they are in from the reverberations of their voice or footsteps. These environmental sounds add detail to the things we see, and draw our attention to events beyond the range of sight, yet they are often ignored in designed systems, where vision, music and speech are given precedent.

Even in the mechanized acoustic environment the variations of the internal structure of a sound reflect the invisible state of the sound's source. Mechanics become adept at diagnosis by listening to engines, and even everyday car users can detect early warning sounds; when things "don't sound right". This important communication is at stake when the acoustic environment becomes noisy.

From communicational perspective one can view noise, not so much as unmusical or annoying sound, but as sound which suppresses useful communication. This perspective also allows us to think of noise as a reduction in our awareness of our surrounding. The problem with traffic sound is not so much the sound itself which may be analyzed as broad-band sound similar to that of waves breaking, but rather that its loudness, board spectral coverage and ubiquity in the cityscape, effectively masks all other sounds so that a city dweller's aural awareness shrinks down to less than two meters. A person walking down a busy road cannot hear his or her own footfall. Thus city dwellers are effectively isolated and detached from their environment. One mode of communication is shutdown, forcing the city dweller to rely more heavy on visual information. The visual cognitive system can become over taxed, leading to feelings of stress and tiredness, without an apparent source (Campbell 1983).

The listeners' use of acoustic coloration to augment the visual image of the environment functions continuously at an unconscious level, even during sleep, it does not require the listeners' full attention. One hears many sounds concurrently and omni-directionally; in contrast vision is focused at a single depth in a narrower direction. This observation has lead to the following taxonomy of listening levels, where listeners dynamically shift their listening in a range between these levels.

**Listening-in-Search**

Listening-in-search involves conscious listening focused on a particular sound to the exclusion of others. The listener actively extracts information from details in the internal structures of the sound. This involves analytical focus and may draw on past experiences or training with these sounds. This is the type of listening one performs during diagnosis, for example by a doctor listening to a heartbeat or a mechanic as listening to an engine.

**Listening in Readiness**

Listening-in-readiness occurs when one unconsciously "keeps an ear out" for an event. The sound event may not be

significant in and of itself but has significance for a particular listener in a particular situation. Examples of this type of listening are becoming rare in city spaces today. The World Soundscape Project (Truax 2001, p.18) quotes the 1920s example of a listener who can accurately describes 3 different distinguishable sounds of vegetable, dry goods and ice delivery carts.

We note that this type of listening is built up over time with experience with these sounds: a newcomer would not be able to make these distinctions. Secondly the listener is able to make these distinctions even while focused on other activities, as the listener was not solely listening for the carts during the working day, but these audible distinctions may enter into consciousness and even prompt further actions, if for example the listener needed some ice. Here we can grasp the dynamic processes in which significance is built up between the sound and the listener.

**Background Listening**

Background listening describes listening that does not direct action, but stays in the background of our attention. These sounds, however do set the mood or tone of an environment for the listener. These sounds are termed keynotes, in reference to the fundamental tone or key of a musical composition. Keynotes may be at an ambient level or loud enough to be clearly distinguishable, but while clearly heard they are not normally noticed because they are expected and predictable. Examples include bird calls in the morning, the rush of passing traffic, or ambulance sirens near a hospital. The

## Guides for Audio Design in the CME I (Acoustic)

**1. Reconnect Sounds with Source Events and Processes**

One value of environmental sound is that it directly reflects the invisible mechanism of physical events and processes. This allows meaning to be found independently of the listeners spoken language. Even speech is surrounded by paralanguage of "um"s and "er"s, and speech sound's inflections reveal the speaker's emotional state. This is not to say that sound cannot have symbolic meaning: certain sounds gain cultural and symbolic meaning over time. The expression of sound is to be found in the combination of representation and reflection. The suggestion here is that earcons should be ideally designed to reflect and represent events and processes. The challenge is that many virtual processes are mute and abstract, making it difficult to choose meaningful iconic sounds and mapping strategies, because they have no real world counterparts. For inspiration, sound designed can look to film sound designers and soundscape artists who create sound analogues for abstract imaginary worlds.

The origin of a sound is important in reconnecting sound objects with their sound sources; quite simply, the perceived localization of a sound needs to correspond the location its source event. In the natural acoustic environment this is almost always the case, except for echoes and other gross reflective phenomena, in which a phantom sound source appears. In the CME, tele-hearing is easily achieved. Teleported sound is well known to telephones users. The character of the telephone voice, which reflects the telephone's mechanism, can be employed to represent distance. Telephones characteristically use a limited signal bandwidth and cut off the low-end frequency response. Simulating this characteristic voice in the CME affords a designed sound whose source seems "far away".

importance of these sounds is that they form the backdrop to listening. Listeners extract their foreground sounds in contrast to this background. If the background masks the foreground sound, sonic figures cannot be extracted. Even when the figures can be extracted, the background provides a meaningful context, which offsets the figure. The visual metaphor employed here is appropriate in reference to an argument (Bregman 1990, pp. 2-9; Shepard 1999, pp 21-35) that suggests gestalt-like principles are at work in both visual and auditory cognitive scene analysis.

The above analysis of listening and the soundscape gives the sound designer a model for how sound functions in the natural acoustic environment and provides design criteria, which promote communication in their designed environment, where the soundscape exhibits a functional equilibrium among sound makers, and there is coherence between sounds and their meanings. The specific guidelines that flow from these criteria are listed in the sidebar entitled 'Guides for Audio Design in the CME I'.

## Guides for Audio Design in the CME I (cont.)

**2. Stimulate Diagnosis using Coloration and Timbral Complexity**

Sound designers can encode the details of events within the subtleties of sound's inner composition (Truax 1992). Experienced listeners can detect aberrations in the sounds, while novices are still aware of events at a lower level of detail.

This calls for design of classes of sounds, which vary with some parameters abstracted from the reflected event or process. There is however a danger that these parameters might alter the sound so much that it will lose its semantic tie. For example if an event's duration is mapped to its sound duration, very short events may be reduced to the sound of a meaingless click.

**3. Avoid Masking, Limit the Use of Soundscape Resources**

In order to promote the emergence of hi-fi soundscapes and thus provide a space for the range of listening levels, sound designers need to establish limits to their use of the soundscape and thus allow a functional equilibrium to develop. These limits might be in terms of loudness, spectral bandwidth use or temporal frequency and duration. For example non-critical sounds can be delayed until the ambient sound level returns to an expected norm.

**4. Do Sonify Important, Anomalous and Even Routine Events**

Careful sonification of routine events can allow sound marks and keynotes to emerge, which will provide the "natural" character of an environment to develop. Care however must be taken in ensure the sounds used have a semantic tie to the events they represent.

## The Electro-Acoustic Environment

The application of electro-acoustic technology has ruptured the relationship between sound and the physical environment. Transduction transforms acoustic energy (sound pressure level) into electrical potential energy (voltage). This new domain sound escapes its roots in time and space. Sound, as electricity, is not subject to the physics of acoustics but can now also be manipulated by the physics of electro-magnetics. Sound can be stored as potential energy, transmitted at the speed of light and manipulated using a vast array of transforms. Amazing as these new potentials are, from a communicational

view, sound has lost its context and its most direct semantic component – the reflection of physical events.

The soft sounds of a mouse can be made louder than an elephant trumpeting. Voices can traverse not just closed doors, but continents, even the voices of the dead stream, life like, from the phonograph. These tricks in the electro-acoustic fun house of sonic mirrors are so common we barely notice their irrationality. People in the CME accept without question the illogic of full orchestra performance emanating from 500 gram portable speakers. In fact the fabricated everyday acoustic environment resembles a series of virtual and augmented acoustic realities. Listeners are virtually transported away listening to a "live" recording of famous musician and news radio augments the working day with a layer of broadcasted news information. R.M. Schafer (1969, pp. 43-47) termed this irrational situation *schizophonia*. We will proceed by examining the electro-acoustic environment from a communicational point of view, again looking to inform design decisions one might need to make in the CME.

As we just noted radio functions to augment the daily experience in the electro-acoustic environment. In Medelson's (1994) study of radio in the role of accompaniment media he identifies five basic psychological functions of radio which, I would suggest, can also be provided by devices in the CME because radio is a close relative to digital devices that have been designed and are being envisioned. Both radio and PDAs have a voluntary audience and radio also functions in the personal sphere, the portability of radio is akin to the close accompaniment apparent in the current wearable digital devices. Like cellular phones, and the current crop of wireless PDAs, radio is connected, (although admittedly radio is one way and often entrenched in the centralized and often bureaucratically sanctioned broadcast paradigm). Radio spectrum use is highly regulated. This contrasts strongly with the decentralized internet and peer-to-peer models, which have already influenced the design of current wireless technology. Hybrid internet/cellular[2] devices have emerged which embrace both the decentralized and centrally controlled modes of communication. These devices have the potential to encourage new forms of communication, but will also act as conduits for communication in established modes of media reproduction. This phenomena of remediation (Bolter & Grusin 1999, pp. 45) in which one medium (i.e. radio), is reproduced in the digital medium (for example the world wide web) as a new form (for example webcast radio), addresses another reason why an understanding of radio remains relevant.

**1. Bracketing the Day**

Listeners use radio in the morning and evening to start and finish their day. In the morning it cues the listener for their daily encounters providing both a status report on the day they are about to venture into and also sets the listener's mood to fit in with the hustle and bustle of the day, by alerting and stimulating the listener. In the evening radio is generally more reassuring and pacifying. Stories are concluded and hope is established for the future. The clock radio lulls the listener to sleep, ready to wake them in the morning. In effect the narrative arc of setting, complication, and resolution of the day is reinforced with the listener as the central character.

[2] Ericsson has announced a dual-mode chipset that combines G3 (cellular) technology with Airport/802.11/WiFi (Ethernet) technology (Orlowski 2003).

**2. Provide Companionship**

Radio acts as surrogate or proxy for human companionship -- an unobtrusive yet personal presence which 'helps to fill voids that are created by (1) routine and boring tasks and (2) feelings of social isolation and loneliness' (Medelson 1964, p. 252). Here we are reminded of Negroponte's desire for a digital butler - a cyber companion, whose presence is comforting. However the radio listener's use of radio as a simulacrum of companionship, begs for a deeper approach -- not just a stop gap solution to fill the created void. The deeper social problems of the "lonely city" and "routine and boring" jobs are beyond the scope of this text but designers must still be aware that providing a substitute does provide a measure of relief in these situations which retards the search for a fundamental change to the situation.

**3. Creation of a Psychological Climate**

Following on from the above point we can note that radio has a significant effect on the listener's psychological frame of mind or "mood". Radio listeners choose to listen to radio programming that fits their state of mind or effects a change to it. Accompaniment media such as radio - especially in the form of music - has been found (Milliman 1986) to strongly effect human behavior. Medelson's qualitative study reveals that people use radio music in two different models: to give them a 'lift' (Medelson 1964, p. 243) or help them relax. This allows the listener to create a custom psychological climate, with radio functioning as a "psychological thermostat".

**4. Provide News**

Clearly radio is also chosen to bring news to listeners. In this role it is particularly effective because news can be heard when the radio is with in earshot, and the listener can continue with other primary activities. Remarkably, a gross redundancy of content is tolerated by radio listeners with the same news being repeated steadily on talk radio stations. Even undesired news is accepted where 80% of listeners (Mednelson 1964) indicated they would not switch off a radio during a news broadcast even if they had selected the station for music listening. Perhaps the importance of radio as a broadcast medium particularly in times of crisis warrants its continued presence on the edge of awareness. Recent legislative action against unsolicited email (Reuters 2003) and new software designed to disable visual pop-up advertisements while browsing the web have demonstrated that unsolicited messages are largely intolerable in the visual domain of the CME.

**5. Social Catalyst**

Lastly since radio is a broadcast medium, it provides the same programming at many receivers. These reception events are shared experiences, through which people often choose to relate - in so called "water cooler" conversation. Even if listeners do not hear the same show much of the information presented is of general or local concern, and functions as a social catalyst by providing listeners with things to talk about.

This function is often lost in the *customized user experience* of the CME which delivers specific information to users whose agents filter a large range of information from far flung sources. Starting a conversation in a the public sphere is difficult with this type of information.

## Listening in the Electro-Acoustic Environment

The above treatment, gives us an overview of the psychological roles played by accompaniment media in the electro-acoustic environment, as demonstrated by radio. These functions arose under the new conditions of electro-acoustic environment. Listening itself has been effected under these new conditions. Background listening can now be more accurately termed *distracted listening*.

In the schizophonic electro-acoustic environment muzak, radio, pre-recorded announcements and electronic tones (beepers, alarms etc) have drenched the everyday soundscape. This background soundscape is different from the acoustic soundscape where two relationships have been inverted. Firstly the majority of the new background sounds are music and voice, which are normally foreground sounds in the acoustic environment. Since humans are especially sensitive to these sounds they can easily distract and strongly affect the listener, but the distracted listener blocks these sounds out pushing them into the background. Secondly the listener often chooses these sounds for the psychological reasons we have discussed in our summary of radios functions above. This is in contrast with the imposed sounds in the acoustic environment, in which *sound object* (the sound as pure acoustic phenomena) is fused with sound source colored by the sounds context, to form a meaningful *sound event*.

An undesired scenario develops if sound is imposed on an audience, is disconnected from it's source-context and of strong psychological effect. This is the case of muzak (and "foreground music") which *imposes* a mood and pace, rather than allowing people to set their own rhythm. The pacifying and stimulating effects of muzak allow employers and shop owner to regulate their employees and customer's moods and activates for their own agendas (Milliman 1986), to the point where psychological dependence takes place (Mendelson 1964). The effect of music is explained as 'helps me in my work', 'makes time go faster' and 'makes work more enjoyable' (White 1975). Muzak itself explains: 'Functional music is designed to have a definite effect on people in a store, plant or warehouse. It effects their mood and attitudes and make them feel better about their work' (Westerkamp 1990). Interestingly White's research suggests that music is most useful to workers and employers, for work that does not fully absorb the workers attention - "music appears to divert unused attention from brooding, talking or off-the-job activities" (White 1975, p. 433). It seems reasonable to conclude that music is being used (by both employer and employees) to make up for a lack that workers find in their jobs. Because listeners become habituated to music in the workplace and find it useful, is difficult separate the sinister use of music by employers from the self-regulation of employees. However employees should always have accesses to the off switch.

A positive example of music in the work place can be found among the Mangbetu of northeastern Zaire, for whom songs reflect the integration between the social and collective rhythm of daily activities with their working environment. Woman washing at the river sing songs or make accompaniment music (from a western point of view), by singing and using the river as an instrument by cupping and sloshing the water surface. This sound making allows for conversation, finding their collective working pace, and fits with the sounds of the river (Metzner 1992).

Finally, we should note the new level of isolation that is possible in the electro-acoustic environment. Using personal headset systems (personal portable cassette, compact disc and mp3 players) listeners can retreat from the public cityscape, further than before. The walk-man provides a personalized surrogate listening environment perhaps in response to the lo-fi cityscape, which has become meaningless to the point that it needs replacement. Unfortunately, in shutting out the city noise, listeners isolate themselves from their peers, and shut out everybody else (Truax 2001, pp. 135). In the CME we can see this trend extended further: advertisements encourage technologically enabled (disabled) people not to enter public space at all, stay at home, telecommute and live through the web browser. Could we extend the idea of a lo-fi soundscape to conceive of this virtual reality, of web-space, as lo-fi surrogate reality?

## Guides for Audio Design in the CME II (Electro-Acoustic)

**1. Music and Voice**

Music has strong mood altering effect and does not easily mix with other music. Use it sparingly and allow listeners to easily switch it off. Similarly humans are particularly sensitive to other human voices, which may be distracting or annoying if they are poorly reproduced. Voice should be reserved for high priority, low frequency messages.

**2. Provide an Off Switch**

Portable personal devices may travel into places where their sound is inappropriate –provide an off switch.

**3. Augment rather than Isolate**

Provide a set of sounds that act as additional identifiable layer onto the soundscape rather than replacing or dominating the soundscape. If the communicational value of this new layer is high, but masked by noise, listeners may demand noise abetment.

**4. Emulate Natural Sounds at the Internal Structural Level**

Electro-acoustically created sounds or processed sounds can be perceived as unnatural and thus more distracting. For example simple and cheap buzzers create sounds of equal amplitude across their frequency spectrum, where as sounds in the acoustic environment have reduced intensity at higher frequencies. The result is that buzzers sound unnatural to the ear.

In summary we have illustrated the electro-acoustic environment as the site of a fundamental departure from the norms of operation active in the acoustic environment. The use of electro-acoustic technology tends to reduce the context of sound, and is thereby disrupting the sound object's communicational value. Sound has also become malleable and reproducible. The potential for creative and commercial use of sound has increased along with an extended audience for reproduced sound. The challenge for the designer is to maintain and create new significance for electro-acoustic sound objects.

## Mass Media and the Electro-Acoustic Environment

Extending our analysis of the electro-acoustic environment through radio we can now turn to radio as a mass medium. During distracted listening, listeners are not directing conscious or analytical thought toward the sound. We know from the study of background and listening-in-readiness that the audience is open to programming by repeated sounds while occupied with other activities (Truax 2001, p.129, 161). In radio as mass medium this openness combined with the listeners' habituated patterns of radio listening is turned into *airtime* – a salable commodity. In effect the radio's use value is turned into exchange value, where airtime is bought and traded between radio stations and advertisers. The resulting political economy and its analysis is again beyond the scope of this text. However we can pick up the concepts of repetition, voice and flow for application in the CME.

**1. Repetition**

Felsenthal's (et al, 1971) comparison of award-winning radio advertisements, reveals that 'use of suspense factor to arouse the curiosity of the listener with regard to sponsor identification' is more effective than repetition of product names, which bore the listener. While this analysis was done on the text of the advertisements, if we view the sound of a radio message as a whole we find that this phenomenon occurs at the message level too (Traux 2001, p. 127), where the perfect replication and repetition of taped messages fuse into a symbolic percept or gestalt whole. Listeners who are exposed to short fragments of the message are then able to quickly recognize and dismiss these known messages as nothing new.

However as we noted with reference to newscasts, redundancy of often-repeated station identification catch phrases on talk radio are tolerated when performed live by announcers, because at a microtonal level they are never the same twice. Exact repetition dulls the listener, further complementing distracted listening mode, and keeps commercials in the background of attention where they avoid critical analysis.

**2. Voice**

As a carrier of advertiser's message radio has an economic need to reach a greater and greater audience, this results in more generic programming. Local programming is replaced with content with a broader appeal and information is presented at a "dumbed down" level. The quest for greater economic efficiency, facilitated by electro-acoustic technology, has prompted syndicated shows to replace the local shows. Rotated play lists replace the DJs music selection role and so the voice of radio becomes dislocated, defused, generic, blandly agreeable, typically male and regular. The identity of the announcer is completely removed. Ironically then, the listeners "friends" at station XYZ cannot say who they are, where they are or whom they are talking to, for fear of breaking the illusion of relevance to the listener.

**3. Flow**

Again for commercial success radio needs to holds its listeners. Listener habituation is maintained by *incompletely* fulfilling the listeners' psychological needs. To hold the listener expectant but not deliver what they want, radio adopts a programming structure that seems to offer everything, but always cuts itself short. As Barry Truax writes:

> '…for a noisy environment it provides a constant level of masking, for loneliness it provides the company of a reassuring (but unreal) friend, for boredom it provides "entertainment" and for meaninglessness it provides "information", but only what is amusing, nondisruptive and most of all, what is nonconductive to thought.'
> (Truax 2001, p. 180)

In a medium employed to communicate content, such as literature, structure would traditionally stems from the content, the opposite occurs in radio. Content is chopped up, condensed to sound bites and poured into predetermined and predictable time slots. The programming of these slots then functions as a simulacrum of content. The *flow* of segments - of differing type, intensity, and duration - forms a pattern the audience knows in general but must listen to hear unfold. Each microscopic segment is disrupted, cut to fit into the structure which is rigid - inflexible to the needs of each segment's content. In a macroscopic view this structure is carefully arranged to hold the audiences' attention, though variety and rhythmic pacing. The whole pattern establishes a quickly identifiable radio *format*, which listeners easily return to.

## Guides for Audio Design in the CME III (Mass Media)

**1. Avoid Repetition of Canned Sound**

Repeated undifferentiated samples will bore listener.

**2. Follow and Trace**

Take cue from the listeners' activities for indication of what tempo should be used, so that a pace can be found interactively, rather than imposed. Let content dictate structure, rather than technological or commercial interests.

**4. Identifiable Variety**

Allow the listener to select the theme, character, voice or distinctive style of sounds. A cohesive style can allow listeners to group desperate sounds as belonging to an identifiable layer of audio augmentation. The act of selection of this style will increase their sense of agency, as they see their own choice reflected in their surroundings. Provide an open architecture so that interactors and sound artist may design their own themes.

## Concluding in the Computer Mediated Environment

Current desktop sonification of virtual events does little to mediate between the interactor and virtual sphere they are engaged with, the focus is task oriented, not environmental. However mediums such as computer games build immersive gaming environments and have largely followed the hi-fi sound design present in film production to become leaders in CME audio communication. Film and computer games are palatably more communicative thought their use of layers of environmental sound, speech and music. The new potential in the CME is the inclusion of interactive feedback mechanisms. These mechanisms can form the basis of a community of interactive audio peers,

systems that are as sensitive to their acoustic environment as humans are. They can listen to the environment and they can be sensitive to the interactors. By giving the active proxies knowledge of their environment and their interactors, they are in better position to function as intermediates.

More simply, the next incremental step remains to translate the successes of film and computer gaming audio into the everyday computing realm, where the audience is not captive to the screen, but is in earshot. This will allow computer users to interact in passing through the complementary mode of acoustic communication.

## Guides for Audio Design in the CME IV (CME)

**1. Model the Environment**

An internal representation of the environment a CME device finds itself in will be useful to help make appropriateness decision for audio augmentation.

**2. Listen**

As members of the acoustic community devices should listen to the acoustic environment too. While generalized voice recognition is in its infancy, even simple ambient noise level measurement can be used to complement heuristic decisions, needed to determine the appropriateness of audio augmentation.

In summary, we have journeyed from acoustic to the electro-acoustic and finally arrived in the computer mediated environment. During this journey we have picked out the features of these environments which contribute and disrupt communication, applying the model of sound as mediator between listener and environment, with a view to answering the question how can sound mediate communication between listeners and the virtual environment? The points I have extracted are a practical but untested set of guidelines to answering this question.

Since the acoustic environment provides the most direct mediation and best communication to listeners about their place in the environment; and because it is based on an ecology of sound, where sound variety and complexity unfolds but is limited in a functional equilibrium, we can follow these principles to form a practice of *ecological audio design*. This is a design process which encourages a variety of complex sound events to develop, but in which some limits are also formulated and encoded in the systems' components. Each system is a member of the acoustic community and limits itself to maintain a hi-fi soundscape. By reflecting the functionality of the acoustic soundscape the effect of this ecological acoustic design should be to give listeners a sense of their relationship with respect to the virtual technological environment.

## Glossary

**soundscape**: An environment of sound with emphasis on the way it is perceived and understood by the individual, or by a society (Truax, 1999).

**sound event**: A sound or sound sequence in its spatial and temporal context as part of a soundscape, it acquires its

meaning through its social and environmental context (Truax, 1999).

**sound object**: A phenomenological sound formation, independent of its referential qualities (Truax, 1999).

**masking**: The effect one sound has on another by making it harder or impossible to hear (Truax, 1999).

**earcon**: A sound that is used to represent a specific event or object.

## References:


Bolter, J. & Grusin, R. (1999), "Immediacy, Hypermediacy and Remediation", *Remediation, Understanding New Media*, MIT Press, Cambridge, Massachusetts.

Bregman, A.S. (1990). *Auditory Scene Analysis: The Perceptual Organization of Sound*, MIT Press Cambridge, Massachusetts.

Campbell, J. (1983) "Ambient Stressors", *Environment & Behavior*, vol. 15, no. 3, pp. 355-380.

Felsenthal, N. et al. (1971) "A Comparison of Award-Winning Commercials and their Day-To-Day Counterparts," *Journal of Broadcasting*, vol. 15, no. 3, pp. 309-315.

Khan, D. (1990) "Audio Art in the Deaf Century", in: Lander, D. & Lexier, M. (eds) *Sound by Artists*, Art Metropole & Walter Phillips Gallery, Toronto & Banff.

Mendelson, H. (1964) "Listening to Radio", in: Dexter & White (eds) *People, Society and Mass Communication,* Glencoe, Free Press.

Metzner, J. (ed.) (1992) *Pulse of the Planet,* [Audio Compact Disc, track 1], Earth Ear.

Milliman, R. (1986) "The Influence of Background Music on the Behavior of Restaurant Patrons", *Journal of Consumer Research*, vol. 13, pp. 286-289.

Negroponte, N. (1995) *Being Digital*, Vintage Books, New York.

Orlowski, A. (2003) *Leave your Cisco WiFi mobile phone at the door*, [Internet], The Register, Available from: <http://www.theregister.co.uk/content/69/30313.html> [Accessed 21 April, 2003]

Reuters (2003) *Senators' bill takes aim at spam,* [Internet], Washington, Reuters, Available from: http://www.cnn.com/2003/TECH/internet/04/11/spam.bill.reut/index.html [Accesed 21 April, 2003]

Schafer, R.M. (1969) *The New Soundscape*, Toronto.

Shepard, R. (2001) "Cognitive Psychology and Music", in Cook, P. (ed), *Music, Cognition and Computerized Sound An Introduction to Psychoacoustics*, MIT Press, Cambridge, Massachusetts.

Thackara, John (2001) "The Design Challenge of Pervasive Computing", *Interactions*, May/June 2001.

Truax, B. (2001) *Acoustic Communication*, Second Edition, Ablex Publishing, London.

Truax, B. (1999) *Handbook for Acoustic Ecology*, [CD-ROM, Ver. 1.1], Cambridge Street Publishing

Truax, B. (1992) "Electroacoustic Music and the Soundscape: The Inner and Outer World", in: Paynter, J. Howell, T. Orton, R. & Seymour P. (eds) *Companion to Contemporary Musical Thought*, vol. 1, Routledge, London.

Westerkamp, H. (1990) Listening and Soundmaking: A Study of Music-as-Environment, in D. Lander & M. Lexier (eds.), *Sound by Artists*, Art Metropole & Walter Phillips Gallery, Toronto & Banff.

White, F.A. (1975) "Physiological and Psychological Effects of Sound", chp 17, *Our Acoustic Environment,* Wiley.