ONWARD AND UPWARD WITH THE ARTS

MUSIC TO YOUR EARS

The quest for 3-D recording and other mysteries of sound.

BY ADAM GOPNIK

Edgar Choueiri wants recorded music to sound as if the performers were in the room.

Of all the amazing things the mind does, the most amazing may be that it can take sound and turn it into music, and then take music and turn it into meaning. The rest of the double leaps the mind makes look almost easy by comparison: we like pictures of babies at picnics in sunlight because, after all, in the world we like sunny days and chubby babies. The stories we tell in literature are like the lies we tell in life. But music is simply a set of physical vibrations that reach our eardrums; from those vibrations we make the emotional map of our lives.

Yet, as generations pass, the style and manner of those maps change. Not long ago, I realized that one of the great changes in my lifetime involves the way we listen to music. As a teen-ager, I was a fanatic record collector, hungry for old albums. My own teen-age kids, as obsessed with music as I was, have an entirely different way of listening. They ignore the glowing-tube amp and classy articulate speakers in our living room; they bounce instead to tinny earbuds, and often spend hours listening to Taylor Swift or Radiohead on the still more tinny speakers of their computers. Sound quality seems secondary to some other thing they take from music. Though both are far better musicians than I ever was, singing and playing guitar and piano, they have a more limited conception of larger forms, of the record's two sides, of the symphony's three or four parts, of the swell and structure of a cantata. It isn't a question of classical tastes against pop; it's a question of small forms heard in motion against large forms heard with solemn intent. "Sgt. Pepper" baffles them as much as Beethoven's Ninth. They snatch at music as we snatched at movies, filling our heads with plural images. A friend with whom I was brooding over the way recorded sound supplies a soundtrack for modern life said that I ought to seek out Edgar Choueiri, a rocket scientist—really, a rocket scientist!—who has spent a good part of his life worrying about such things. Choueiri, my friend said, had broken the code of something fundamental about the reproduction of sound, and so I went to Princeton, where he has two laboratories, to seek him out.

Those of us who have no laboratory at all might regard what Choueiri modestly calls his "other" laboratory as the only laboratory that anyone would ever need. It is the size of a small airplane hangar, and it is filled with plasma rocket engines that run on electricity: instead of a wasteful explosion of liquid fuel, a judicious leak of ions pushes the craft forward through a vacuum. If we ever start commuting to Mars, it will likely be a Choueiri-style engine that gets us there and back.

The president of the Electric Rocket Propulsion Society, Choueiri is also the president of the Lebanese Academy of Sciences, and is very much, in spirit and appearance, a man of the old Levant. There's the elegant classical nose, the high, anxious brows, and the worried expression. In his smaller laboratory, adjacent to the rocket lab, he works on his musical projects, trying to force three-dimensional sound from ordinary stereo speakers. By three-dimensional sound he does not mean wraparound sound, the kind produced by speakers posted strategically around the room. (Elvis had fifty-two speakers installed in his private jet, the Lisa Marie, trying for that effect.) In Choueiri's system, when you listen to choral music by his hero, Bach—from any pair of speakers, even the cheap ones on your computer—you will hear it coming not from speakers but as if from performers in the room itself.

Many of us dream of the moment when a glint-eyed scientist with a tiny box will do something amazing—turn off all the lights in the city, or send us back in time, or make us glow emerald and fly. Choueiri is that man, and his box is that box. Outside his smaller lab is an office whose shelves are filled...
with those strange white dummy heads which sound scientists love (though they look as impersonal as crash dummies, each one, I learned, was modelled on a specific head and given a nickname: Carl, Philipp, Emanuel). Choueiri plugged in his box, which runs what he calls his BACC filter—the acronym also stands for “Band-Assembled Crosstalk Cancellation Hierarchy”—and Bluetoothed it to my iPhone. I chose the Stones’ “Beast of Burden,” more or less at random, and there they were. I do not mean that the soundscape was widened—I mean that Keith Richards was limping over to my left, licking at chords, and Ronnie Wood to the right, absentmindedly stabbing away, as he does, and Jagger in the middle and Charlie Watts and Bill Wyman impassive to their rear.

And what made this more amazing is that no one, as the track was recorded in layers, over three months in 1977, had had any intention of re-creating the dimensional layout of the studio.

Choueiri belongs to a distinctly modern type: the engineer-aesthete. In his Princeton house and in an apartment he has in Manhattan, on the Upper East Side, he discreetly displays collections of Cubist design, ceramic pipes, and nonfigurative Greek vases of the Periclean period. He was brought up in Lebanon in the nineteen-sixties, among the Antiochian Orthodox—much the most ancient of Christians, the Antiochians look upon the Catholics rather the way Boston Episcopalians look upon Appalachian snake handlers—and he writes poetry in at least two of his many languages. Teased about being an aesthete in the guise of an engineer, he might nod cryptically and, later that day, send a poem he wrote, several years ago, in French, a rueful personal testament called, simply, “L’Esthète.” He is also an adept in the art of Zajal, an ancient Arabic form of freestyle rap in which two speakers debate a subject in improvised song, chanting back and forth in strict strophic verse. (Many of his Zajal debates can be found on YouTube, posted by hardcore Zajal fans.) Yet his passion for those forms is mixed with a faith that beautiful things and sounds can be fully understood, and even mechanized, like the plasma propulsion that makes a rocket move forward. His primary passion is music—Bach’s Mass in B Minor is for him the “most beautiful thing ever engineered”—and his dream is to try to reproduce its minute subtleties and thereby make sense of its mysteries.

Crosstalk is the core problem in creating three-dimensional illusions. Essentially, we hear stereophonically and see in depth because we have two ears and two eyes. Information from your eyes or your ears arrives slightly separated by the width of your nose or the space of your head, and the brain, using a variety of cues, computes the distance between the signals and re-creates the three-dimensional space the signals come from. (The Cyclops could not watch a 3-D adventure movie about Odysseus and the Cyclops.) There are three kinds of cues that your ears and brain use to locate sound in space, Choueiri says. There’s I.T.D., or “interaural time difference,” which means how long it takes for the sound to arrive at one ear rather than the other. I.L.D., or “inter-aural level difference,” means the tiny differences in volume; the sound of a left speaker is very slightly softer for the right ear than it is for the left ear. And, finally, though not least important, there are the differences in sound coloration—the tonality of the sound that you hear, depending, in part, on the shape of your pinnae, the curly outer ears.

But the creation of three-dimensional sound depends on each ear’s hearing only what it’s supposed to hear. When you listen to your stereo speakers, the right ear hears sound not just from the right channel, the sound intended for it, but also from the left channel, the sound intended for the left ear. The same thing happens when you look at a flat representation of a three-dimensional space: the right eye sees what the left eye is looking at. Cancelling the “crosstalk” is the key to creating an illusion of depth. It’s easy to do with your eyes. “You just put a physical barrier between the two eyes, show each one a slightly different image, and, presto, you see in three dimensions,” Choueiri explains.

The same principle holds for sound, and the same solutions are in some ways possible. “To get binaural sound is not that hard,” Choueiri says. “You can do crosstalk cancellation with a mattress!
Really! Just place a mattress between your two speakers, press your nose against one end so that each ear has a different channel, and you get a very robust three-dimensional effect." There are drawbacks. "It's clumsy, awkward, and ugly," Choueiri goes on, "and it has the important psychological difficulty, of course, of working only until your wife comes home." You'd think headphones would do the trick, neatly dividing the aural feeds. But, Choueiri explains, in the real world, when you move your head, the sound signals change a little, and the brain knows where the sounds are coming from. That doesn't happen with headphones, so the mind decides that the sound source can't be "out there." Instead, as Choueiri says, "the sound image collapses into your head.

Thinking about water waves helps to elucidate the solution. Suppose, Choueiri says, you dropped two pebbles in a pond. Their wave patterns, as they spread, would intersect. In theory, if you dropped a third pebble where one of the two pebbles originally dropped, and timed its impact perfectly, you could create waves that would arrive at the left ear of some water nymph just in time to cancel out the waves from the right pebble. The crests of one would coincide with the troughs of the other, creating a little zone of silence. Then you'd do the same for the other pebble's waves and the other ear. There wouldn't be any crosstalk.

The catch with previous attempts at that kind of crosstalk cancellation, or "XTC," as it's known in the field, is that the sound coloration, the timbre of any particular instrument, is extremely sensitive to small changes in position. If you move your head even slightly, the wave interferences get out of synch. As a result, the sound coloration distorts, in a sort of acoustic moiré. Pianos sound as tinny as xylophones. Engineers have long known that the way to fix this is to feed "error" into the design of the XTC wave. But that, it was feared, would tend to destroy the 3-D effect. It's as if the guy dropping the pebbles had to drop bigger pebbles in; the troughs created by the bigger pebbles would at some point become wildly out of proportion to the crests of the original pebble.

Choueiri has discovered a way to feed more error into the designs of the XTC than anyone had previously imagined possible, so that the signal will never discolor, whatever the shape of your pinnae and however you swivel your head. And yet the three-dimensional illusion remains stable. The human ear-brain system is good at discerning changes in sound level," Choueiri explains, "but subtle changes in the relative timing between the wave components of a sound are too subliminal for humans to detect. The BACCH filter, essentially, shifts the XTC action from the more palpable level domain—called the amplitude domain—to the more subliminal temporal domain, called the phase domain." Since our brains are hypersensitive to color and signal but rather dumb when it comes to tiny time changes the illusion is convincing, but the differences that produce it are too subtle to notice.

Choueiri, as an amateur closeup card magician, sees a likeness between what he has done and a theory of magic called Too Perfect Theory. Basically, Too Perfect Theory says that error can reinforce illusion. Any trick suggesting only one logical path, no matter how skillfully done, will be disconcerting to a spectator, while the tricks that please do so because the magician has, so to speak, opened many different doors for the bemused watcher to explore. Pass a cigarette through a quarter, and every spectator will deduce a hinged hole in the coin. Pass a cigarette through a coin, and then lead the viewer to wonder whether it might be the cigarette—anything that contains the gimmick—anything that broadens or coarsens the path enriches the effect. Choueiri: "Both techniques—the magician's and that behind the BACCH filter—rely on using imperfection to shift the attention from the palpable to the subliminal."

Choueiri's system can produce remarkable effects from ordinary speakers: the sound of a fly buzzing in a circle around your head; the sensation of someone walking toward you and then whispering in your ear. But its real value to the music lover, he believes, is that it eliminates the strain and tension of listening to two-dimensional music. Listen to a Mozart divertimento through the BACCH filter, and—apart from the uncanny experience of depth—a happy sense of release, of calm serenity, like that of being in a concert hall on a good afternoon, runs through your body.

The added bonus is that the sound of all stereo-era recordings, those of the past sixty or so years, can easily become three-dimensional, because they were all recorded with at least two microphones—they have sufficient information encoded within them to switch over to 3-D. "It's exactly as if every movie since the nineteen-fifties had, for some reason, been filmed with two cameras, even when it wasn't meant for 3-D projection," Choueiri says. "You would have this entire signal latent in the film, even if it hadn't been employed for the effect."

Several catches remain. The "sweet spot" of the 3-D effect—the space in which a single listener perceives it in full—is small, with room enough for just the single listener. Choueiri has a solution for this problem, but it is of Rube Goldberg-like complexity. "We have a motion-capture camera placed above the filter, and all you have to do is signal it," he says, demonstrating by waving in the air, but only once, like a taciturn drowning man. "And it takes your picture—captures your unique skeletal structure. Then, as you wander around the room, it tracks you, and sends the information on your location to the filter, so that it automatically adjusts the sweet spot." This means having a motion-capture camera in your living room to track the musical husband as he roams in tune with the music, and the prospects of household resistance, as Choueiri is the first to admit, cannot be dismissed.

Yet more than wave forms and pinnae are at play when we listen to music. We hear music with our minds. Reproduction isn't transparent. One of Choueiri's favorite cautionary tales is of an experiment conducted during the First World War, in which a tiny Victoria recording and an operatic soprano were cloaked in darkness at Carnegie Hall; the auditorium was unable to tell one from the other. The audience's will to hear perfect sound mattered as much as the perfection of the sound heard. And it's alarmingly easy to mistake the apprehended sound for the actual signal. Consider the story of Hugo Riemann, a great nineteenth-century Ger-
man musicologist, who insisted that he had discovered "undertones," sympathetic vibrations that could be heard beneath a single note, just as "overtones" are known to resonate above it. For a while, Riemann's "undertones" were a mainstay of music theory, until modern acoustic analysis made it plain that no undertones exist, and that Riemann had somehow wished them into existence, and then into his ears and those of his students. Listening and wanting are intricately entangled, in ways that may evade any measure. Talking to Choueiri, I had learned a lot about how we listen but was still struggling with the other question: why do we listen to it. Who could teach me something about that deeper level, not just where sound becomes music but where music becomes meaning?

I discovered that perhaps the densest concentration of sound scholars in the world could be found in my home town of Montreal, at McGill University, where I, along with five brothers and sisters, went to school. (And where my parents taught for many decades.) One reason for this was the presence of the psychologist Albert Bregman, a former professor of mine, who spent almost fifty years at McGill studying the psychology of sound, and whose masterwork, the eight-hundred-page "Auditory Scene Analysis: The Perceptual Organization of Sound," remains a basic text in the field.

Bregman was a mentor to many of the significant figures in the growth of what has come to be called "cognitive science," that new discipline in which psychology, philosophy, computer science, and, sometimes, sociology and evolutionary biology all meet. At a less exalted level, he also gave me some of the best advice I've ever received. Trying to decide whether to major in psychology or art history, I had gone to his office to see what he thought. He squinted and lowered his head. "Is this a hard choice for you?" he demanded. Yes! I cried. "Oh," he said, springing back up cheerfully. "In that case, it doesn't matter. If it's a hard decision, then there's always lots to be said on both sides, so either choice is likely to be good in its way. Hard choices are always unimportant."

Montreal has changed in the twenty-five-plus years since I left, and mostly for the better—for one thing, there is more good food in the city than there ever was before, most of it genuinely rooted in the culture of Quebec, where the fancy food used to be touched by a colonial cringe toward France. But the places I had known and the people I had grown up with in the old Anglophone quarters were largely gone. I walked down St. Catherine Street, the main drag of Montreal, now drabber than it once was, and past the site of a long-vanished sheet-music store, International Music, where upstairs, in a kind of keyboard bordello, you used to be able to rent one of a chipped set of rickety, out-of-tune pianos for half an hour at a time. I would spend happy afternoons away from school dallying with the Jerome Kern and P. G. Wodehouse song "Bill," with its sharp edge of the dominant-seventh chords and its pretty major-seventh cadence. How the chords had amazed me by their instant assertion of emotion: the poignant, wistful C-major seventh (making its re-signaled move to F-major seventh) had got me through teen-age heartbreak. In those days, even buying records was almost as exciting, and usually as frustrating, as chasing girls. I could still recall finding a copy of the long-out-of-print "Ella Sings Gershwin," with Ellis Larkins, and racing home, to find out what "Someone to Watch Over Me" sounded like when played by someone who knew how. Music represented for me not the endless, shifting weather-cover of sound that it does for my kids, a cloud in every sense, a perpetual availability of emotion to suit a mood and moment. Music meant difficulty—and, when the difficulty was overcome, the possibilities of life, too. It was something to master.

The faculty club at McGill, a cozy converted brownstone, hadn't changed since my father lunched there, on finding Anglo-Canadian specialties. (I recalled once ordering steak-and-kidney pie, and picking past the kidneys.) I hadn't seen Bregman since my wedding day, thirty years earlier. He had aged and whitened over that time, but his mind was as gently acute as I remembered. Among highly intelligent people, there are two kinds of minds, the sharp and the soft. We expect smart people to have minds like swords, made to fight and slash and slay. Soft smart minds, though, are of another, rarer kind. They absorb great quantities of data and opinion, often silently, even sluggishly, and turn them around slowly until a solution appears. Darwin is probably the best instance of the soft style in science history, and Bregman is very much in this soft-mind tradition. Sitting down for lunch, I haltingly tried to describe Choueiri's work in 3-D sound, and he quietly nodded. "Yes, I suppose he must be finding a way of re-creating the delays in the appearance of the signal to the ear," he said, "though I suppose he'd
have to base it on generalized features of human heads? Or else broaden the signal. But either way it must have a really small spatial range, right?” I weakly agreed.

Having lunch with us was Robert Zatorre, an organist turned neuroscientist, and an expert on what music actually does to the brain. Zatorre explained that there seem to be two systems in the brain that respond to music. One is “veridical,” and responds to the pleasant synthesized signal, oscillating between started studying it because I was interested in language. How is it that, when we hear this stream of sounds, we recognize words? How does the mind know when they start or stop—how does it organize this stream of pressures on our eardrums into language and background noise? What we discovered is that the ear ... and the tail of a serpent. We discovered is that the ear is a lot like the things that the Gestalt psychologists had found out years before about the eye—that it is a piece of the mind. The ear creates aural figures and aural backgrounds the way the eye makes figures and ground.

If, for instance, you play a three-note synthesized signal, oscillating between low notes and high, the signal “comes apart” as it accelerates, and the brain turns one stream of oscillating sound into two distinct streams of pulsing sound. On a strange and wonderful CD, Bregman has catalogued and named such auditory illusions with charming specificity, including “Segregation of a melody from interfering tones” (we hear a melody separately from any noise that might occur right in its midst; we don’t strain to hear the tune—it just appears) and “Stream segregation of vowels and diphthongs” (we “over-divide” words into their component phonemes, hearing boundaries in our heads that don’t exist in the recorded sequence).

“So now the question arises: What has this got to do with music?” Bregman went on. “Look at some of the features that we use to pull sound apart in the environment—we have to pull musical sounds apart in a musical composition, you have to be aware of many lines more or less at the same time. That’s why I think that music exploits a feature that allows you to store information and manipulate it and play around with it.” He turned to Zatorre. “And, you know, Robert, what’s always puzzled me is that melody is based on steady tones and steady tones are almost nonexistent in nature. The natural environment doesn’t have periodic pitch. Leaves, winds, and rain—they don’t have a harmonic structure.”

In “Auditory Scene Analysis,” Bregman made a daring suggestion: that music is essentially a form of what he dubbed “chimerical perception.” (The Chimera was a beast in Greek mythology with the head of a lion, the body of a goat, and the tail of a serpent.) “We use the word Chimera metaphorically to refer to an image derived as a composition of other images,” he writes. “An example of an auditory Chimera would be a heard sentence that was created by the accidental composition of the voices of two persons who just happened to be speaking at the same time. Natural hearing tries hard to avoid chimeric percepts, but music often tries to create them. It may want the listener to accept the simultaneous roll of the drum, clash of the cymbal, and brief pulse of noise from the woodwinds as a single coherent event with its own striking emergent properties.” In some sense, our taste for music may be a by-product of the way our auditory-processing system intends to eliminate auditory chimeras. We want to distinguish the rustle of the vines from the slither of the snake. Musical sounds both draw on and stymie the mind’s mechanisms for making distinctions.

After lunch, I went to visit the lab of another of the McGill musicians, Daniel Levitin. Though most people who study music tend to have been musicians once themselves, Levitin is unusual in the extent of his early musical career. He was a successful commercial producer and sound engineer for musicians as varied as Santana, the Grateful Dead, and Blue Oyster Cult, until the deeper questions that had been nagging at him, the “why’s” of music, compelled him back to school and on to a second career as a psychologist and neuroscientist. (He keeps in touch with his earlier world—he’s the author of the liner notes on the recent Stephen Stills boxed CD set, full of smart stuff about guitar clusters and Nashville harmonics.)

A visit to Levitin’s lab is a bit like going to the music department of the
Academy of Lagado in “Gulliver’s Travels.” He studies systematically things that one would not have thought open to systematic study. In one music room, there is a hyper-cold bath; you dip your arm until it becomes painful—as it very quickly does—and then you listen to music. Levitin and his students have shown that you feel less pain if you listen to music and much less pain if you listen to music you like and have chosen yourself; and, as an improbable older experiment predicted, that men report much less pain if they are in the presence of a woman whom they are trying to impress with this strange sort of music appreciation.

Levitin’s prize possession is what might be called the Expressive Piano. It’s a Yamaha Disklavier, a kind of electronically assisted player piano. It can record the precise fingering and pressure of a pianist, and then play it back. Levitin and his team had a professional pianist play Chopin into it, and then laboriously spoon-fed the expressive dimensions, the “phrasings,” into a computer program: first, how hard he pressed down on the keys, and then how much he varied speeds within a fixed rhythm. Then they taught the computer to intensify or minimize those variables—to play versions of the same Chopin piece with much more variation within the tempo, or much less, with more variations within the volume of notes, or much less. It turned out that people sought out an optimal middle of expressiveness; they liked the Chopin the way the pianist had played it, with enough rubato and musical italicizing to indicate the presence of a player, a human hand, but not so much that it all became randomized mush.

That’s not surprising. We prefer a touch of vibrato in a singer’s voice to the full Kate Smith tremolo. We like a pianist who, as the phrase so rightly has it, tickles the keys, and dislike one who bangs them. But, Levitin suggested, the smallness of these results is made sane by their sureness. “We’re only taking these little thimblefuls of knowledge from the great sea of music,” he said. “But what we know now we really know. We’re not guessing, or just assuming, or just asserting things about the way these expressive dimensions work, or how universal they can be shown to be. We really know. And if I had to, so to speak, explain to the muse of music what I’m trying to do in my life now, I’d say, I’m trying to show that what you make seem so beautifully simple is really, really hard. So hard that you have to study it note by note.”

Later on, I asked Levitin about Riemann and his missing undertones. He pointed out that most of the lowest notes on most pianos are actually inferred rather than heard. The soundboard on most pianos isn’t long enough to produce the bottom octave, but the brain hears the right overtones, which the piano can produce, and neurons in the brain begin to fire at the frequency of the missing bass note. Riemann may have been hearing “undertones” of that sort, unknown to the psychology of his time, and was aptly, if not entirely accurately, generalizing from them. Here, I thought, was where psycho-acoustics mattered: it mapped with a new precision the hazy but crucial area between what the sound-sensitive ear hears and what the pattern-detecting mind infers, which is exactly the place where music happens.

Spending a day among scientists who study music can seem disappointing at first: people like music played with a bit of, but not too much, expression; our minds take sounds and turn them into scenes. There was one truth, though, that connected the McGill music men’s work to Choueiri’s: the vital role of the not-too-perfect in our pleasures. The two expressive dimensions whose force in music Levitin had measured and made mechanical were defections from precision. Vibrato is a way of not quite landing directly on the note; rubato is not quite keeping perfectly to the beat. Expressiveness is error. Just as, at a subliminal level, Choueiri could make music come alive in space by introducing tiny errors into the amplitude and timing of the XTC wave, Levitin could show that what really moves us in music is the vital sign of a human hand, in all its unsteady and broken grace. (Too much imperfection and it sounds like a madman playing, too little, and it sounds like a robot.) Ella singing Gershwin matters because Ella knows when to make the words warble, and Ellis Larkin knows when to make the keyboard sigh. The art is the perfected imperfection.

In the academy, there is another account of how music works. The new discipline of “sound studies” takes as its subject what might be called the sociology of sound—how styles of recorded music interact with social aspirations and the friction of economic classes, producing a map of music listening that has more to do with money and mass culture than with the way neurons trigger and ears organize.

One of these music men is in Montreal, too—Jonathan Sterne, the author of “MP3: The Meaning of a Format” and “The Audible Past: Cultural Origins of Sound Reproduction.” The morning after my day with the psycho-musicians, I marched up to his office, in the Art History Department, where I had spent many hours studying art, after learning from Bregman that it didn’t matter what I studied. Well, it had once been the Art History Department; now, inevitably, it was the Department of Art History & Communication Studies, and, alongside seminars in Duccio and Giotto, I now saw classes listed on “Hacker Culture and Politics” and “Media and Urban Life.”

Sterne is a hefty, Minnesota-bred guy who plays the double bass. He was a big kid, and when he was ten, he recalls, the instrument “seemed appropriate to my body size. They told me, ‘You can play electric bass guitar when you get a little bit older.’ I still mess around. I sort of identify as a bassist—it’s a personality thing. I’m the reasonable person in the band. I like to play with other bassists, because they’re all reasonable people.”

As a reasonable person, he says, “I don’t see the grand synthesis of one truth of hearing.” In particular, he mistrusts the desire of the psycho-acousticians to “universalize—the brain does this,
What's lost in Whig "lossy" than sound in should change. I think actually the fundamental insight of psycho-acoustics emphasizes computer detecting vibrations out of nature. Therefore, perception in aence. For me, I'm much more interested the constant ascension to better fidelity, the difference from a microphone and a is incredibly profound. Human ears aren't natural reflectors of sound in the world. They are themselves these transducers that make reality—the perception of sound is not a mirror of nature. Therefore, perception in a way makes sounds, and it makes sounds differently from a microphone and a computer detecting vibrations out in the world."

Sterne's preoccupation is with the fallacy of what one might call the official, Whig history of sound recording—a constant ascension to better fidelity, the triumph of signal over noise. Instead, he emphasizes the double movement where technology makes the musical signal more and more compressed, more "lossy" than it ever was before, as is the case with the information in an MP3. What's lost in the compression process is supplied by the mind's capacity to fill in musical gaps and the public's willingness to tolerate what is in some ways a worse product in exchange for the constant novelty of a changing one.

"We have the story of ever-increasing verisimilitude," he says. "But, throughout the stories of infrastructures that transmit electronic signals, there's this very basic engineering problem: you've produced this experience and over here you have this strange medium and you want to put as much as possible on it, but you want to reduce the cost of doing it." That's what happened with the advent of MP3's: "They say, We'd really like to transmit CD-quality sound through the lines, but there's not enough bandwidth, so we have to do something. And they investigate what parts of the sound people are unlikely to hear—you omit those parts and send the rest down the line. That's also what happened in the phone line way back when. Bell Labs' human-hearing research goes back to the twenties: we don't want to reproduce sound that people don't need to hear and still have intelligible phone conversations. All of information science comes out of these acoustic questions from the nineteen-twenties—Bell Labs people trying to figure out how to cram more signals into a phone line."

The notion of a pure musical experience is, for Sterne and his cohorts, the last sad effort of a nineteenth-century cult of attention that placed the solitary alienated (and almost always male) listener in a temple of silence, the concert hall. Everyone faces forward, no one moves, applause is tightly regimented, and no one ever does the things that human beings normally do when they hear music: dance, move, act, eat, flirt. "It isn't strange that the MP3 generation walks around with earbuds on and listens to music while they're doing everything else," Sterne says. "That's the normal human condition of listening. It's very, very unusual to have any concept of music apart from a dance practice—the separation of music and dance is very late and highly unusual." The sociologists, his work suggests, are dissolving music back into the field of sound from which an act of Western will has divorced it.

Sterne's diagnosis of Choueiri and the other high-end researchers is that "they're trying to resolve the anxiety of the modern by reproducing the anxiety of the modern." He means that the anxiety that produced the isolated urban listener in the concert hall is only aggravated by the technology that, pretending to liberate listening from the concert space, simply makes for more lonely domestic concert halls. The sweet spot on the sofa is a sad place to be.

I am, both by temperament and by training, a little allergic to this kind of thinking, but there is no denying that it adds a necessary historical dimension to the study of music's workings. Choueiri's project could, as Sterne suggested, be seen as an allegory of the engineer's dream: incredible intelligence put to work to solve a problem whose solution merely re-states the problem. In this view, the BACH filter, with its narrow listening spot and its Rube Goldberg-style machinery to take that sweet spot with you, is an elaborate ode to a dying practice: it is a way of mechanizing the cultural prestige of attention, of enforcing the kind of listening that we think we ought to give to music and mostly don't. There doesn't, in truth, seem to be much dissatisfaction with what people have now; those tiny, tinny earbuds playing music from detail-diminished MP3s are satisfying
because, as Sterne says, in all but a handful of aberrant cases nobody sits down to listen to music.

When I got back to New York, Choueiri had something new to show me—a true Mr. Peabody device, which he calls the Stereo Purifier. It is designed to fit into one large box, and to simplify the business of finding the one right filter for your particular ears. Inside the box is jammed every imaginable audio cable connector, to accommodate any possible listening system, and jammed among all the cables and electronic components is a Mac Mini and the BACCH filter. In this newest iteration, everything has been automated—in neat, self-generated, Deco graphics—so that the tiresome adjustments that he had to make by hand before can now be done in half a minute. You put on in-ear microphones, and the Stereo Purifier measures the air pressure at the entrance of the ear canal.

Choueiri admitted that the Stereo Purifier was more likely to flourish as an aid to video gaming than as a way to hear Baroque choral music. “There may be new 3-D audio techniques,” he said, “that will combine ambisonics and binaural dimensionality, and that would be the ultimate delivery system.” Choueiri can actually imagine a new musical frontier where you could go to hear Bach at Carnegie Hall with microphones in your ears, and come home to reproduce the concert in your living room, exactly as you’d heard it.

He was, I thought, at once encouraged by the commercial attention the BACCH filter was beginning to receive—it has become available in what’s called a Jambox, and there is lots of Chinese interest—and discouraged by the realization that the “high end” of music listening was very small. We listened to Bach, and then sat briefly in silence, and I suddenly remembered something I’d been meaning to ask him. Passing through the bedroom on an earlier musical visit, I had noticed that Choueiri had a small, old-fashioned record-player by his bed, the kind I had as a child. I asked him what it was, and why he had it near his bed.

It was, it turned out, a single-tube monaural record-player made the year he was born, 1961, and though its fidelity was, technically speaking, “horrendous,” he thought that the pleasure to be had from a scratchy record of Rosalyn Tureck playing a Bach prelude came through unscathed. “I often use it when I am in bed reading or relaxing,” he wrote me later, admitting that “our minds tend to automatically compensate for the shortcomings in tonal fidelity and get to the music almost irrespectively of how shrouded the sound is.” He likened it to “a sublime apple pie that transcends its unpalatable shortening.”

Reading his letter, I was put in mind of an entry I had recently come across in a diary kept by the English essayist Edward Marsh, written in England at the height of the Blitz, about listening to a concert of madrigals on a floating platform in Cambridge. “The river lined with canoes and punts, and crowds sitting on the banks or standing on the grass, in a delightful atmosphere of joy in widest commonality spread,” he wrote. “The programmes were sold out by the time I got there, so I don’t know what they sang—but it was beautifully done, and such a lovely calm bright warm evening.”

That is music as we hear it, and its pleasure, as we know it, with the beautiful pair of undivided adjectives—lovely calm and bright and warm. To worship music’s fullness as a fabric of sound is to deny its thickness as experience. The answer to Bregman’s question “Why do we like music?” isn’t this thing or that thing but many things at once pressing down hard, and then lightly, on our minds, as Ellis Larkins presses on the keyboard. The few writers we think of who capture something of music on the page do so not with a crisp formula or any kind of technical precision but through a gentle, fluid, many-adjecived, metaphoric web of words, laid out over the pool of sound.

Music is a current of hard choices, made to seem easy by the mind. I like to think of Choueiri, amid his dreams of dimensional music, listening to his small imperfect record-player before he goes to sleep. I can imagine the sound of it travelling across the New York night, calm and bright and happy, filling all the ears and spaces between.

NEWYORKER.COM/GO/OUTLOUD
A conversation with Adam Gopnik.