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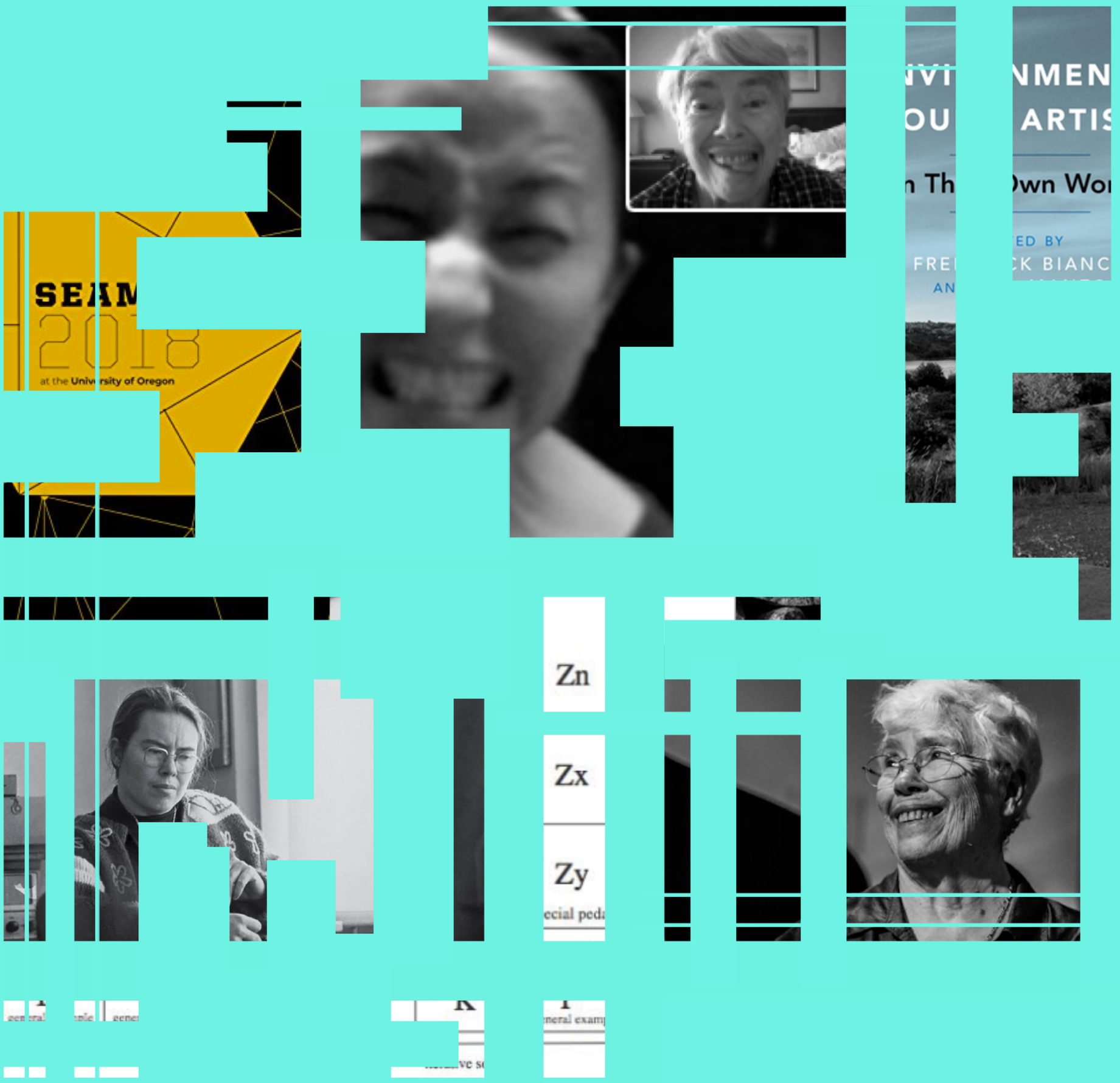

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From the Editor

This edition of Journal SEAMUS functions primarily as a tribute to an inspiring, far-reaching, and incredibly impactful member of the American electroacoustic music community: Pauline Oliveros (1932-2016). Some of Oliveros' earliest forays into electroacoustic music involved magnetic tape and early synthesis systems at the San Francisco Tape Music Center, established in 1962. An avid improviser on the accordion and other instruments, Oliveros performed with visionaries including Stuart Dempster, Terry Riley, Loren Rush, and Morton Subotnick. She taught at Mills College, University of California San Diego, and Rensselaer Polytech. Her output includes the celebrated *Sonic Meditations* (1974), a collection of graphical and textual scores that focus on community music-making, new roles of sound in society, and the power of "deep listening." In 2015 the Pauline Oliveros Foundation was renamed the Deep Listening Institute, which recently merged with the Center for Deep Listening at Rensselaer Polytechnic Institute in Troy, NY. Oliveros was also a lifelong advocate for gender equality, inside and outside of the Arts.

Having been born in the 1990s, this editor is a generation (or two) separated from Oliveros' generation, but as a student of electroacoustic music I clearly felt her work rippling through the fabric of my education, and studied with a number of her students. Her text compositions, electroacoustic performances, writing, and life's work espousing the value of Deep Listening have mythic connotations in my mind. I never got a chance to meet Oliveros, but having met a few of the other legendary figures of American electroacoustic music (Max Mathews, to name one), one is confronted with the reality that these are very human, very excellent researchers and practitioners, and through their tireless efforts they have made significant contributions to global conversations around electroacoustic music.

Two heart-felt writings remembering Oliveros start the Articles section of this edition, from Heidi Von Gunden and Tomie Hahn. Next, you will find a reprint of an interview with Carla Scaletti from the SEAMUS Newsletter (given by Elizabeth Hinkle-Turner), another fantastic musician and pioneering researcher of electroacoustic music practice. This is followed by the second in our two-part series by Gemma Peacocke, *Des Voyages Des Sonores Part II***,** a meticulously well-researched history of computer music programming at IRCAM, and rounded out with an article looking at the difficulties of analysis of electroacoustic music by Jaesong You and Tae Hong Park. Within the Reviews section of this edition is an event review of the 2018 SEAMUS conference held at University of Oregon by Aurie Hsu, and a book review of *Environmental Sound Artists: In Their Own Words*, Edited by Frederick Bianchi and V. J. Manzo, by Joshua Groffman.

Lastly, a special note: this edition, and Editions 29-31, will be published anachronistically, due to a backlog of incomplete issues starting with Edition 27 in 2016. Editions 33 and onwards (2021) will be published in real-time.

Eli Stine, Editor

Articles

In Memory of Pauline Oliveros (1932-2016)

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In honor of Pauline, let's begin with at least 45 seconds of listening to whatever sounds you are experiencing.

Hopefully you participated. For many of us Pauline will be remembered for her Deep Listening. In the 1950's she left Houston, Texas and moved to San Francisco to pursue her career as a composer. She had her accordion and $300. Deep Listening began with a clumsy reel to reel tape recorder. Pauline put a microphone in her apartment window, left it recording and was surprised on her return to discover the many sounds taking place inside and outside her room. She decided to always be listening. This was a serious commitment and listening led to improvisation that became the focus of her music.

In the 1960's Pauline developed listening skills with her friends, Terry Riley, and Loren Rush. They formed an improvisation group and met in the studios of KPFA, recording their acoustic improvisations and studying the results. Later they established the San Francisco Tape Music Center. Here Pauline tried another kind of improvisation, tape-delay using two reel to reel recorders. She practiced sonic awareness to control and shape the results. In 1961 she applied her listening abilities to a notated composition, *Sound Patterns* for mixed chorus, that won the 1962 Gaudeamus prize that launched her career. She became a faculty member at the University of California at San Diego in 1967.

I knew Pauline when I was a student at UCSD from 1971-75. At that time she team taught a large undergraduate music appreciation class. One assignment was to record an interesting sonic environment. The Music Department had small Sony battery operated tape recorders that students could check out. I was one of several TAs who listened to these tapes and I still remember one student's recording of a windmill with fascinating sounds of ropes and pulleys. Students were also required to keep a sound journal. Pauline kept her own sound journals.

By 1972 Pauline's research about sonic attention and awareness became *Sonic Meditations*. (1972). These tuned listening to breathing, environmental sounds, walking, the sound of one's name, and other sonic sources. Many of the *Meditations* encouraged performers to responded vocally creating elegant sound masses produced from simple directions.

Eventually her improvisatory skills and sonic awareness intensified and became Deep Listening, the source of her meditative improvisations. Several years ago when Jason Fickelman invited Pauline to the University of Illinois, she performed a long meditative improvisation with her computerized accordion. While listening, I noticed the beautiful and mesmerizing sounds. Pauline had completed a full circle--the accordion and tape delay were replaced by computer-controlled sound shaped by her Deep Listening

I always considered Pauline a pioneer, a strong woman at the forefront of contemporary music and, as her website shows, she lectured and performed in many places even as her life was drawing to a close. As a coda and tribute, I invite you to spend another 45 seconds just listening in memory of Pauline.

Tomie Hahn

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Breathing in, then…
Brrrgkkk…k.k.k…
Wupah. paa a a a.
Zzznnsssssss
Schhhhpitueyyyy
Gkk, gkkk, ghhh, gkkhhhhhhhhh (clearing throat)
Spitueyyy!
(giggling, giggling giggling)

I begin with a photo, emailed to me by Pauline after an iChat over a dozen years ago (see Hahn 2006). While not the most flattering portrait of either of us, it reflects a side of Pauline so many close to her know and miss. For me, Pauline's sense of humor pushed the boundary of inquisitiveness right over the crest of serious, and I fell into a mindset of improvisation of the everyday.

Let me explain… Pauline was listening ALL of the time. Really.

While she held weekly Deep Listening classes and workshops specifically for heightening listening awareness, Pauline served as an embodied example of how conscious listening practices can integrate into everyday life. In other words, the act of listening isn't switched on only during specialized sessions of music making, dance, concerts, audio recording, and so on. Listening awareness and varied levels of attention can become increasingly refined, redirected, or stretched.

In Pauline's presence I came to profoundly appreciate how the attempt to listen all of the time affords a sensibility of being in the moment, supporting possibilities. But just what kind of possibilities? For me, possibilities offer a consciousness of potentials of experiencing each moment, being present—yes, all of the time. Awareness of potential possibilities offers insights into imaginable choices of direction, sonic or otherwise. Pauline seemed to approach improvisation fluidly, from everyday interactions to improvisation

on stage. She did not verbally articulate this fluid nature of improvisation notion to me. Pauline lived it and revealed it every moment, in meetings, classes, hallways, on stage, and online.

The playful and deeply witty side of Pauline I will miss. Yet, such a vital gift without her means I am responsible to transmit it, "gift it" to others in any way possible. Her playfulness was driven by a sense of the everyday potentials of connecting with others and improvising. Here, I share the personal as an example of Pauline's nonstop ways of being *in* improvisation and listening.

Although I experienced Pauline improvising as early as the 1980s, it was not until we were working side-by-side at Rensselaer Polytechnic Institute in 2001 that I discovered the many sides of her personality. Soon, we were greeting each other with tiger-like growls and laughter. These early greetings soon developed into our own ritual greeting of sputtering, or spitting sounds. Pauline surprised me with her lightning fast responses! Before and after faculty meetings we'd improvise churtlings alongside untamed smiles and grimaces. 'Twas our idiomatic custom of improvising and communicating in the hallways, Skype, and even spilling into rapidly typed email exchanges. From time to time people noticed our sputtering salutations and appeared stunned, probably interpreting that we were spitting *at* each other. To this Pauline would raise her eyebrows and add laughter into the mix. Crackling spontaneity. I use my own Pauline salutation story as a personal example, but I know that countless Deep Listeners, affectionately known as "DLers," had similar, very wild Pauline greetings. No words of hello, just a… *Gwaaakzzzpshhhhh!*

The sputtering-as-greeting ritual displays Pauline's embodiment and use of playfulness in improvisation. She often talked about playfulness as a vital element of Deep Listening. For example, during an interview in 2014 on "Heart to Heart," a Korean Arirang television show, Pauline talked about Deep Listening, Sonic Meditations, and improvisation. At one point she turns to the studio audience and asks them to join her in a breathing meditation and improvisation. A discussion about playfulness and improvisation followed. Pauline offered:

> That is an example… of an energy exercise, or energy practice but also developing a sense of playfulness and improvisation… you don't need any musical training to do that…
> I think laughing and giggling is important. Laughter is a very healing part of our world, our life… and I think that it loosens people up a bit to have fun and to find fun in something… especially if it is unfamiliar, you haven't done it before. And sometimes what I am offering is maybe strange… "What is this? Eeek." (Arirang TV (2014, April 7) posted on YouTube)

The Arirang television audience seems quiet and self-conscious during Pauline's on-the-spot improvisation. However, we can observe Pauline encouraging them, through playful means, to reach beyond the vulnerable moment and feeling of a "strange" practice. Driven by her mindset of inclusivity, that all people can freely join sound and movement improvisations, Pauline found playfulness and laughter as a path to healing, and that "loosens people up a bit to have fun and to find fun in something."

I leave you with a challenge. Next time you see a friend or colleague, smile, then add an improvised movement and sound salutation. See where it leads. How did that moment of vulnerability and play feel?

GZZzzzzaahhh. . . *Bzzzpp!*

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An Interview with Carla Scaletti (from the Summer 2017 Issue of the SEAMUS Newsletter)

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Introduction

I have known Carla Scaletti virtually all of my compositional life starting with her appearing "in the distance" as a quietly awe-inspiring presence (so many people spoke so reverently of her creative intellect and thoughtfulness) in the Computer Music Project of the University of Illinois at Urbana-Champaign in 1986. I was privileged to work with some of the early incarnations of her Kyma System at a Sound Computation Workshop with the CERL Sound Group towards the end of my studies at UIUC in 1991. A year later I recall sitting next to her at a SEAMUS banquet trying very hard not to let on to everyone how miserable I was after my first chemo treatment, and listening to her discussions with others at the table helped to focus me. There have been many subsequent conferences and workshops and interactions in between. Finally, in 2011 I was asked to write a chapter about her for an upcoming text (Laurel Parsons and Brenda Ravenscroft, eds. *Analytical Essays on Music by Women Composers, Volume 4*, Oxford University Press, forthcoming), a project which has just been completed by the editors and authors.

Though I have joked with Carla that sometimes I feel as if I am the "Robert Craft" to her "Igor Stravinsky," she has been unfailingly polite and generous with her time, her thoughts and her resources. I have found this to be a universal about Scaletti: when asking other composers and colleagues about working with her, the Kyma System, and her company, Symbolic Sound (kyma.symbolicsound.com), they speak of this generous responsiveness, avid curiosity, and genuine desire to collaborate in every way. In this interview (an emailed dialogue with the composer and inventor), I enjoyed asking her about things we had never previously discussed and only just generally touched upon in earlier conversations that directly relate to her recent 2017 SEAMUS Award acceptance speech. Let's continue the discussion!

Elizabeth Hinkle-Turner (EHT): On your personal homepage (carlascaletti.com) you begin with a Mu-Psi manifesto. You write that it is "sound art that seeks to transcend the personal and to express universal concepts, patterns, and processes" and continue with an explanation of how it is analogous to science fiction. For as long as I have been familiar with your composition catalog, your starting point of *"a Mu-Psi sound work begins with a hypothesis, a 'what if' premise*" that then explores the ramifications of the premise has been a primary creative interest. Am I correct in that assumption? Can you provide us with a narrative of how this started and emerged as a primary creative interest?

Carla Scaletti (CS): I think that concept had always been there, but I hadn't noticed it until you asked me a question about it for your first book; you asked me if there was anything that characterized or unified all of my work, and that's when I noticed that there had always been a thread of science and mathematics throughout the work I had done up to that point. I was pretty excited to discover that there was a unifying theme because it made it clearer where I'd been and gave me a guide of where I wanted to go next, so thank you for asking that question!

Where did it come from? My father was a scientist, we were very close, and I grew up thinking that I would be a scientist too. It was only at the last moment when I had to choose a major that I chose music composition, instead of a scientific area. To this day, I'm often able to access that elusive sense of transcendence we're

all seeking by reading articles in *Science* magazine. I think there is something about science and the arts and education that let you become part of a project much larger than any one individual could finish in one human lifetime. I remember being amazed to find out that it took several generations of architects and builders to complete some of the cathedrals in Europe. In a way, we too are contributing to more abstract edifices of knowledge by contributing to the arts and to scientific research. And in education, you can trace the lineages of your own students and their stud ents and reflect back to your own teachers and their teachers and feel connected to a long tradition that stretches backward and forward in time. For me, the ultimate goal for making music is to be able to give people a sense of transcendence, even if just for a moment or two. That's what I'm always trying for anyway.

EHT: At ICMC 2015 you gave a keynote address "Looking Back, Looking Forward" providing an overview of a shared history in creative computer-based exploration and then moved to a more specific discussion of the early days of your work which lead to the Kyma system and the formation of your company. What are a few of the major pivotal events, people and/or experiences that were essential to the emergence of Symbolic Sound?

CS: In retrospect, everything that happened prior to that was leading up to the emergence of Symbolic Sound.

My parents were very entrepreneurial educators; they loved starting new programs, even when it meant taking a less traditional career path. My father left a tenure-track position at the University of Minnesota to help start a new medical school, initially housed in a re-purposed 7-up bottling plant at the University of New Mexico. My mother started several alternative schools within the Albuquerque public school system, to educate the "misfits" who were on their way to dropping out or being expelled, and she started the first computer literacy classes at her high school even before she knew how to use a computer herself (I remember the two of us learning LOGO programming together during one vacation). So they were constantly experimenting with new formats and derived energy from the excitement of building new programs.

The CERL Sound Group also had a very "high tech-startup" atmosphere. It was up on the top floor of the Computer Based Education Research Laboratory, accessible only by metal fire escape stairs so "adults" rarely went up there. Lippold Haken and Kurt Hebel were unusually independent, self-motivated, and creative for undergraduate engineering students; they loved the work so were there late every night and on the weekends. Don Bitzer, the founder of CERL, brought a lot of money into the university through his patents, and he supported the music lab in part because the Sound Group could always provide some entertaining demos for what he called the "dog and pony" show he would present to grants agencies and investors. In between those rare dog and pony shows, we were left alone and unsupervised for long stretches and had a budget for buying parts and designing/building PC boards. It was an amazing opportunity! But it's not every undergraduate who would know what to do with that opportunity. Kurt and Lippold were pretty amazing individuals. Even as teenagers, they already had their own ideas, the motivation to apply what they were learning from their classes, and the ability to teach themselves whatever they weren't learning in school. For me, discovering the CERL Sound Group meant I'd finally found some people I could discuss Computer Music Journal articles with! It was so inspiring to be in that atmosphere, learning things, making things, and actually seeing them being used by people, that, even though I had finished my doctorate and was already teaching in the School of Music (I was covering John Melby's course the year he had a Guggenheim grant), when Lippold offered me a research assistantship at CERL, I didn't hesitate. I turned down an offer from the School of Music to teach music theory courses the next year as a visiting assistant professor and became a student again (this time pursuing a masters of computer science).

Working at the CERL Sound Group was actually good practice for starting our own company. At CERL, we had to design, plan, program, order parts, call suppliers; we even had

"customers" we had to support (the students and faculty who worked in the open studio up on the fourth floor). So, in a lot of ways, we already knew how to run a company even before we started Symbolic Sound.

But as is often the case in life, taking a risk requires a little push. We would have been happy to continue pursuing our research at CERL; I had started applying for grants when Bitzer's patents began to expire. But like many successful people, Don Bitzer also inspired his share of envy (he often made a point of how independent he was, since he had large grants from industry partners and NSF, and his patents) and when his money started to dry up, there were others at the university who were eager to push him out. He ended up with an endowed chair at North Carolina, but everyone else at the lab was given a year to find another job. Kurt and I had already talked about starting our own company. But losing your job is a good motivator! The non-academic employees got unemployment benefits but part time academic employees (I was a quarter-time research assistant at the time) were not eligible. Lippold felt bad about that so he told me unofficially that there was no reason for me to show up at the lab anymore and that I should go home and work on Symbolic Sound full time. So, thanks to Lippold, I had a subsidized year where I could work full time in my new office (which was the second bedroom in our fourth floor student apartment). The UPS and FedEx employees got a kick out of delivering parts to a student apartment and taking away large boxes containing Capybaras destined for addresses all over the world. Last year, we got a delivery at our current offices by one of those guys who recognized me and had a big smile on his face, "I remember you guys! You used to be in that little apartment!"

I never expected to start a company; I thought everything in my life was leading up to becoming a music professor. But in retrospect, it is easy to see the events and experiences that led into Symbolic Sound as a nearly inevitable consequence of my early influences and my collaboration with Kurt Hebel. For me, the work has always been the essential thing. And we've been able to pursue our research, to continue learning, to make music, and to teach others through Symbolic Sound. That's everything that I had wanted to do at the university, and I've been lucky to be able to do it as an independent artist/developer.

I guess the reason I mention that is to encourage any students who might be reading this to focus more on *what* they want to do than on the specifics of *how*. The political economy is constantly shifting such that the jobs titles your parents and professors had may not exist for you (or, if they do exist, the jobs may be very different in character, remuneration and benefits from what they were in the previous generation). In other words, if you ever feel like society doesn't value or want what you have to contribute, there may still be alternative ways to do your work and to make your contribution, even if it's not with the job title you thought it would be when you were growing up.

EHT: This is a bit of a follow-up on the previous question. I am trying to get of sense of this: you started at some point in your life as a harpist. When did that happen and what got you started as a harpist? How did that harpist become the head of Symbolic Sound Corporation?

CS: The harp lessons came about because of a Title 3 grant to the Albuquerque public schools. One day in my middle school orchestra (where I played violin), they asked if anyone who was taking piano lessons wanted to learn to play harp, and I volunteered. It was more of a "Hmm that would be something interesting to try" than any angelic aspirations on my part. The grant provided six small lever-harps to the public schools and lessons with the harpist from the Albuquerque Symphony for six students, one in each grade from 7-12 (I was the one in 7th grade). They needed harpists for the Albuquerque Youth Symphony so they wrote a grant to encourage public school students who were already interested in orchestral music to study harp.

EHT: Just as an "fyi," in the little town of Sherman, Texas where I grew up, the only person who played harp was a girl who came from the richest family in town because they were the only ones who could afford a harp and the van to take her and her harp to Dallas each

week for her specialized harp lessons! The harp was an instrument of the privileged class in my background.

CS: Hahaha, we weren't the richest family in town, but I consider it a privilege to have grown up in a house where there were books, and a record player, and a tape recorder, and where learning was valued for its own sake and teaching was a highly-respected profession; my parents were both educators and both of them encouraged me to follow my curiosity. It *was* a privilege to grow up in that kind of an environment (though maybe not in the same sense that you're using the word "privilege?") It was also a super strict environment — even my younger brother had a lot more freedom of movement than I was ever allowed, "because he's a boy" — but intellectually, there were no restrictions, so all of my energies went into the world of music and ideas.

My dad had an Ampex reel-to-reel tape deck and he liked to experiment on me! He was always trying out different mic placements and different ways to record the piano. For fun, we would go to Hudson's Audio store together and A/B the speakers, always bringing in our own recordings for testing. He was such a regular visitor at Hudson's, that they would let him bring home various pieces of equipment to test overnight. One night he brought home a Triadex MUSE synthesizer (https://en.wikipedia.org/wiki/Triadex_Muse) and handed it over to me; I stayed up all night playing with the settings and recording the sequences on my little cassette tape recorder (my dad didn't let me use the reel-to-reel for anything but "serious" music) before we had to bring it back to the shop the next day.

I also grew up on family stories that always ended with a moral or a lesson. To give just one example, my dad told me that when he was away at college, my grandfather got sick so my dad immediately came home to take care of him. When my dad walked in the door, my grandfather was furious with him. He stood up, walked over to the window, opened it, and threatened to throw himself out the window unless my dad went back to school; he refused to close window until my dad promised him that he would go back to school and finish his degree.

Looking back, I have to smile at how many times my dad repeated those kinds of stories to me, but I understand why he did it: he wanted to convey just how important education is — and that there is an intrinsic value to learning. He also wanted me to know how much my immigrant grandparents had sacrificed to make it possible for him and for me to be able to realize the dream of going to the university. Sometimes, I still have a sense that any time I have an opportunity to make music or learn something new, it's not just for me, it's also on behalf of all my grandparents.

EHT: To expand on this with you, for example, in second grade I started taking piano lessons and in fourth grade I started taking violin lessons. I worked quite hard playing traditional music and being in all-state orchestra and the like but at a certain point I started to move towards the person who went to Illinois and studied with Scott [Wyatt] and Herbert [Brün] and did what I do. There was a path I went on – what was yours?

CS: I grew up thinking that I would be a scientist. My parents thought that music was part of a balanced life, but not a profession. They didn't anticipate how intensely I would get into music, or the school orchestra or that I would volunteer to study the harp or especially that I would get obsessed with electronic music.

I had a really cool first piano teacher named Paul Muench who played in a jazz combo and taught group lessons at his piano store. He taught us music theory as part of our lessons (that was my favorite part). One day, he asked, "Who's brave?" and I raised my hand. He said, "If you play this piece without any mistakes, I'll give you a dime." And I did (my first time earning money for performing). From then on, every time he asked who was brave, all six girls' hands shot up immediately. He hated shy performers and trained us to always have something ready to play at any moment. He was a brilliant, intense pianist — and he died in an accident at an air show doing stunt flying in his antique prop plane.

After I "graduated" from the group lessons, I started taking lessons from the piano professor at the University of New Mexico who would give

private lessons in his home on Saturdays. He would accept new students only if they agreed that they did *not* want to become concert pianists. Since I wanted to be a composer, not a performer, he accepted me. That turned out to be an incredible stroke of luck because George Robert (formerly Katz), came from Vienna where he had studied composition with Anton Webern and piano with Eduard Steuermann (who studied with Schönberg and played piano for the first performance of *Pierrot Lunaire*). Most of Mr. Robert's Saturday students were heavily into music of the romantic period, so he was delighted to have a little middle school student who was eager to learn about new music and music theory. As a professor, he was always getting complimentary disks and music, and if he had a duplicate, he would give them to me! One time, he discovered a new piano piece by Shostakovich, and he assigned it to me just so he could listen to it the next Saturday (none of his other students cared about music written after 1900). One Saturday, after my lesson, he said he had a new disk to play for me: it was Steve Reich's "Come Out." We stood in his living room listening to the gradual de-phasing, when his wife came in with their little dachshund, Schnatzi, and started screaming at him in German to turn that thing off because it was driving her crazy! He just held up a hand as if to say "wait a moment," and we finished listening to the piece with her screaming in the background. I always loved sitting in the living room waiting for my lesson, because it was the first house I'd ever been in where there were original paintings on the walls — and there were a *lot* of them. Sometimes we would get into deep discussion about music and never get to my lesson. It's hard to picture just how ignorant and naive I was, but one time I asked him why he left a beautiful, musical city like Vienna to come to Albuquerque New Mexico; he looked at me for a moment, considering how he should answer, and then just silently shook his head.

You may not have expected a strong Viennese influence on music students in Albuquerque New Mexico, right? But Kurt Frederick, who started the Albuquerque Youth Symphony and conducted the Albuquerque Symphony and the UNM symphony, was also part of the diaspora. He introduced us to Mahler, Strauss, Penderecki and more. Unlike George Robert, though, he seemed perpetually disappointed in how ill-prepared and uneducated we all were. The phrase I remember him muttering to the orchestra most often was "This is a disaster!" Everyone was terrified of him. When we played Mahler's *Kindertotenlieder*, he decided to combine the glockenspiel and the harp parts into one and handed me the extracted part which he had penciled on manuscript paper. Throughout the rehearsal, he yelled at me, berating me for coming in early. I finally figured out that when he had extracted the part, he had accidentally left out a measure. I never said anything about it; I just checked out the score from the library, corrected the pencil manuscript, and played it correctly after that. From then on, I was never intimidated by him (or of any other conductor) again.

When I was in high school, I attended a seminar at the University by John Donald Robb along with my friend Mary Ann. Robb was an attorney, a composer, and music folklorist who attended the first workshop by Bob Moog (Pauline Oliveros and Dick Robinson were also at that workshop) and was one of the first people in the world to own a Moog synthesizer. Robb played his electronic pieces at this seminar and when I heard the synthetic voice in his piece "Rima of the Jungle", I was hooked! I knew that was the kind of music I wanted to make.

At the University of New Mexico, I continued studying with George Robert and studied composition with Scott Wilkinson (who had studied at Mills with Milhaud). Rather than giving us free rein to compose whatever we wanted, Scott would give us musical "puzzles" to work out; I loved that way of learning composition. Scott came to UNM by way of New York, where he had worked for G. Schirmer publishing house before he came to Albuquerque for health reasons; in Albuquerque, he opened a sheet music bookstore called Music Mart and UNM hired him to teach music theory. Scott was the first person I knew who talked about composing as a profession (up to that point, everyone I knew viewed it as an avocation or a hobby that you could do in parallel with your "real" work).

While I was at UNM, a visiting composer from New York named Max Schubel (he was also the

founder of Opus One Records) arrived for a week of teaching and recording sessions, and he hired me as his assistant (and as a harpist) for those recording and editing sessions. He had an unusual approach to recording, which was to get the ensemble to play just a few bars at a time, recording multiple takes of each segment. It was my job to walk into the concert hall, announce the take, and run back into the recording booth to help him catalog the hundreds of takes we were capturing. And, of course, my job included running out for sandwiches and coffee (and eventually for breakfast since the recording and editing sessions would often run all night). My favorite part was watching Max edit all of those takes to produce a single, flawless performance! I got to observe him cutting, and splicing quarter-inch tape for hours. Sometimes, when there wasn't a good take, he crafted a plausible new take out of the material that he had, even slicing the attack off one note and seamlessly splicing it onto the sustain of another. Watching him, it became gradually became clear to me that tape music was not merely a recording of live music — it was a new art form! I consider his recordings to be compositions in their own right!

Max kept getting invited back to UNM and every time, he would hire me as his assistant and as a harpist for the recordings. On his last visit, he told me to prepare one of my own compositions to be recorded on Opus One ("Motet"). Every summer, Max left New York City to live off- the- grid on a tiny island in Moosehead Lake, Maine, and I would get long letters from him, written in different colored inks, full of advice about life and music, stories about his travails with the vinyl pressing factory or the trouble he had getting the printers to do the florescent ink effects he loved so much, or telling me about the water tower he was building on his island or how I should never move to New York unless I could come there with a huge bag of money. So not only did Max show me the art of splicing tape, he was also a role model for how one could live as an independent artist, composing music and producing new music recordings outside the university.

At UNM, I majored in music, but I also continued taking classes outside of music like calculus and human genetics, and enrolled in the honors program. It was not a conservatory-style education; it was definitely a "research-university-style education."

And I saw, in electronic music, a chance to bring my interests together. I saw it as a way to study mathematics and science *and* music. It was a resolution to what, at first, had looked like two conflicting directions. So, I think I was always on this path toward electronic and computer music. There wasn't a sharp detour or overnight change. It was more like a sequence of choices that kept going toward what was most interesting to me (along with some incredible luck in finding engaging and unique role models and mentors along the way).

When I arrived at the University of Illinois, it was like discovering and reuniting with my long-lost tribe: at the U of I, it was normal to combine music and technology and science and mathematics. You could walk into Treno's (the cafe right next door to the music building) and have a lively discussion on the ideal computer music language with students, music faculty, and programmers from local software startups. The first week I was there, I remember hearing a radio ad for a store called "Playback — the electronic playground", and I used to walk around campus with that jingle playing in my head. I felt like I had found an electronic playground!

EHT: Turning now to the Kyma system, when did Kyma become "a tool others could use" in your thinking (or did you always want it to be something that others could use?) rather than "my personal composition tool?"

CS: Kyma started out as a term paper in a survey of programming languages course and, at first, I thought of it as a composition tool and my own theory of music. But I was a member of the CERL Sound Group, and we were very oriented toward making tools that others could use. CERL was a collection of undergraduate students in electrical engineering and computer science who were building sound-generation hardware and software to work with the PLATO network. Everything developed by the CERL Sound Group went into an open-studio on the same floor as the development offices, so there was always someone in the studio using the

hardware and software we were creating next door — graduate students and faculty from the musicology division, high school students from the University High School, engineering undergrads, math majors, and some other random characters (I was never quite sure where they all came from). So, people could use the studio and the developers were right next door, fixing bugs and seeing what it was that people needed in the next release.
So, it was only natural for me to immediately think of Kyma as a language that other people could use too. Very early on, when Kyma still used the Platypus as its audio engine, I gave a Kyma workshop at CERL that was attended by music composition graduate students and even a programmer from Wolfram Research.

And, as you know, I organized the summer Sound Computation Workshops — two-week, intensive bootcamps in sound synthesis and composition using Kyma; people came in from all over the world to attend those workshops and we invited six graduate students from the School of Music to attend for free (that's when you and I first met!). Now Symbolic Sound organizes an annual meeting called KISS (Kyma International Sound Symposium) where people report on their research during the day and perform live interactive Kyma compositions each night.

EHT: Kyma has been used by both "academic" and "commercial" composers with perhaps the most notable commercial use being the tool for the creation of the voice of "WALL-E." Have your interactions with composers outside of the academy been significantly different than with those within the academy? What have been some constants that all composers have wanted; what needs have been different?

CS: In the case of WALL-E, Ben Burtt is a sound designer, rather than a composer. Having said that though, the line between sound design and composition is definitely blurred and getting blurrier all the time. When we hear from sound designers, it's usually when they need something unusual, unique, and amazing — which is both exciting and terrifying, because we usually get contacted *after* they've tried everything else. After trying all the standard plug-ins and traditional solutions, if it seems impossible, that's when people turn to Kyma. I'm not sure what I think about only getting contacted for the "impossible" jobs, except that, whenever we *do* manage to help them come up with a solution, it's a pretty surprising and amazing result, so I guess it is worth the risk.

When you work with a professional sound designer, they are usually at the mercy of a director or a producer who has something vaguely in mind but is unable to articulate what it is that they want. Consequently, there's a lot of trial and error, where you try to interpret what the director means by phrases like "more organic." It's the perennial issue that our society has with sound; people rarely get training in how to listen attentively or analytically, and the vocabulary for describing sound is fairly impoverished. Most people who haven't had the benefit of musical training find it difficult, if not impossible, to imagine a sound. So, it turns into the cliché of "I don't know what I want, but I'll know it when I hear it."

The primary difference I've noticed between academic and non-academic musicians is that those of us who were trained at the university tend to be more word-oriented. We tend to write and discuss and describe and theorize about sound and music; it makes perfect sense that the role of a musician at the university should also be reflective, philosophical and theoretical as well as practical. Whereas many of the non-academic professional musicians I've met seem to use sound and music directly, as their native language; they're always making music, constantly thinking in music, and very often able to pick up a new musical instrument and start making plausible music with it almost instantly. Often, I get the sense that they feel that they might have missed out on something by not going through school; it's often the case that they were prodigies who were already in demand professionally even before they finished high school, making it difficult to postpone life in order to attend the university.
One thing that is definitely *not* different between the two groups: there seems to be an equal percentage of highly intelligent, creative individuals in the academic and non-academic worlds. One difference may be that the non-academic people are more likely to be autodidacts (of necessity) which requires a

high degree of perseverance and self-motivation. I've learned a lot about music, sound design, recording, and other fields from everyone we work with at Symbolic Sound — commercial, non-commercial, professional and avocational alike.

I've noticed that I admire and respect the technique of so many composers and musicians — both academic and commercial — often I'm in awe of how well they compose and perform. It's odd because I don't feel competitive with them. I think it's because I enjoy what I do, which is to experiment and explore sounds and ideas and create software structures. It's not that I'm an uncompetitive person; I just see myself in a different role. And I derive a lot of satisfaction from solving problems posed by the musicians and sound designers using Kyma in addition to the satisfaction I get from making my own music with the system (which, by the way, poses its own problems which demand their own solutions that help keep pushing Kyma forward).

EHT: In your SEAMUS Award acceptance you emphasized the roles of educators and students: "You're the ones gently shepherding your students out of their comfort zones, opening their minds to new ways of thinking, and problem-solving, and music-making. And you are the students who do the same for your professors." What do you think makes your hardware and software a good tool for this work? How do you think Kyma is best presented in a creative educational setting in order to accomplish this?

CS: Kyma seems to invite some musicians out of their comfort zones, because it's based on *sounds*, rather than on musical notation. Composers like Schaeffer, Stockhausen, Berio and other early tape-music pioneers created a disruption in the linear history of European art music. They created a music that was radically different from anything that came before — it's music that we can create very directly with sounds, where we can re-arrange time, much in the way a film editor creates a new sequence of time with images. Just as film has become its own art form, independent of live theatre, electronic music is a new branch of music, independent of traditional music.
What's different about electronic and computer music is *not* the technology; it's the radical notion that one can make music directly with sound, without the intermediary of notation or instruments. There are lots of very traditional approaches to music that share the technology of computer and electronic music, but which are simply software models of making music with scores played by instruments. That's why I prefer the term 'experimental music' over the term 'electronic music' which refers only to technology and says nothing about the attitude of experimentation. Experimental Music for me, is literally designing experiments, trying out new ways to structure music or to present music or to conceive of music. In some ways, that's a thankless job, because, by definition, you'll never become popular since, even if you did, you would be doing something completely different in your next piece. But I'm thankful that *some* people are doing it. It injects fresh ideas and approaches and sounds into music that eventually find their way into games and films and advertising and even into traditional art music and popular music.

Many people have told me that Kyma changed the way they think about music, that it opened their minds and their ears to a new way of thinking about music.Usually, it's the professors who guide their students into new ways of thinking, but because Kyma is set up for autodidacts, a motivated student can dive in and teach themselves and discover new things that they can teach their professors.

EHT: Any thoughts that you have had since the SEAMUS conference that you would like to add for us?

CS: Hahaha…I've had *many* thoughts between then and now!

Shortly after SEAMUS, Jeff Stolet invited me out to work with his students at the University of Oregon; Jeff was generous enough to open the workshop to everyone, so I also worked with one of Steve Ricks' students from BYU, several independent composers who came to Eugene for the concert and workshop, and even some

engineers from Google and Microsoft, so there were some fun discussions about deep-learning!

I've also been thinking a lot about data sonification and strategies for how we might introduce more "attentive listening" training into public school education which I talked about at ICAD (International Conference on Auditory Displays). And right now I'm under a deadline to finish a new project with Gilles Jobin (the choreographer/creator of QUANTUM), doing the sounds and music for a new dance piece he's creating in VR. So, I've been immersed in Unity3d and C# scripting on top of doing sound-designing and composing for the project. I've been thinking a lot about Virtual Reality, game engines, and about the challenges of collaboratively working on a shared project in the Cloud.

As soon as the VR project is finished, I can focus on the next Kyma International Sound Symposium, KISS2017: Augmenting Reality (http://kiss2017.symbolicsound.com). We'll be talking about all the new opportunities for sound designers and composers in Augmented, Virtual, and Mixed Reality content creation. We're also reminding the world that sound and music are the original augmented reality technology! Throughout human history, sound and music have played an intrinsic role in magic, ritual, ceremony, and celebration, transforming the mundane into the sublime, marking everyday events as memorable milestones, and enhancing the flow of experience.

By the way, KISS2017 is open to everyone and it's a lot of fun, so I hope to see many of you in Oslo in October!

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The Importance of Programming

As IRCAM and electroacoustic music technology developed, it became clear that one of the barriers for composers in writing electronic and electroacoustic music is having the ability to program, and the time it takes to master a programming language. The composers interviewed for this paper had different views of the necessity of programming ability to be able to compose music with some element of live processing or fixed electronics. Tom Mays rejected the idea that in order to successfully write for the computer, a composer has to have a good understanding of programming.

> The whole reason they started doing the CURSUS at IRCAM in the early nineties was the idea that composers need to learn the computer tools to be able to compose for computers, and they're absolutely right. But does that mean that someone who relies on an assistant to do the programming can't write anything interesting? That's not really true either. At the very least they need to know what they can do with the electronics and how their music can come through that; how they can rediscover their music through these other tools and […] how to use them musically (Mays 2015).

Chaya Czernowin discussed her attitude towards programming as a composer who does not programme, but who works with assistants to programme the electronics for her compositions.

> When I was a graduate student, I did take the first semester of [Emeritus Professor of Computer Music at UCSD] Dick Moore's course. I was very slow at writing and I just knew that it was a question — it was very clear to me — it's either I get into this (and I never do something half-heartedly) and if I do it I will have to give up a year or two of my composition for the basis, and every now and then continue, and even if I do this, I might still not be the best. So, I thought to myself, if I'm able to get people to help me with this… It was not a necessity of my creative drive. Any necessity that I have creatively, I just go and I fulfill it regardless of what it takes, because it's part of the body of my work, but this was not a necessity. I did not have to know exactly how something is programmed. My husband, [composer] Steven Kazuo Takasugi, he's a great programmer. I've seen him dealing with that. That is not my area. And now there is no question about it because I have so much on my plate that there is simply no way of putting anything into it (Czernowin 2015).

Kaija Saariaho first began writing music with electronic elements in the early 1980s at the Radio Finland experimental studio. Describing her introduction to writing for electronics, she said,

> One of my first pieces was called *Study for Life* for soprano, light, and magnetic tape. It could not be performed more than the two first times because it had text from T.S. Eliot and I did not have the rights, but it was a very important piece for me. So, very early on, I very naturally went to the studio and of course continued when I continued my studies in Freiburg. I heard about [the IRCAM courses] from Roger Reynolds who happened to be visiting one of the festivals in Germany – I think it must have been Donaueschingen Festival. He was working for some project for IRCAM at that time and […] I realised that that would be something very interesting for me, so I applied even though I was still studying in Freiburg, and I took a leave of absence for two months so I could attend the courses at IRCAM in January

1982 (Saariaho 2015).

Since her time at IRCAM, Saariaho has continued to work closely with a technical assistant in order to create the sound world she envisions. She explained that while it is not always possible at first to realise the sounds she has imagined, that over time she has always found solutions with the help of an electronic music assistant. She talked about the necessity of developing tools for her projects.

> Right now, I'm working with Christophe Lebreton [an engineer and RIM at Grame in Lyon, which is part of a network of six national centres of musical creation in France] for my next opera which will be in Amsterdam, so we are working on tools. He just sent me some sounds. It's normal. Of course, you need to develop things. It cannot happen by email or Skype. We have met many times and I have been working with him in the studio and we have tried things out – changing parameters and so on. It's always a long [process].

Mays compares writing for the computer to writing for any given musical instrument, although the possibilities in terms of sound created or processed with a computer are endless. The French Spectralist composer Tristan Murail said in an interview with Bálint András Varga, "I have been working with IRCAM's equipment for two years now – an experience which has opened up new vistas. The possibilities are well-nigh infinite" (Varga 2011, 183). In regard to the relationship between an understanding of programming and the range of imaginative possibilities that a composer could conceivably have, Mays argues a middle ground, saying that,

> Any composer is going to write for any instrument. They're going to go meet with the musician and try out different techniques. They're not necessarily going to know how to play the instrument, but they're going to know what you can do with it and how to indicate that and what it sounds like. At the very least they need that on the computer. I'm not going to be somebody who's going to say that if you don't do your own programming, you're not composing for computer. I don't think that would be honest considering most composers do not play all instruments that they write for, and yet they can write good pieces for them. I think there's often a difference for a composer that writes for an instrument that they master as a performer. [They're] going to do things that some other composer is not going to be able to do on that instrument, but it's the same thing with computers — somebody who does their own programming and extensively uses Max or some other language or tools — they're going to have ideas and ways of expressing them that some other person who doesn't know that won't have, but in the same way that a composer-pianist is going to do things that a non-pianist composer won't necessarily do for a piano piece (Mays 2015).

Saariaho worked with Gilbert Nono for *L'Amour de Loin, La Passion de Simone,* and *Adrianna Mater*. She had no difficulty communicating her ideas, and said, "We were working together at the studio. I had a very clear idea of what I wanted, so it was not really that somebody would have done something in my place — it was that we defined the tools together and made tests together, and then there was some programming or the creation of patches — all this technical work was done by Gilbert, for example, but all the sounds, all the processes, the mixing in the space we were doing together" (Saariaho 2015). Saariaho does in fact have a lot of experience working with IRCAM technology, though she doesn't assess her own programming skills highly. "I know quite well the tools also, so I can describe in technical terms what I need to be done. I don't think there was ever any problem with communication in that sense" (Saariaho 2015). Both Saariaho and Czernowin felt unbounded by their use of an assistant or partner to create the electronic parts of their works. Each expressed a conviction that with an unfettered imagination, a composer working with electronics but not programming their own patches could still conjure a desired aural result without difficulty. Discussing her approach to working with electronics, Czernowin said,

> It was never a question of possibility; it was a question of the imagination and finding the ways to realise this imagination, just like in normal composition. If you are surrounded by very good people, if it doesn't go that way, it will go another way. My imagination is quite concrete. I know very clearly what I want and how to get it.
>
> The score [for *Hidden*] talks about the result, but it also suggests how to get the result. The suggestion is not technical in terms of the computer software, but about a possible way to achieve what is needed. To begin with, even the way that the score is laid out on the page it is very revealing in relation to the concept of the electronics. In spite of the fact that this is a string quartet, what you have is [the] front wall, right wall, left wall, and back wall, and you have three forms of speakers: you have ⊠s, triangles, and squares with each. The score really talks about what I want to hear. The square ones are speakers that project what you hear; so normal speakers. The triangle ones are speakers that will have a kind of a filter or working on the sound which will give the sound the feeling that you are outside and you are listening to something but it is behind a big wall. The ⊠ ones are speakers that will make the material sound as if you are outside of a huge cave, so you are hearing what is coming from the cave, but you are actually outside (Czernowin 2015).

The success of Czernowin's piece bears out her view that a good composer who has access to a technical assistant can create works with electronics that are carefully planned and astoundingly beautiful. Rather than feeling curbed by her level of technical knowledge, she uses the limits to her advantage.

> I feel that things will always have limitations, which is good, because those limitations are a fuel for understanding better what you want. They help you grow. Otherwise, things become very flat. In some ways – there is a point that a black and white movie is much more nutritious to the imagination than an amazing colour movie. In that sense, I don't feel the challenges of the technology. That is not where it's at to do something technologically amazing; that doesn't interest me at all. What interests me is to create something which is a fruit of an imagination that is really alive. An imagination which is really alive will find a way around the technological limitations, and the barriers will even be very conducive to that kind of search.
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> I'm not a believer in craft. I'm a believer in the force of vision and imagination, and craft is a supportive force of that. The real craft is the craft of untangling your imagination and understanding what it is. That's the craft I really teach and which I work with (Czernowin 2015).

Czernowin is currently working on an opera that has been co-commissioned by IRCAM, Vlaamse Opera, and Mannheim Stadttheater. Her experience with *Hidden* helped her to make the decision to write the opera with electronics, and in her interview, she described her vision for the piece and how she will use electronics to realise the project.

> *Hidden* was a big pill to swallow in a way; it really enlarged my vision, so that's why I decided that my opera will also be done with electronics. I will be working with Carlo Laurenzo. We feel, both of us, that we have made a basis for something that can be developed over the next years and the opera is going to develop on the basis of *Hidden.*
>
> The opera is a kind of hybrid opera which has two kinds of universes. They meld into each other very slowly: the universe of World War 1 and the universe of a Chinese story [*Homecoming*] by Can Xue. The electronics will create the different universes, and from magnification of the noises inside the body, like breathing, to a huge desolate desert, they will create the notion of slow apocalypse, where slowly developed cracks create an eruption […] There is a reading by a Chinese woman and I'm going to create rivers and seas of her reading: make a huge amount of approximate doublings to create a crazy stream of consciousness of reading voices. These readings will become landscapes. It

> will create the notion of movement in the whole — I have very clear moments in my ears and eyes about how the whole becomes this desolate desert — there is one word that goes from the back of the room up to the other side of the room and nothing comes back, or you have lots of wind coming in one direction so you can almost feel it in the audience.
>
> I have all these visions of things that the electronics will help to materialise. It should be a very, very physical and concrete experience of something that is highly imaginative (Czernowin 2015).

Still, Mays argues that there is perhaps some circumscription in composition in relation both to traditional forms of composition and for composers whose technical understanding of electronic programming is not advanced. He noted the tension felt throughout the 20th and 21st century for composers trying to break free of any formal strictures, and also the inverse necessity of circumscription in providing structure in composition. Mays said that composers who don't do their own programming,

> […] limit themselves to what they've heard and what they know. That doesn't mean that they can't write. They define their language around what they understand of that and they hear within that. How was Mozart able to write complete pieces in his head and then go and write them down? Well, when you think about it, as free as he was and artistically powerful as he was, the language was still very — in the contemporary music sense — restricted. Obviously, it's within a certain structure. Of course, he had total freedom and of course that was his genius, but he was within a tonal structure. For us today it's very codified what he was doing — that's not a criticism — it's also very freeing and expressive within those codes and that's the genius of it. But somebody else who doesn't do the programming but knows certain codes, certain kinds of sounds and ways that computers can interact – if they know that, then why not? They can hear things and they can compose for them (Mays 2015).

Mays' broadminded view on whether composers need programming skills to write electronic music is mitigated by his acknowledgement that without being able to freely experiment in terms of programming, a composer's sound world may be limited to what they have either previously heard or what they can imagine and describe to a musical assistant. "There's so much that can happen that personally I don't know what it's going to sound like until I start programming it. You get an idea but what's actually going to happen might be pretty different from that. There are things that you're not going to be able to do unless you really get in there and programme it and experiment with it" (Mays 2015).

Karlheinz Essl, on the other hand, said, "I know a lot of composers who have technicians or assistants and tell them, 'I need this type of sound – can you give me something?' Ok that's a possibility. But you have to be completely independent and you have to formulate your own ideas, and this needs programming. Programming nowadays doesn't require C code, which is very abstract, but you can write with Max or SuperCollider on a very high level and create your own musical ideas, and not using software that somebody else has constructed for a different means. Most of the means in commercial music are based on commercial music, not on exploring new ways of making music" (Essl 2015). For composers who do not have the opportunity to work with a programmer, Essl argues, it is vitally important to be able to programme one's own work in order to fully realise the potential of electronic music.

With the development of the Max programming language by Miller Puckette, IRCAM finally had a tool that would become an industry standard, and with it came a broader democratisation of technology in the area. Originally ported to the 4X machine and later to the NeXT workstation, Max went through several iterations at IRCAM before being licensed to Opcode in 1990, and later sold to Cycling 74, who own and develop Max MSP (Puckette 2002). With the rise of personal computers and the wide distribution of Max

MSP, composers began to have access to the same kind of technology they had previously had to work within an institution like IRCAM to access. Essl said that,

> With Max, the fun thing is that immediately I got a musical or acoustic result which in turn enabled me to change the algorithm in real-time. The first thing I did with it was parallel to my composition commission that I was working on. I made a sort of experimental project, […] *Lexicon Sonata*. It's a piece for computer-controlled piano, and this generates in real-time very complex, very emotional piano music, and it's a piece, which never ends: it's an infinite composition. I started [the piece] in 1992 more or less as an experimental situation in order to learn Max, and using piano sounds as a sonification of data. Then it became a really musical project, which is still existing. It's now a standalone Max program which everyone can run at home (Essl 2015).

Composing with electronics

Writing about his time at IRCAM, Tristan Murail wrote that, "Once I was faced with the task of formulating my ideas for the computer, I realized that I had up until then lived in the prison of traditional patterns which had fettered my imagination. Patterns had lost their raison d'être. The computer prompts me to make use of the laws of mathematics, physics, and acoustics" (Varga 2011, 183). Saariaho heard the music of Murail and Gérard Grisey at concerts at the Darmstadt Summer Courses and was fascinated by the Spectralist sound world. At IRCAM, she studied spectral analysis and began to combine her purist-modernist style — in part derived from teachers like Brian Ferneyhough and Paavo Heininen — with the expressive harmonies of French Spectralism. Julian Anderson, who wrote about Saariaho for the *Musical Times*, noted that, "At IRCAM, she quickly became acquainted not only with the large number of computer-assisted composition environments developed there, but with the substantial body of research into psychoacoustics being carried out by such people as Steve MacAdams [sic], whose work on auditory streaming and perception had a big impact on Saariaho" (Anderson and Saariaho 1992, 616). Saariaho carefully considers her use of electronics in her works, and employs them only if they are necessary to describe the sound that she has imagined for the work. "I do sketch the electronics very often in the beginning. I write down my ideas and I mark on the score the exact places and things. It makes no sense to use electronics if you feel that you don't need it in the project. It's horrible — in more than thirty years of all the pieces I have written and the time and the trouble for updating the patches and all that — it's a nightmare, so I think it needs to be justified. Why do it otherwise? We have fantastic instruments and fantastic musicians, and if you write a violin piece, in twenty years, it's fine. There are no problems in playing it. That's my attitude" (Saariaho 2015).

G.W. Hopkins and Paul Griffiths wrote in an entry for the *Grove Dictionary of New Music* that Pierre Boulez's "[…] hopes for IRCAM, expressed in manifestos, were that it would be a meeting-place for scientists, composers and performers, a laboratory in which the musical adventure of the 20th century could at last be continued – not the sophisticated electro-acoustic music studio it quickly became. If, nevertheless, he took advantage of what he had, and created *Répons* partly to show off IRCAM's digital machinery for storing and transforming sounds in live performance, the electronic aspect here is perhaps less central than the opposition that had generated *Éclat/Multiples*, between tuned percussion (six soloists, amplified and altered) and a chamber orchestra of wind and strings (untransformed)" (Hopkins and Griffiths 2015). It is unclear whether Boulez, a trained mathematician and a devout Serialist, was ever truly satisfied with the results. Georgina Born wrote that, "[…] Music has throughout history been subject to two main forms of theorizing: in relation to the emotions, and to mathematics and science" (Born 1995, 20). The mathematics and science of music is still to an extent fetishised at IRCAM; Born writes extensively about the privileging of an intellectualist approach to composition at IRCAM over a more immediate, sensory approach, and the "intertextual importation of scientific and technological discourses into music" (Gerzso 2015). IRCAM was not originally intended as an institute solely focussed on music and sound created with

computers, but because it was one of the few places in the world with the funding and the technology for computer music research, that is inevitably what it became.

Boulez wrote only four pieces at IRCAM (Gerzso 2015), and Andrew Gerzso worked with him as the musical assistant on each of them. Describing his work on Boulez's *Répons* (1981-2005) Gerzso described two ideas: "One is explicitly spatialisation: the soloist and the chorus and dialogue between the two. The other one is proliferation: a simple idea in which you make a multiplicity of things. Boulez conducted Wagner's *Ring* in 1980 at Bayreuth. You don't think of Wagner when you're listening to the work but the influence is there in its large form and in the harmonic thinking." It is interesting to think of *Répons* in terms of Wagner, as Gerzso does, in that both Boulez and Wagner were seminal figures in their eras, drastically altering the status quo in music with vociferous published discourses, and both men built an aura of greatness and mystique around themselves and were able to build large institutions to support their own work. Boulez famously fell out with his American contemporaries John Cage and Morton Feldman, prompting Feldman to write in an essay that, "It is Boulez, more than any composer today who has given system a new prestige – Boulez, who once said in an essay that he is not interested in how a piece sounds, only how it is made" (Feldman and Zimmerman 1985). There remains the sense that empiricism, physics, and mathematics are privileged above a sensory approach to music at IRCAM. Gerzso described the process of working on the spatialisation of *Répons* with Boulez, saying that, "Boulez is a discrete composer, mathematically. He invents a distinct alphabet of possibilities, which is why he was attracted to serial music at one stage. He is different from the Spectralists and the spectral impression that you get. The two approaches both come from different traditions: Boulez comes from Bach in that he is interested in notes, chords, and permutations. The Spectralists come from Ravel and Debussy" (Gerzso 2015). The sound world of Spectralism is arguably richer, more accessible, and in many ways more related to traditional harmony than that of strict Serialism. Spectralism was taken seriously at IRCAM, however, and Saariaho explained the formalist approach to Serialism which allowed this, but which was also a sort of intellectualist disguise for poorly-composed music.

> Spectralism can be very mathematical depending on whom you are talking about. Tristan Murail, [for example], there are algorithms, but as I never worked with the pure Serialism, I never worked with Spectralism either. The strictness of structure doesn't bother me – my structures are often quite strict – it's the relation of an overly complicatedly notated score which doesn't permit the person reading the score or hearing the music to make the connection. This always bothered me, and also what bothered me was that many of the composers did not have inner listening of their music. In fact they did not know how their music sounded, and of course there are many jokes how people didn't even recognise their pieces in concert or rehearsals, so this all was for me was very anti-music and horrible. In that sense, of course the approach of Spectralists was really interesting and I found it very comforting for me that there were other people thinking like this, and had already gone further finding their own aesthetic. France being such a polemic place, of course they had to defend it verbally and so on. This has always been very far from my personality, being polemic verbally; I always just wanted to compose my music, but I found that it was a big support for me mentally to realise that there was this completely other movement and that I was not alone or it was not absurd to defend the idea that music is for ears (Saariaho 2015).

Born writes in *Rationalising Culture* that the "techniques and technologies associated with musique concrète – tape recording, analogue electronics – were subject to an almost irrational neglect and indifference with IRCAM culture" (Born 1995, 77), and indeed IRCAM continues to focus its research on the synthesising of acoustic phenomena and acoustic environments. Its main compositional tool today is the Max MSP software, which, as a programming tool, lends itself to synthesised sound and live processing rather than the creation of fixed electronics. Saariaho, Czernowin, and Marc Battier work primarily with pre-recorded material that is triggered during live performances, as did Essl in his IRCAM-commissioned piece *Entsagung*. Describing his

compositional process at IRCAM, Essl recounted that,

> For the composition of the instrumental part and the electronic part I used the same algorithmic ideas. The Logo [programming language, with which Essl composed until learning Max at IRCAM] system created the score events for the instruments and also the electronics. For the electronics I made a lot of recordings of little sound snippets, which I did with musicians from Klangforum in Vienna. I had a recording session with the flute player and I asked her to play all the sounds of the flute that you are never allowed to play in a concert: all the clicks and glitches and noises and whistles, and also the piano… always things that are noisy and very interesting sounds. I didn't record longer passages – only very, very short grains of sound, and this was the basis for the electronics music.
>
> Logo created a sort of score, so, for example, the event starts at second 1 and lasts until second 3.5, and it consists of 50 grains of flute sounds which are arranged in this transposition, with this envelope, and this was given to the Max patch that I wrote, and the Max patch could interpolate the score in real time, generating the sounds.
>
> The score is fully notated and very precise, so you have a conductor. The electronics consist of pre-recorded sound files which are triggered by the conductor with a foot pedal and often several of those sounds are overlapping. It's like the classic situation of having a piece for ensemble and tape but the tape part is sort of flexible, so it is always in different layers, and the conductor starts the layers and they overlap and form the sound together.
>
> In the very beginning the idea was to do everything on the fly in real-time. The idea was that at the beginning of the piece, all those sound materials are live-recorded: this was risky. It would have been possible, but it's so stressful, and I didn't want to make an experiment with an uncertain result […] It would have been impossible at this time to make this piece without IRCAM. I didn't know NeXT and I didn't have a studio environment (Essl 2015).

Essl described his experience in terms of 'resorting' to fixed techniques because of the uncertainty of the result of a live sampling process, yet this is a valid concern and influences the choice of many composers today to use pre-composed material.

Saariaho said in an interview that she feels no sense of hierarchy between concrete techniques and the more IRCAM-like synthesis or live processing. "The idea can be the same — it's part of my composition — I propose whether I write for string trio or big orchestra, I'm choosing my tools. For me, I never had any aesthetic problem with this. At that time [in the early 1980s] there was a very strict division between IRCAM and GRM, but today it doesn't matter at all" (Saariaho 2015). Mark Battier unreservedly explained his sole used of fixed electronics parts, saying,

> [I was] at IRCAM long enough to see how difficult it is to play with real-time. The IRCAM technicians are really very good. I mean they are excellent both in positioning the mics to capture the instruments, avoiding feedback, finding the right levels, and diffusing, but apart from IRCAM, it's terrible. The situation today is pretty bad; I've seen so many concerts where things went wrong.
>
> At the moment I can do pretty much anything I want. One thing I show my students is sound design software so that they are not really involved in real-time interaction because I don't do that. […]
>
> When we had a piece for instrument at IRCAM we would record the performer once, and we would use the recording for everything live afterwards as a [stand-in] and it worked very well, and of course when the time came to rehearse we just replaced the tape with the live performer, and everything was already set. I take this as a model (Battier 2015).

Despite the reputational division between IRCAM and the GRM, IRCAM's musical assistants in fact relied on concrète recordings, even in the 1980s. On the advice of her IRCAM musical assistant, Carlo Laurenzi, Czernowin too made use of pre-recorded material in the electronics for her 2014 string quartet *Hidden*.

> It was an amazing way that we worked because Carlo wanted to be involved from the beginning, […] so we had about four or five three-hour talks before I came to IRCAM. My idea at first was to

> have on the walls pipes connected to the speakers so that we will hear a speaker that is surrounded by a pipe. I still have this dream to do something that is actually in reality doing all those things, but together with Carlo we figured out, "Let's do it electronically," because in this piece it would allow so much more flexibility.
>
> Everything is notated – all the noises – all the things which are recorded so you can see what is done in any other part of the whole. [The *Hidden* score] is a diffusion score as well because it shows you what is done and where it should be diffused, or what is in the fixed media and what is projected onto which wall.
>
> We had a really nice recording to begin with, with excellent players who spent a week with us in the studio. We recorded scales and scales with quarter tones, of all kinds of things, so that the machine could just take from this reservoir and do whatever it needs to do: different kinds of pizzicato etcetera, all kinds of knocking on the walls (Czernowin 2015).

Austrian composer Olga Neuwirth's *Le Encantadas o le avventure nel mare delle meraviglie*, which was developed at IRCAM and premiered in Paris in October 2015, combines extensive use of higher-order ambisonics with recorded sound fields, and recreates the acoustics of Saint Mark's Basilica in Venice as well as employing Antescofo score following software. For all the technological accomplishment of the work, it is the concrete use of recorded acoustic sounds and pre-recorded voices that is most apparent to the audience. In this sense, IRCAM seems to allow more and more for the use of concrète techniques without snobbery that might previously have been judged as unsophisticated.

Spectralism

The first composers invited to learn about computer music at IRCAM were the Spectralists of L'Itinéraire (Battier 2015). In her book *The Spectral Piano*, Marilyn Nonken describes the "sometimes acrimonious discourse" of musical perception, and writes that, "As spectralism came to international visibility and serialism fell into critical disfavour, music theorists pondered the possible mismatch between avant-garde "compositional grammars" and psychological "listening grammars" […] In this environment, within which empirical research in music perception was central to the agendas of all major computer music centers, the spectralists distinguished themselves by taking into account, in the very processes of composition, the psychological reality of the listener" (Nonken (2014). Saariaho described her compositional evolution in relation to IRCAM as one of an educational process. Studying psychoacoustics, tuning systems, and the synthesisation of sound changed the way in which she thought about sound and the human experience of listening. She maintains that her compositional process did not change during her time at IRCAM, although as Grégoire Lorieux describes it, spectral music is itself a specific compositional approach. "The first approach [in Spectralism] is the visualisation of the sound, and making a structure out of it. Saariaho took this idea and looked at the spectrogram as a visual impetus: only the first idea. The second idea in spectral music is the processes in music: Stockhausen using one big chord (B♭ major) for *Stimmung*; Ligeti's *String Quartet No. 2* in which he used small cells of sound evolving slowly; Pink Floyd's rock sound that the spectral composers were influenced by with its electric guitars and synthesisers" (Lorieux 2015).

Lorieux described the "evolution of technology and aestheticism being in partnership" in the 1980s, and the relationship between Spectralism and the "institutionalisation of music" (Lorieux 2015). He describes the "very strict writing from one point to another" in Murail's 1982 IRCAM commission for a piece for 17 instruments and computer-generated tape, *Désintégrations*. With the development of Spectralism, "the melding of all sounds" — acoustic instruments and electronics — became paramount. The structural ethos shifted from the rows of Serialism to a sense that sound should evolve "in an almost biological sense" (Lorieux 2015). IRCAM had a team working on spatialisation and ambisonics to try to represent sound as a living, three-dimensional phenomenon. Both Lorieux and Battier described the creation of Jonathan Harvey's *Mortuos Plango, Vivos Voco* in detail, citing it

as one of the most successful pieces to come out of IRCAM at the time.

> One of the first and only tape pieces was *Mortuos Plango, Vivos Voco* by Jonathan Harvey. That was an enormously successful piece with several recordings and many, many performances, although it's not easy to perform because you have to have eight speakers and eight channels. It was all done with MUSIC 5 and an early version of the CHANT program. All of the sound – the voice of the child and the two sounds of the bell – were recorded into the computer.
>
> There were no IRCAM tools except for CHANT, which is not really an IRCAM product because it was done by Xavier Rodet at the science university, but he developed it at IRCAM. The early version was done elsewhere and he brought it to IRCAM and developed it for many, many years. CHANT was used for the interpolation between the bell and the voice. MUSIC 5 was used to transpose sounds, to play the sounds backwards, but the mix was done on a 16 track analogue tape recorder.
>
> The structure of the piece is in eight sections […] because everything is based on the analysis of the bell, and the overall shape of the piece. It's very funny the way it's organised because Harvey was also a great admirer of Stockhausen. *Mortuos Plango* is really inspired by *Gesang der Jünglinge* and *Telemusik*, because every section of *Mortuos* starts with the percussion just like every section of *Telemusik*. If you look at the score of *Telemusik* you notice that it's an inverted fan shape. The middle section of *Telemusik* is very quiet, but the section before that glissandos down, and the section which follows goes up, and he did exactly that in *Mortuos Plango*. You have the sections which glissando downwards, and the centre section is only bell, but then the voice of the child starts saying prayers and it goes up again (Battier 2015).

Harvey's piece was perhaps so well regarded because it bridged Spectralist ideas, Boulez's standard of precision and unity in form and content, and mathematically derived material. Boulez, according to Gerzso, was interested in working with spatialisation purely in terms of clarity. He wanted the audience to be able to hear individual sounds more clearly in order to be able to analyse them (Gerzso 2015). In comparison, Saariaho's approach to spatialisation is also about control, but as part of the composition as a whole rather than as a tool for clearly projecting separate sounds. "One important thing is space – that's how I got into working with electronics in the first place. I was always really interested in working with space and acoustics, and I wanted to have more control over it" (Saariaho 2015). Describing the place of electronics in her works, she said, "Sometimes it's like an extended part of orchestration, sometimes it's connecting different kinds of acoustics at the same moment, like bringing sound material created with sounds from nature to an instrumental context – all this you cannot do otherwise" (Saariaho 2015).

Like Harvey, Saariaho also worked extensively with CHANT, and she composed her first IRCAM pieces using the technology.

> CHANT was something very new at that time; it was more about MUSIC 5 and oscillators and so on, but there was Steven McAdams [a psychoacoustician and, at the time, an IRCAM musical assistant and pedagogy director] also speaking about psychoacoustics, and that interested me enormously, and David Wessel [formerly a pedagogy director] who was a very, very interesting personality. Then I learnt about the CHANT programme, which I completely connected with, because you could manipulate physical and acoustic parameters rather than build sounds with oscillators. That was something completely different. I found it really, really inspiring, so that became right away my passion, that programme.
>
> Everybody who was working with CHANT realised that I'm really talented with that specific tool, and of course it was interesting for all of them – to many people: Xavier Rodet who was developing the program [and]

> Jean-Baptiste Barrière who later became my husband, but who knew the programme and who was also really interested in it.
>
> It was not an official project. The functioning was very different than it is today. Because we were in a time-sharing system (we had only one computer on which everybody was working) it was good to work at night-time because there were less people working, and the calculation was very, very long, so I often worked at night-time. Then what often happened was that if the piece was successful, even if it was done in underground conditions, it would become an official IRCAM piece later, and this was a little bit the case with *Vers le blanc* (Saariaho 2015).

Saariaho used CHANT mainly as a tool for the slow transformation of timbre. She began her exploration of gradual, organic morphing of sound during this time and in 1982 she wrote *Vers le blanc*, a tape piece. The concept of the piece is an evolutionary process in the form of a fifteen-minute glide from one three-note chord to another, the movement of which is so gradual that the changes of the individual pitches are imperceptible. In a paper written by Clifton Callender for *Music Theory Online*, Saariaho is quoted as having said, "The harmony is a continuous stream and cannot be heard as a series of changing chords. One only notices from time to time that the harmonic situation has changed" (Callender 2004). Saariaho used CHANT to interpolate between different phonemes by gradually modifying the values of various parameters including the amount of vibrato in the formant's central frequencies, and the amplitude and bandwidth of the frequencies. After *Vers le blanc*, Saariaho began to focus her musical ideas around interpolation, which drew on different sources including Minimalism in the sense that there is a gradual change from one state to another. The computer allowed Saariaho to have careful control of every aspect of her music, and out of this came the idea of cohesion: that music should be one morphing body, paradoxically creating something organic through exercising complete control over every element.

Essl, an algorithmic composer with a very different sensibility to that of Saariaho, has developed over time a similar understanding of the use of electronics in composition. He said that after his first residency at IRCAM in which he wrote *Entsagung* for fixed electronics and small ensemble, "it became much more important [to consider] "how does it sound?" Before it was a bit abstract. It was music that I tried to compose out of a situation of nothing, with no references to anything – to any type of music. I developed music that came out of nothing, like a natural phenomenon, which unfolds. This can also be very dramatic and emotional. The way I composed was different afterwards when I had experience with live listening to music from the loudspeakers. This changed a bit the aesthetics of my music." Saariaho does not consider that her compositional process changed at IRCAM, but rather that her thinking about music and sound was drastically altered.

> The tools I found when I had just finished my studies in Freiburg helped me very much to define my own thinking as a composer, and also the knowledge I gained when analysing sounds and studying physics and psychoacoustics – all that has affected my understanding of how we listen to sound, and how we experience music. All that detailed work on analysing sound – it has also affected my orchestration, so in that sense, certainly I have been influenced by this work.
>
> I don't think the process of composition changed at IRCAM but I questioned many things – I questioned tunings – these tools gave me a possibility to experiment on different kinds of microtonal tuning – synthesizing sound – I think all this knowledge and these tools which were rare at this time, they put me to another place, or another starting point when I was still creating my musical vocabulary (Saariaho 2015).

Like Saariaho's, Battier's compositional practice evolved as technology changed. He developed an affinity for spectral techniques and describes the ideas he used in his piece *Constellations* as, "something I learned at IRCAM during the eighties. *Toca* for marimba was first premiered in Japan in 1993, and I used a sort of Spectral approach. Maybe because I'm French, or maybe because I worked at IRCAM, I really got

influenced by Spectralism, which means that I work with the sound of the instruments" (Battier 2015). Battier says that he learnt a lot at IRCAM and very naturally applied what he learned to his compositional practice. His practice is informed by technological advances.

> I wrote the manual for MUSIC 10 for the composers and for other young *tuteurs*. It has a lot to do with technology. It's hard to separate it. I go with the flow because I follow the technology. There's always this interaction with the technology and how can you do something with it and how can you turn around its limitations and change what the latest technology is offering you into something else. There's always this mental game of twisting things around. But today it's more complicated because the software that we're offered is packaged – it's like a black box. I always have this attitude of trying to see what's new. I'm always on the look out for new software. The way an algorithm is implemented makes a difference in the sound quality. For instance, for simple time-stretching, it's all FFT-based, and FFT-based programmes are all based on the same algorithm, but the way they're implemented changes everything (Battier 2015).

Like Essl, Battier is interested in sonification, and he recently completed *AudioScans: from works of Roberto Matta* which sonifies the artwork of the Chilean painter pixel by pixel based on how Battier's eye is drawn over the abstract figures.

> I could not have done [*AudioScans*] without the programmes to do that. This thing came from a programme that is very simple: where a pixel is turned into a frequency (Battier 2015).

IRCAM today and into the future

While the value of IRCAM changed after the advent of personal computers in the 1990s it is its power to attract - and connect - highly-trained and brilliant computer programmers and composers that persists and ensures its unique place. For Essl, his time at IRCAM did exactly that, opening up opportunities for further commissions and teaching roles at universities. "It would have been impossible at this time to make *Entsagung* without IRCAM. I didn't know NeXT and I didn't have a studio environment. It was really wonderful that I could use the spaces and the studios at IRCAM. After this project at IRCAM I got a teaching position in Linz for 12 years, and for the last eight or nine years I've taught here in Vienna. IRCAM helped; with IRCAM I had a lot of performances. We presented the project in Vienna and people heard it and I was asked if I wanted to teach. We started a small electronic studio in Linz with only a handful of students. We were all experimenting like crazy" (Essl 2015).

Reflecting on his time at IRCAM Battier talked about a sense of gazing into an unknown future, saying, "When I think back in those days we could not imagine what would come next. It was pretty much impossible for us to transport ourselves ten years later. We had no idea. When I was in San Diego, that's the time when the first Macintosh arrived. When I arrived in San Diego I […] built a studio, which somehow got me fired two years later! […] My students loved the Macintosh. They almost never used the PC, so that told me something. We had a board in the Mac for sound control. We were very far from thinking that one day everything would be integrated like today. The field was growing very fast" (Battier 2015).

IRCAM today is a very different institution from the one Boulez founded, and its aims have shifted markedly towards scientific research for commercial and military applications. The composer is no longer preeminent, and the institution's programmers work in an environment more closely aligned with a university research institution than a creative hub. Composers no longer need scientific research institutions within which to develop electroacoustic techniques; the scientists and programmers package their tools for general consumption and anyone with a computer can experiment with audio processing and synthesised sound. With Boulez's death, IRCAM's role in the future of music is even hazier, though as long as it is well funded, its scientists will inevitably create tools that composers find ways to exploit in their sonic experiments.

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Challenges in Electroacoustic Music Analysis and Analytical Systems

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Although electroacoustic music has quickly flourished in spite of its relatively short history, the difficulties presented by its analysis have remained a pressing and lingering issue. From technical, social, cultural, and historical perspectives, we identify the analytical challenges of electroacoustic music: its rapid expansion/evolution, its novelties, contesting perceptual models, the dearth of socio-historical contextualization, and the lack of organizing/archiving efforts. As the critical field is suffering from a severe discontinuity between analytical projects, we draw connections amongst past studies as they relate to each of the aforementioned challenges.

Introduction

Electroacoustic music is now a firmly-established genre in both the academic and cultural domains. It is generally agreed that its musical possibilities began to be explored in earnest during the 1940s and 1950s. Electroacoustic music has since rapidly developed to become an independent genre of its own, as well as a critical component of New Music. A large number of concerts and festivals are dedicated to the genre, and it is practiced and appreciated by devoted artists. Furthermore, the growth of electroacoustic music is not limited to the creative domain; it has also become a widely-accepted academic discipline, with many major academic institutions investigating its technological and musical possibilities, offering relevant courses, publishing journals, and hosting conferences.

However, in comparison to the formidable volume of creative output and the technological advancement of electroacoustic music, the progress made in regard to its musical analysis has been relatively modest. Many have recognized the challenging nature of electroacoustic music analysis, and identified various problems. In his review of electroacoustic music analysis, Leigh Landy discusses notable issues: few heroes; a bias towards formalism in scholarship over contextual, aesthetic reception; the self-sustaining nature of the field (the majority of scholarship comes from within the community rather than from outside); a bias towards technology/theory; and no middle ground literature between laymen and specialists (61). François Delande underscores the problems of "no score, no system, and no pre-segmented discrete units like notes" (14). In addition, Tae Hong Park addresses the following issues: "confusion in nomenclature, lack of consensus regarding appropriate techniques, reliance on subjective and perceptual approaches, insufficient response to the lack of a visual representation, and absence of a comprehensive analysis methodology" (167). The list goes on.

While the problems in electroacoustic music analysis are being addressed and responded to by a number of researchers, we see a severe discontinuity between relevant projects, which hinders the development of the field. To better address this issue, we identify several critical challenges of the analysis of electroacoustic music, and classify them into the following categories: (1) Evolution of Electroacoustic Music, (2) Novelties of Electroacoustic Music, (3) Contesting Perceptual Models and Analytical Frameworks, (4) Dearth of Socio-historical Contextualization, (5) Lack of Organizational/Archiving Efforts. [4] By introducing relevant studies according to this framework, we aim to develop a sense of connection between past analytical achievements.

[4] These challenges in the field of electroacoustic music analysis are not necessarily exclusive to electroacoustic music.

Challenges of Electroacoustic Music Analysis

Evolution of Electroacoustic Music

As technological advancement permeates every aspect of musical activities in the generative, performative, and even appreciative domains, electroacoustic music—a genre that embraces technology at its musical core—continues to redefine itself at the fundamental level. Andrew Ross observes how technology and its sociocultural surroundings are always interrelated and mutually mediated through one another: "it is important to understand technology not as a mechanical imposition on our lives but as a fully cultural process, soaked through with social meaning that only makes sense in the context of familiar kinds of behavior" (Ross, 3). An applied technology is always socially situated. What is noteworthy is that the new sociocultural context develops in relative autonomy from the technology from which it originated. Electroacoustic music is, through the mutual influence between its technological aspects and its musical aspects, being constantly reshaped in a state of flux, which makes it difficult to delineate instances (individual works) of the genre, and to analyze it in a broader context.

While electroacoustic music, due to its dynamic techno-cultural nature, continues to internally redefine itself, its external socio-cultural presence has been drastically increasing. In recent decades, technology has been "emancipated" by the emergence of affordable digital machines and the distributive power of the Internet. Computational machines, means of synthesis, recording equipment, and mixing/mastering technologies can easily be acquired by anyone interested in doing so. Consequently, the creative domain of electroacoustic music, which was previously bound to industrial and academic studios, has been democratized to a great extent, giving birth to new breeds of electroacoustic musicians. The influence of independent artists, such as Ryoji Ikeda, Ametsub, and DNTEL, among many others, on younger generations of electroacoustic musicians has become comparable to that of academic composers. Furthermore, there are musicians who are more inclined towards the popular music domain, but who still utilize technological means that are often employed in the academic realm—notably, Amon Tobin, Squarepusher, Kraftwerk, Jonny Greenwood, and Aphex Twin. They keenly follow and employ state-of-art technology, such as Kyma, Supercollider, and Max/MSP, in their creative processes, resulting in auditory and visual effects that are momentarily indistinguishable from those of academic composers. These new types of electroacoustic musicians are challenging the hegemony of academic institutions in the practice of electroacoustic music as well as the traditional conception of the genre.

To attain a coherent analytical understanding of the rapidly-increasing flux of electroacoustic music, one must be able to deal with a wide variety of works, clarifying the target parameters, and constructing a convincing technical understanding through them, as well as finally connecting the technical analysis to its social, cultural, and historical surroundings. These are particularly difficult missions to achieve when the genre of interest is quickly expanding both internally and externally.

Novel Aspects of Electroacoustic Music

Referentiality

As electroacoustic music explores novel expressive possibilities, new musical features arise, which are not necessarily compatible with the traditional notion of music analysis. While many of the current analyses of electroacoustic music focus on reading a hierarchy of sound form, the content of electroacoustic music cannot be simply reduced to a formalistic structure. For example, *Gloria* (1994) by Michel Chion, a highly cinematic, narrative *Musique Concrète* piece in which found sounds are often played with little or no processing, so that their sources and linguistic contents (if they are verbal) are identifiable. How would we be able to fruitfully discuss this piece in a purely formalist manner without taking into account the abundant and extremely evident extra-musical references? Unlike in traditional instrumental genres, in which almost all of the references (if they exist at all) are musically mediated, in electroacoustic music, composers have access to real-life sounds that can create immediate

referentiality, functioning as a signifier of extra-musical objects/concepts through iconic, metaphorical and symbolic relations (McGookin and Brewster, 350). Since the analytical study of music has been evolving around repertoires of reference-free instrumental music, the possibilities of strong referentiality—the unprecedented degree of realism—in electroacoustic music remain an analytical difficulty for music theorists.

Interactivity/Nonlinearity

In more recent years, electroacoustic music has evolved to fully embrace interactivity as an expressive means. Interactive systems are often nonlinearly designed to offer a network of possibilities, through which a listener/performer can navigate oneself. Joel Chadabe's interactive composition, *Solo* (1970), is a good example where the performer and the responsive algorithm share the control over the tempo and timbre of the piece (Chadabe, *Interactive Composing*, 24). In Nick Didkovsky's interactive improvisation, *What sheep heard* (2000), the performer is asked to interact with the algorithmically unfolding melody through 'deep listening.' This indefinite musical structure is particularly prevalent in installation works that offer multiple sonic scenarios with no fixed entrance or exit points in time. Michael Musick's series of *Sonic Ecosystem*s—which take both human and non-human agents equally as a source of energy to drive the virtual sonic ecosystem—well demonstrates this non-linear interactivity of installation arts. As traditional analytical frameworks are focused mostly on explaining a static organization of sound, they are inadequate to explain the flexible nonlinear structure of interactive systems.

Multi-modality

Today's hardware permits the generation of inaudibly low sound, as well as for its fine-control. Cat Hope calls this "infrasound," and remarks that "infrasound is generally considered to be a sound below the audible range for human beings" (Hope, 51). An important ramification of infrasonic music is an exploration of multi-modality between tactility and aurality, as it simultaneously creates an artistic expression through both senses. Technological advances have also made possible different forms of multi-modality. For example, one can now physically couple video and audio beyond the traditional poly-sensory summation of aural and visual information (e.g., opera). Visualization of audio data and sonification of visual data can be easily attained with powerful pieces of software, such as Processing and Max/MSP/Jitter. Consequently, multimedia elements are increasingly becoming a norm for electroacoustic music performance. On the other hand, analytical models are still based solely on listening (i.e., heard structure of music). We are yet to witness the creation of any analytical tools that make systematic sense of this multi-modality of electroacoustic music.

Other features

In addition to the aforementioned referentiality, interactivity (nonlinearity), and multi-modality, there are many other features of electroacoustic music that elude the current analytical approaches. For example, an algorithmic composition blurs the division between a composing system and its composed artifacts and consequently introduces the ontological question of where the music really is and what should be analyzed for musical understanding. In addition, along with the permeation of technological advances, the realm of composition is spreading out into peripheral fields. As the notion of an instrument, for example, has been abstracted into that of interface, the instrument/interface design frequently turns into a part of compositional process in and of itself. Furthermore, producing (mixing/mastering) is increasingly accepted as a legitimate part of composition, as it is so critical that composers are capable of getting the exact sounds they want. These novel aspects of electroacoustic music composition demonstrate how technology and culture merge, and thus exceed the scope of traditional analytical models. To the best of our knowledge, there have not been any comprehensive analytical models that successfully tackle any of the difficulties mentioned above. Therefore, we limit the subsequent overview of analytical models to those that target a fixed organization of reference-free sound units without taking into

account the possible intermediate algorithmic systems between human and composed outputs.

Contesting Perceptual Models and Analytical Frameworks

Although many highlight the absence of a score as a critical analytical problem for electroacoustic music (Park, 167, Delande, 15), the lack of visual representation is only a surface matter. The inapplicability of a score is due to the fact that the compositional process of electroacoustic music often involves fundamentally different assumptions about human listening than those inherent to the score representation. The premises of score-based composition—discernibility of intervallic relation and harmonic progression, their long-term memorability and modularity, and clear registral and timbral segregation of auditory stream, etc.—are often questioned and refuted in the creation of electroacoustic music. Consequently, to build a new musico-operational system for electroacoustic music, one must establish a new set of assumptions about human listening/hearing that are consistent with a different constructional logic. Researchers are approaching this challenge from various perspectives; a multitude of sophisticated perceptual models have been developed in the fields of psychoacoustics, cognitive science, neurology, and Gestalt psychology among others. Unfortunately, there is no single authoritative system as of yet; the analytical approaches for electroacoustic music are sometimes incommunicable with one another, as they are built upon different perceptual models. To cultivate a sense of continuity amongst prominent past achievements, we provide a brief overview, in which the analytical frameworks are grouped into three categories: listening-based approaches, quantitative approaches, and alternative approaches.

Listening-based Approaches

Pierre Schaeffer's notion of a sound object—one of the earliest studies on electroacoustic music—is influential not only as a compositional technique, but also as an analytical discipline. Schaeffer carefully differentiates four modes of listening, which Brian Kane describes as follows: *Écouter*, "an information-gathering mode where sounds are used as indices for objects and events in the world"; *Ouir*, "a disinterested and inattentive mode of passive listening that merely receives globally what is given in perception"; *Entendre*, "a mode of listening that actively selects, appreciates and responds to particular attributes of sounds"; and *Comprendre*, "a meaning-gathering mode of listening where sounds are heard as communicative signs" (Kane, 4). Schaeffer then devises an extensive typology for identifiable sounds, denoted "*TAbleau Récapitulatif de la TYPologie* (TARTYP)" (Figure 1). Schaeffer's early study is particularly important as it offers a complete procedure of technical analysis of electroacoustic music, establishing (1) a perceptual model, (2) a typology (semantic model) of basic sound units, and (3) a morphology of how they operate (assemble and

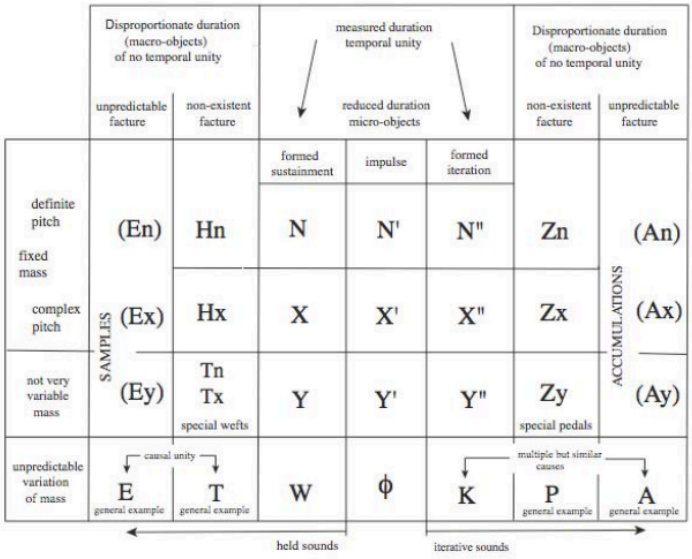

Figure 1. Schaeffer's TARTYP

transform).

Schaeffer's research has greatly influenced subsequent investigations of electroacoustic music analysis. Kane observes the revived interest in Schaeffer's work due to the rising popularity in networked music and concatenative synthesis (1). In addition, the new discourses of Acoustic Event Detection/Classification and Auditory Icon are also contributing to the rekindled interest in the Schaefferian perspective. Delande understands Michel Chion, Lelio Camilleri, and himself as good examples of Schaeffer-influenced theorists of electroacoustic music (15). He aims to achieve a higher level of objectivity by performing multiple listening tests for different modes of listening. The ultimate goal is to identify certain coherence in listening behavior, and to turn it into an improved taxonomy of electroacoustic music (Delande, 25). Chion is well-known for the reinterpretation of Schaeffer's *Traité des Objets Musicaux* in a form of encyclopedia, which serves as a valuable taxonomy of sound object (*Guide to Sound Object*), and Camilleri, in collaboration with David Smalley, proposes three objectives of electroacoustic music analysis from a Schaefferian perspective: the study of how listeners construct their listening, how salient sonic features relate to such listening strategies, and how this musical pertinence turns into signification (5).

Along with the Schaefferian notion of sound object, Smalley's spectromorphology is one of the most cited analytical frameworks for electroacoustic music. In spectromorphology, a piece of work is understood as "texture-gesture mixtures" (Smalley, 114); various categories of texture and gesture, as well as their morphological operations, are accordingly formulated. Through consideration of various perceptual dimensions, such as emptiness, diffuseness, streams, and overlap (121), the operational principles and the basic archetypes constitute an informative spectral space onto which we can project a piece of electroacoustic music. Subsequent studies by Lasse Thoresen combine Schaeffer's concept of sound object with Smalley's spectromorphology to further develop the representational and descriptive power. (Thoresen, 2)

There are novel listener-centered approaches that have been influenced very little by the studies of Schaeffer and Smalley. Simon Emmerson derives abstract syntax from the heard structure of sound and invites the linguistic methodologies to advance the syntactical system, and according to musical types and syntax types, he devises nine different compartments of electroacoustic music as illustrated in the table 1 (Emmerson, 24). This study is important in that it is a pioneering application of the linguistic, mimetic discipline to the analysis of music.

Musical Types	Syntax Types	Examples
Aural discourse dominant	Abstract syntax	Babbitt: *Ensembles for Snythesizer*
	Combination of abstract and abstracted syntax	Harvey: *Mortuous Plango, Vivos Voco*
	Abstracted syntax	Smalley: *Pentes*
Combination of aural and mimetic discourse	Abstract syntax	Nono: *La Fabbrica Illuminata*
	Combination of abstract and abstracted syntax	McNabb: *Dreamsong*
	Abstracted syntax	Parmegiani: *Dedans-Dehors*
Mimetic discourse dominant	Abstract syntax	Stockhausen: *Telemusik*
	Combination of abstract and abstracted syntax	Wishart: *Red Bird*
	Abstracted syntax	Ferrari: *Presque Rien no. 1*

Table 1. Emmerson's categorization of electroacoustic music

Matthew Adkins, in the same vein as Emmerson, discusses electroacoustic music from the perspective of the Neo-Darwinian theory of 'meme': "neuronally-encoded cultural information and their phemotypic products spread through a process of imitation form one individual's memory to another" (Adkins, 1). He identifies four types of memes at different hierarchical levels—structural memes, topic memes, musico-operational memes, and low-level memes. Since the idea of meme is inherently derived from the cultural context, and is applicable beyond aural stimuli, it might open up new methods to discuss the referentiality and multi-modality of electroacoustic music.

In addition, from the perspective of cognitive science, Robert J. Frank propounds a framework that segments electroacoustic music into five basic temporal elements—sustaining, aligned/repeating, aligned/non-repeating, non-aligned/repeating, and non-aligned/non-repeating—and considers their combination and transformation (Frank, 3-4). Higher-level cognition is also being explored. Gary Kendal examines feeling and emotion to explicate the mental process in which meaning arises as the listener experiences electroacoustic music (Kendall, 192). Furthermore, Anıl Çamc includes esthetic and poietic perspectives to design a cognition-based framework for electroacoustic music analysis (Çamc, 1). As theorists of electroacoustic music are actively exploring and utilizing relevant fields, such as cognitive science, neurology, and psychoacoustics, the perceptual models put forward in the future will most likely better reflect how a human senses and processes auditory stimuli in the experience of music.

Quantitative Approaches

While researchers have reexamined and redefined fundamental suppositions about human listening in the context of electroacoustic music, they have also advanced the understanding of music from a quantitative perspective. One of the common motivations behind this movement is the desire to introduce a higher degree of objectivity into electroacoustic music analysis beyond subjective listening. Such efforts have led to now prominent fields, such as Music Information Retrieval (MIR) and Computational Musicology. Park et al., for example, devise a Systematic and Quantitative Electro-Acoustic Music Analysis (SQEMA) that methodically combines quantitative MIR components—Sound Analysis ToolBox (SATB)[5]—with human validation and interpretation. The overarching process is as follows: (1) multiple listenings, (2) multi-level (high-middle-low) analysis including identification of sections, subsections, divisions, and events, (3) reexamination for associations, connections, and correlations, and (4) aesthetic interpretation (166). In addition, the subcomponent of SATB, Sound Event Annotator (SEA), crowd-sources the detection (start-time and end-time), nomination (free tagging), and evaluation (valence and presence) of acoustic events[6]. The approach of SEA is generally in accordance with the Schaefferian typology, although, one notable difference is that it is a bottom-to-top process of collecting the sound taxonomy as it exists in the perception of the public.

Gulluni et al. also combine human judgement and automated machine quantification. On the one hand, their research is similar to the SEA of Park et al.—the most basic musical unit is conceptualized as "the subjective identification of sound objects of interest to the user," and the research is structured to better define the sound objects through a multitude of ground-truth data obtained from human participants (Gulluni, 145). On the other hand, its design purpose is exactly opposite to that of the SEA—the bottom-up crowd-sourcing of the links between concept and sound events. Gullini et al. interactively loop the sound object transcribing process where the machine segments the audio and labels each of the segments, which is evaluated via human feedback (146). This system maximally respects

[5] In the cited paper, this MIR system is called ElectroAcoustic MuSic AnalYsis (EASY). Sound Analysis ToolBox is the improved rendition of EASY toolbox.

[6] http://citygram.smusic.nyu.edu/~citygram/usec/usec_web_survey

the subjective judgment of a single user who is in the interactive loop.

One might question the rather large swath of common ground between the quantitative approach and the listener-centered approach. We suggest, however, that these categories are not mutually exclusive. There are quantitative methods that are solidly based on models of human hearing. In one instance, Simoni et al. employ the perceptual model of ASA[7] as the basis for their analytical system (333). A quantitative technique of multi-band pitch-tracking is then applied to detect recognizable pitches from Paul Lansky's *Late August* (1990), and they borrow post-tonal set-theory techniques to make structural sense of the found pitches.

While the examples above try to merge quantitative methods and human interpretation into a complete framework, there are various practical applications whose purpose is supplementary, simply serving to aid music analysis. Pierre Couperie, for instance, has devised a quantitative toolbox—called *EAnalysis*—for the better visual representation of electroacoustic music. The toolbox is composed of various modes of scalable representation (e.g., sonogram, similarity matrix, BStD graphs, etc.).[8] Similarly, *Acousmographe* by Inagram allows a clear and intuitive visual representation of an input musical signal by presenting a well-scaled spectrogram.[9]

Alternative Approaches

While recent analytical studies have largely focused on understanding human listening and exploring quantitative techniques, Leigh Landy cautions that electroacoustic music analysis is biased towards technical aspects, which has the consequence of marginalizing other critical aspects of music—most notably, historical musicology and ethnomusicology (Landy, 68). However, despite this heavy bias, alternative possibilities are being examined. Denis Lorrain began pioneering an application of the musicological approach to electroacoustic music in his analysis on Jean-Claude Risset's oeuvre.[10] Along the same lines, Laura Zattra, for analytical purpose, looks back to the composer's intentions and intuitions and examines historical data, denoting this methodology "genetic approach," "poietic approach," or "philological approach. Analyzing *Stria* (1977) by John Chowning, Zattra adopts this strategy, actively taking relevant artifacts, such as digital and audio sources of a piece, as valid analytical evidence. In so doing, she traces a multitude of assembling stages of *Stria* (Zattra, 42). This poietic approach is important in that it underlines the multidisciplinary nature of electroacoustic music analysis, and brings the musicological methodologies back to the discussion of electroacoustic music.

Finally, there are modern analytical models for New Music that are applicable for electroacoustic music, since they often deal with repertoires that defy the assumptions of traditional tonal analysis and post-tonal set theory. Among them, Fred Lerdahl and Ray Jackendoff's generative theory of tonal music has earned wide recognition. Drawing inspirations from Psychology and Linguistics, they formulate a generative grammar that aims for "a formal description of the musical intuitions of a listener who is experienced in a musical idiom" (Lerdahl and Jackendoff, 1). Although this framework is focused on the interpretation of tonal structure and is largely based on the score representation, the basic principles of systematic grouping are applicable across different genres.

James Tenney and Larry Polansky's model is another good example. They embrace hierarchical Gestalt psychology and apply it to

[7] Albert Bregman's theory of Auditory Scene Analysis (ASA), having evolved from Gestalt theory, has been established as a viable model of human auditory perception in the recent decades. The basic principle is that the human brain tends to group any complex sound patterns into distinct streams based on auditory similarity and proximity (Bregamn, 10).

[8] http://logiciels.pierrecouprie.fr/?page_id=402

[9] http://www.inagrm.com/accueil/outils/acousmographe

[10] Lorrain, Inharmonique: analyse de la bande magnetique de l'oeuvre de Jean-Claude Risset

make sense of musical structure. The basis unit is "temporal gestalt-units" defined as follows: "[…] distinct spans of time—at several hierarchical levels—each of which is both internally cohesive and externally segregated from comparable time-spans immediately preceding and following it" (Tenney, 205). Temporal gestalt-units are segmented according to proximity and similarity, and they constitute a hierarchy of multiple layers. Although these systems are not specifically for electroacoustic music, they have been influential in the study of electroacoustic music analysis.

Lack of Socio-Historical Contextualization

As Hugh Davies observed as far back as the 60s, electroacoustic music as a genre was fragmented from the very beginning, simultaneously emerging throughout the 40s and 50s in different locations: "This proliferation of different names for what is basically the same kind of music shows that a considerable number of composers in different countries are all trying to find a workable idiom" (Davies, 8). Arguably, the most notable centers of electroacoustic music at its infantile stage were the *Groupe de Recherches Musicales* (GRM) in Paris, the Studio for Electronic Music of the West German Radio in Cologne (WDR), and Columbia-Princeton Electronic Music Center (CPEMC) on the east coast of the United States (Manning, 19). There were also other vibrant, but often less-credited laboratories of electroacoustic music, such as the *Studio di Fonologia Musicale di Radio Milano* in Milan and the NHK studio in Tokyo (Chadabe, *Electric Sound*, 43). The pioneers at these institutions approached electroacoustic music from widely varying perspectives. Various taxonomies, schools of thoughts and communities thus developed independently in a disjointed manner.

In addition to its fragmented origins, electroacoustic music flourished only after the disintegration of the common practice of tonality, without inheriting the general historical narratives—that connect Bach, Beethoven, Brahms vs. Wagner, Schoenberg, and Boulez vs. Cage in a chronological scheme—of Western music. The genre thereafter developed in terms of both technological and musical aspects at an unprecedentedly rapid pace. Landy recognizes the difficulty of meaningful analysis of electroacoustic music due to this lack of historical continuity: "Although electroacoustic music is not really the antithesis of its predecessors, as this particular author would hope to believe, a synthesis can still be reached […]" (69). Moreover, in recognition of the dearth of interest in non-technical aspects of electroacoustic music, You et al. propose that the historical, social, cultural surrounding too must be preserved and investigated to cope with a piece of electroacoustic work in its proper context (194).

Despite the importance of historicity in analysis, so far, there have been only a few notable large-scale historical discourses on electroacoustic music, which include Peter Manning's *Electronic and Computer Music*, Thom Holmes' *Electronic and Experimental Music: Technology, Music, and Culture*, and Joel Chadabe's *Electric Sound: The Past and Promise of Electronic Music*. Although these are all prominent achievements in their own rights, the focus is largely on accurate reporting about composers, works, and technologies. A sense of continuity between historical events, however, does not automatically arise from the chronological juxtaposition of hard facts. Since electroacoustic music contains technology at its core, to better understand the continuum of socio-historical processes of the genre, one would have to take into account how technology and culture have been mutually mediated over time. Analytical connections between the intrinsic content and the extrinsic context of a piece of electroacoustic music can be convincingly made only when it is situated in its proper socio-historical background.

Lack of Organizational/Archival Efforts

Given the numerous conferences and festivals dedicated to electroacoustic music, one might be made to believe that electroacoustic music repertoires are ubiquitous and easy to obtain. However, it frequently turns out to be difficult to acquire a proper version of a particular piece of electroacoustic music. In the case of score-based music, the preserving medium, the score, is generally agreed to contain a sufficient level of information, which constitutes a composition. More importantly, the preserving medium is

often equal to the actual creative output, as a composer creates a piece of music by means of constructing a score. On the other hand, a piece of electroacoustic music tends to be scattered across varying media—source code, custom programs, custom instruments/interfaces, fixed tape-parts, and many others. In addition, it is not uncommon that a piece of electroacoustic music is integrally bound to pieces of hardware and software in a highly specific manner, and is therefore prone to obsolescence as the technologies get lost (e.g., Amiga, floppy disk, etc.). The current situation makes it difficult for music theorists to test the universal explanative power of their analytical frameworks on the lesser-known contemporary works of electroacoustic music. To facilitate theoretical and analytical discourse, systematic electroacoustic music archival is a crucial prerequisite.

Hugh Davies' *Electronic Music Documentation 1961-8* is the earliest example of electroacoustic music archiving (Mooney, 2). As the title suggests, the goal was extremely ambitious: the documentation of all the electronic music pieces that had been written during the stated period. This type of one man's job quickly became impossible, as the quantity of electroacoustic music exceeded a humanly trackable level, and so electroacoustic music archival has stagnated. The International Digital ElectroAcoustic Music Archive (IDEAMA), for example, was initiated in 1988 by Max Mathews, Johannes Goebel, and Patte Woodis at CCRMA, however, the project—which focused only on early, endangered electroacoustic works—was too limited in scope to serves as a general-purpose archival resource. In addition, there have been unorganized and small-scale archiving efforts like the Free Music Archives[11] and various personal electroacoustic music webpages and accounts (e.g., Youtube, SoundCloud). These projects are, however, often dubious in terms of their reliability and sustainability. In summary, we have not seen any large-scale, systematic, sustainable archival resource for electroacoustic music until very recently.

ElectroAcoustic Music Mine (EAMM)—a project led by Tae Hong Park—invites, collects, connects, and explores the social, cultural, and historical relations amongst contemporary electroacoustic works. The project crowd-sources the filtering system of the major agencies of electroacoustic music—notably, the Society of ElectroAcoustic Music in the United States (SEAMUS, International Computer Music Association (ICMA), and the New York City Electroacoustic Music Society (NYCEMS) (You et al., 197). Once a composer agrees to participate in archiving his or her work, he or she is asked to provide detailed metadata of the piece, including technical details such as codes, custom interfaces, custom hardware, and so on. This extensive, flexible list of metadata covers the unique diversity of electroacoustic music as it is practiced in the contemporary musical context. Once solidly established, the EAMM project is expected to serve as the first general-purpose electroacoustic music archival resource and exploration system.

Conclusion

We have identified various challenges in the analysis of electroacoustic music, which is rapidly evolving and expanding, so that its new features—such as nonlinearity and multi-modality—frequently lie beyond the boundaries of the traditional sense of music analysis. Admittedly, we have not discovered a viable solution that properly tackles all of the aforementioned problems, and it is clear that more work has yet to be done. However, even if we limit our analytical task to a more traditional model that targets a fixed organization of sounds, pressing issues linger. Currently, there exists a multitude of contesting perceptual models and analytical frameworks with no solid agreement. The historical discourse on electroacoustic music is focused more on reporting hard facts than on looking into the mutual mediation between technology and culture. What makes the socio-historical contextualization of electroacoustic music even more difficult is the absence of a large-scale organizational/archival effort.

[11] https://freemusicarchive.org/genre/Electroacoustic/

Finally, an important missing link in electroacoustic music analysis is, in fact, the dearth of overviews of past analytical projects, which leads to a discrepancy in chronological and thematic continuity between the studies thus impeding the development of the field. Therefore, we have organized various analytical frameworks in response to the challenges of electroacoustic music analysis addressed, and highlighted the connections between them. This paper is neither an exhaustive nor a systematic overview; rather, it is designed to serve as a humble beginning step towards a better organization—as well as a comparative evaluation—of analytical models for electroacoustic music. More comprehensive organizational efforts will allow future researchers of electroacoustic music analysis to successfully build upon prominent past achievements.

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Conference Review: SEAMUS 2018 at University of Oregon

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The Society for Electro-Acoustic Music in the United States (SEAMUS) mission is to promote and support electroacoustic music practice in the United States. The SEAMUS annual conference features many flavors of electro-acoustic music practice: a celebration of acousmatic sound through musique concrète, immersive multi-channel spatialization, music for live performance and electronic music, interactive music, innovative performance technologies, and multi-media work.

Drs. Jeffrey Stolet and Akiko Hatakeyama hosted SEAMUS 2018, a three-day showcase of electro-acoustic music concerts, papers, workshops at the University of Oregon School of Music and Dance in Eugene, Oregon from March 29-31, 2018. The entire SEAMUS 2018 team ran the conference impeccably, welcoming attendees from across the country, managing twelve elaborate concerts alongside paper presentations, workshops, installations and listening rooms. Eugene, Oregon provided a beautiful vibrant setting with a bounty of meeting spots to catch up with colleagues and meet new friends.

It is beyond the scope of this review to report on all works presented, so I include a few highlights to feature the variety in programming. For the full list of presenters, please visit the conference information website (www.seamus2018.org). For the CD release of music from SEAMUS 2018 on New Focus Recordings, please visit https://www.newfocusrecordings.com/catalogue/music-from-seamus-vol-28/. This volume is a result of ballot voting by SEAMUS 2018 attendees and is produced and remastered by Scott Miller, SEAMUS Director of Recordings.

In Concert One, Jonathan Morgan performed *Pivot* for viola and electronics by Dan VanHassel. The augmented viola resonated in this energetic interactive performance that alternated between lyrical lines and rhythmic patterns. *Rust* for audio fixed media by Eli Stine featured an enveloping, unfolding narrative with delicately placed environmental sounds in a visceral cinematic experience. Evoking pop vocaloid characters, *"Red" for Csound, Vocaloid and Elaine* for audio fixed media by Joseph Chen compiled futuristic, space-age vocal samples in a quasi-dramatic operetta format.

Concert Two featured the first in a collection of presentations featuring data-driven instruments, a signature research area and practice at the University of Oregon's School of Music and Dance. Michael Musick performed his own *Ecosystemic Improvisation System No. 3* for data-driven instrument in an energetic and playful improvisation of morphing rhythms with sweeping, overlapping filters. Sarah Pyle (piccolo) performed Annie Hui-Hsin Hsieh's *The Warmth of the Nebula*, which explored both the physical and sonic space of the venue. The performance created an ethereal atmosphere with breath-like sounds in the electronics and a spotlight on audible "quiet" sounds in a captivating ebb and flow of sound. In *A Strange Diversion* composed and performed by Brian Belet and Stephen Ruppenthal on data-driven instruments, cowboy "beat-bop" complete with costumes took the stage in a compelling pairing between a Buchla system and KYMA spinning out tales between the two instruments. Caroline Miller's *Subsong* certainly sang through the Genelecs with the subwoofer producing entrancing low end and glitch elements, vocal fragments, deconstruction, and reconstruction woven together. The piece was a striking companion to Miller's paper presentation, "Texture, Materiality, and Sensation in the

Digital Production of Electronic Dance Music Subgenres."

Concert Three featured an impressive collection of data-driven instruments, audio-visual, and instrument/voice plus electronics pieces. *Mandala* by Cecilia Wu showcased stunning, effervescent visuals and music. Simon Hutchinson and Paul Turowski's playful *Plurality Spring* featured an innovative interactive graphic score that engaged us not only in the music, but also in rooting for the performer's gaming success. In Jacob Sudol's *…a darker down*, electroacoustic timbres augmented the extended techniques of Sarah Viens' trumpet in a beautifully layered textural piece. In Concert Six, Zachary Boyt gave an energetic performance of his piece *unFamiliar* through tethers, timbral control, and ambisonics. Hong Hong Gianakon graced the stage in a beautiful performance on the *pipa* in *Behind the Back* by Timothy Roy*,* a 2018 ASCAP/SEAMUS Finalist. David's Gedosh's *Guitar Construction #3: Hg-Cr-As* explored changing sonic states and landscapes. Heather Stebbins expertly combined a collage of vivid static, machine, mechanical sounds, and sine tones in a captivating *what I am not*. Concert Seven showcased *Striate* by Timothy Paige, the 2017 ASCAP/SEAMUS First Place Winner. T.J. Borden animated the stage with the "timpani-enhanced cello" in a vibrant rendition of the piece. An audio-visual delight and a highlight of the conference, the innovative, physical, and virtual-world, *Within, Above and Beyond,* by Russell Pinkston and Yuliya Lanina blended Lanina's dance performance, large-screen projected animation, and Pinkston's transformational sound worlds.

Concert Eight celebrated SEAMUS Award Recipient, Scott A. Wyatt, with a showcase of his pieces. This concert also featured a performer-curated concert by Transient Canvas composed of Amy Advocat (bass clarinet) and Matt Sharrock (marimba). Transient Canvas performed their program, *Wired*, "a portrait of technology's integration into modern life." Through their concept album performance, Transient Canvas was captivating with dynamic and stirring interpretations of pieces by Peter Van Zandt Lane, Kirsten Volness, David Ibbett, Mischa Salkind-Pearl, and Dan VanHassel. Advocat and Sharrock nimbly shifted between various genres, technology setups, hybridized instruments, and playing styles. Through this exciting collection of pieces, Transient Canvas presented a wide range of musical references "from Aphex Twin to electronic dance music" traversing rhythmic complexity, jazz influences, rich electroacoustic textures, lyricism, minimalist/ambient and noise elements along the way.

Awe, revelation, and delight were all palpable when Scott Wyatt's *In the Arms of Peril* filled the concert space through the eight-channel performance system. Also present were generations of former students, admirers, and audience members to honor Wyatt for his inspiration, mentorship, and artistry. A sonic revelation and virtuosic feat, *On a Roll* for fixed media and eight-channels, immersed listeners in 3D sonic play including delicate details realized through the custom miking techniques, the illusion of spinning and rolling, illuminating textures, and a sense of voyage through a hyper sound designed space. Crystal Chu performed *Time Mark* for solo percussion and two channel electroacoustic accompaniment. Chu's musicality and vibrant playing style paired synergistically with Wyatt's combinations of acoustic and electroacoustic timbre and texture. Chu's performance electrified the space to a roaring applause and a long-standing ovation in deep appreciation of Wyatt's artistry and invaluable contributions to the field of electroacoustic music.

Concerts Ten, Eleven, and Twelve continued to showcase a variety of electroacoustic music. Concert Ten featured Christopher Jette's *Wimal* for fixed media in a richly quiet backdrop articulated by layers of vivid sounds. Christopher Poovey's *only through fractures may light shine* featured Josh Lambert on Contrabass. Poovey's piece seamlessly combined the grit of extended techniques on the bass with a sound world of beautiful scratch, crunch, and resonant fragments. Alexis Evers performed Mengjie Qi's *Spirit of Sword* for flute and electronics. Qi crafted a duet that unfolded from elaborate extended flute sounds leading gusts of resplendent layered electronics. Becky Brown's performance of layered text and vocals in a cathartic *Tomorrow, When I Grow Up: i. the*

empties, was mesmerizing and moving. Concert Eleven featured Abderrahmán Anzaldúa performing Aaron Hynds' *SID6581* for violin and electronics, a hyper-instrument sequence of dynamic, rhythmic, driving glitch textures. Akiko Hatakeyama's unforgettable ち- *chi* for candles, live voice, and sounds was a transporting, visually stunning, sonically enthralling multi-sensory experience. The piece unfolded just as Hatakeyama describes, "the performance is a way of purification through a ritualistic sharing of the space, time, and experience being in the environment. The warmth, smell, sight, and sound all speak to us." *The Frost Performs its Secret Ministry*, a collaboration between Scott Miller and Mark Zaki for audio video fixed media combined intricate, crystalline, tactile qualities through enthralling fractal-inspired visuals. In Concert Twelve, Chi Wang's performance of *Peony Garden* for data-driven instrument was captivating with suspended wiimote controllers creating a fantastical sonic garden of reimagined *Kun* Opera. Kyong Mee Choi's *Train of Thoughts* for fixed media was an evocative journey through brilliantly juxtaposed sound source pairings. *Chasing Alse Young* for drumset and electronics by John Thompson maximized the palette of the drum set, performed by Matt Fallin. The electronics, seeming to bloom from each drum stroke, created a splendid augmented instrument.

Each year, the SEAMUS conference offers an abundant display of electroacoustic music from all over the globe. In all of this music lies a treasure trove of distinctive compositional and performance approaches, a vehicle for exploration and innovation, and sounds that stir our imaginations. This SEAMUS 2018 conference provided an exceptional opportunity to celebrate the history, development, and futures of electroacoustic music practice.

The Berklee College of Music and Boston Conservatory at Berklee will host SEAMUS 2019 from March 21-23, 2019.

Environmental Sound Artists: In Their Own Words
Edited by Frederick Bianchi and V. J. Manzo

234 pages, Oxford University Press, 2016, $36.95 (paperback)
ISBN: 9780190234621

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Artistic depictions of the environment are much more than simple recreations of the world around us. The way artists respond to the places they inhabit gives us a window into their understanding of their own identity: how they situate themselves and their work among the complex intersection of the physical—the natural and human-built environment—with the social, political, aesthetic, and historical currents that flow through their contemporary moment. The landscapes of Albert Bierstadt and others in the Rocky Mountain School give us not just magisterial views of the American west but a window into the *zeitgeist* of nineteenth century America, in which God and nature are one and the same. The "grand opera" style of painting captures the wonder and pride that society felt in the American Eden; as Barbara Novak argued, such paintings "augmented the American's sense of his own unique nature, his unique opportunity, and could indeed foster a sense of destiny" (Novak 2007).

Nowadays, when artists turn their focus to nature, they are likely to see a more mechanistic world, informed by our own age's passion for hard data and a scientific mindset. And rather than limitless potential and a vast canvas for our ambitions, we tend to see in nature the need to preserve what may be lost before long. Art in the age of climate change is more humble, and more pessimistic.

Not that there's no room for wonder. As the works presented in the valuable new collection of essays *Environmental Sound Artists: In Their Own Words* prove, we are if anything perhaps more disposed to appreciate the beauty and uniqueness of natural spaces as they are increasingly pushed aside by human encroachments. As the collection also shows, we are learning to listen and look closely, to appreciate the beauty not simply in the vast and the unsullied, but in smaller, unexpected spaces.

What does it mean to be an "environmental sound artist?" In an insightful and erudite introduction, Jonathan Gilmurray calls environmental sound "a specific *conception* of sound in which it is defined by its environmental context: thus, the tweeting of birds and the rustling of leaves in the wind are part of the environmental sound of a forest; the hum of air conditioning and the tapping of computer keyboards are part of the environmental sound of an office." Environmental sound *art,* then, is "a collection of artistic practices in which environmental sound constitutes the medium, material, and/or subject matter for the work." In tracing its aesthetic and technical origins, Gilmurray touches on evidence from the science of archaeoacoustics, antecedents in art music from the sixteenth through nineteenth centuries, the early twentieth century expansion of music's sonic palette to include found sounds of urban spaces, the development of the electroacoustic discipline, and advances in sound and recording technology, illustrating his discussion with both well-known works and ones I was happy to discover. His division of environmental sound art into "site-specific," "field-recording", "sonification-based," and "environmental*ist*" categories, with accompanying differences in techniques, aims, and effect, forms a useful framework for approaching the works in the volume, as well as the analysis of sound art in general.

In their preface, editors Frederick Bianchi and V. J. Manzo write that they aimed to create "[a] collection of individualized and introspective writings that, when taken as a whole, coalesce into a body of writings that offer a penetrating and self-examining view of environmental sound art. This is not a book of hymns but an encyclopedic journey exploring the multiplicity, assortment, conviction, and range of ideas as articulated by the artists. The essays contained in this book are extensions of the artists' creative work." The voices represented here are indeed diverse, juxtaposing eminences of the worlds of experimental and electroacoustic music with emerging artists and those from other related fields. Many of the essays take the same basic format, beginning with the general aesthetic principles and animating concerns in the composer's work, often coupled with a personal narrative of how the composer acquired these particular interests; then, the specifics of one or more works are examined.

One of the most interesting threads to follow among these essays, and the best-represented, is the link between sound art and science, particularly in Gilmurray's "environmental*ist* sound art" strain. Connections to hard science and technology have, almost by definition, been part of the electroacoustic music tradition since its inception. As our society continues to grapple with technology as a change agent for both good and ill, interdisciplinary works that straddle the art-science divide would seem to only increase in relevance.

Andrea Polli, for instance, notes that in a world with increasing masses of data on environmental phenomena, there is a need for "a language or series of languages for communicating this mass of data." Her work *Heat and the Heartbeat of the City* (2004) seeks to make the threat of climate change tangible to listeners by using projected models of future weather to sonify the increasing number of consecutive ninety-degree days in New York City's Central Park. Through his use of sound sculptures, Bernie Krause explains that he can vividly recreate "the unfolding of wild soundscapes in the real world of terrestrial landscapes." Such vividness allows him to illustrate the unique aural characteristics of a "healthy state" ecosystem, and in this way an abstract scientific concept is made powerfully tangible.

Some composers take the art-science link further, imagining works that not only communicate scientific truths to the listening public, but actively participate in the process of scientific discovery itself. Marty Quinn demonstrates that his work on sonifying complex streams of data with musical representations has the potential to allow scientific observers to perceive patterns in those data much more effectively than through purely visual means such as tables or graphs. In David Dunn's work, sound art becomes explicitly utilitarian: by recording the sounds of pinion engraver beetles in an infestation of New Mexico pine trees, and then playing those sounds back combined with chaotic, non-repetitive sounds, he effectively overloaded the beetles' cognitive function, stopping reproduction, feeding, and tunneling.

Another group of works prods us to notice more carefully the world around us, and thereby to inhabit it more fully. John Luther Adams discusses his acclaimed multimedia environment *The Place Where You Go to Listen* (2006), which represents weather data, daylight and darkness, seismic activity, and geomagnetism of the Alaskan wilderness via sound and color to create a "contemplative space for tuning our ears to the unheard resonances of the earth and sky." Matthew Burtner, too, cites the inspiration of his native Alaska. In his *Six EcoAcoustic Quintets* (2010) he realizes his vision of "bring[ing] the fundamental systems of the natural world into music" by having the musicians perform with ice, water, sticks, leaves, stones, and sand, literally merging nature and the concert hall. But the environments need not be the awe-inspiring wilderness: Philip Blackburn reports on an ingenious use of speakers to activate the natural resonance of the sewers of St. Paul, MN as a way to encourage citizens' awareness of their everyday environment. Joseph Bertolozzi, too, uses the built environment as a musical instrument in *Tower Music* (2013) and *Bridge Music* (2009), album-length compositions made of samples recorded while striking the components of the Eiffel Tower and the Mid-Hudson Valley Bridge in Poughkeepsie, NY.

Finally, there are those who are inspired by the idea of humans-in-place. Ximena Alcarón creates a virtual landscape by documenting commuters' memories of soundscapes in the metros of London, Paris, and Mexico City. Chris DeLaurenti, in a fascinating essay on recordings made at the protests surrounding the 1999 World Trade Organization meetings in Seattle, WA, explains that after initial experiments with recording natural soundscapes rang hollow, he found his own version of field recording ran through "protests, testimonies, and other pertinent sonic materials of social change."

The cumulative effect of these essays and the others that comprise the volume is as if the reader were keeping company with a group of composers talking shop, a virtual conference on the techniques, the meanings, and the possibilities of environmentally-based composition. The authors' preface provides a brief overview of what each artist is up to, and the reader looking for information on specific approaches will use it as a way to access information quickly. The volume is well-indexed, too, allowing for searches on, for instance, "data sonification" or "deep listening."

Plentiful illustrations of scientific data, photographs of installations, and site-based artwork accompany each chapter. One issue for which there is no easy solution is the availability of recordings, videos, and other documentation that can make these works come alive for the reader. The only true way, after all, to experience a site-specific work is to visit the site. Aware that URLs can change, the volume opts not to include web resources, leaving it to the reader to Google what may be out there.

Still, as the editors note, the concept of these pieces is sometimes just as thrilling as the event itself and the reader will find plenty to fire the imagination. As a timely anthology of primary documents from working artists, these essays will serve as blueprints for many further compositional developments. With time, too, it will remain a valuable document, a catalogue of the possibilities artists see in responding to the environment, and our historical moment, through their work.

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